A Taste of Their Own Medicine: 
Guideline Adherence and Access to Expertise

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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, controlling for demographics, income, and education, 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.

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1 Introduction

Widespread non-adherence to medical guidelines is believed to contribute to a large number of hospitalizations, deaths, and health care spending each year (Neiman 2017). 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, lack of trust or communication in the patient-provider relationship, and financial barriers such as copayments (Alpert 2010; Aslani et al. 2019; Bosworth 2012; Neiman 2017).

Different explanations for guideline non-adherence suggest different approaches to increasing adherence. For example, the hypothesis that non-adherence results from complexity or limited information has motivated 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). Likewise, the hypothesis that financial barriers are important for non-adherence has motivated efforts to reduce or eliminate copayments (Choudhry et al. 2011; Volpp et al. 2015).

In this paper, 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. Patients with access to expertise are likely to be better informed, better able to make decisions, and better able to communicate with their medical providers. If ignorance, complexity, and patient-provider communication or trust are important barriers to adherence, then it is reasonable to expect that patients with access to medical expertise will tend to be more adherent. However, we find the opposite.

We assemble rich administrative data on the entire population of Sweden from 2005 through 2016, including detailed information on pharmaceutical claims. We measure adherence to 63 government-issued prescription drug guidelines. These include 6 guidelines related to antibiotics (e.g., to start with a narrower- rather than a broader-spectrum antibiotic to combat a urinary tract infection), 20 guidelines specific to the elderly (e.g., to avoid certain sleep medications), 20

\[1\] For example, only a minority of patients adhere to the recommendation to take high-intensity statins following myocardial infarction (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).
guidelines related to specific diagnoses (e.g., to take statins after a diagnosis of transient ischemic attack, otherwise known as a mini-stroke), and 17 guidelines on medication use during pregnancy (e.g., to avoid certain antibiotics).

We use information on a person’s completed education to determine if they are a doctor. We use a population register to link doctors to their relatives. In our baseline analysis, we classify a patient as having access to medical expertise if the patient is an adult and a doctor or married to a doctor, a child whose parent is a doctor, or an elderly person whose child 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. The association strengthens when we control for education and income, as we do in our baseline analysis. Among the 63 guidelines that we study, the association between access to expertise and adherence is negative in 41 cases and statistically significant in 20 of these. 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 its prevalence in the population. We estimate that while the average patient without access to expertise adheres to 54.4 percent of guidelines, one with access to expertise adheres to 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. We find lower adherence among those with access to expertise in all major categories of guidelines we consider. The association between access to expertise and adherence becomes less negative if we broaden the definition of access to include having a doctor in the extended rather than just close family, or if we broaden the definition of expertise to include other medical professionals (i.e., nurses and pharmacists) who are not doctors.

We consider several explanations for these findings. We first consider a potential role for unobserved socioeconomic differences between those with and without access to expertise, despite our inclusion of rich controls for income and education in our baseline analysis. We show that across a
wide range of occupations, there is a positive association between the incomes of those with access to members of the occupation, and their adherence to guidelines. The major exception is doctors and their relatives, who tend to have relatively high incomes but relatively low adherence. We therefore think it unlikely that unobserved socioeconomic differences explain our finding. We also argue that unobserved differences in underlying health are unlikely to explain our finding.

We next consider the possibility that access to expertise leads to greater comfort with pharmaceutical solutions to medical problems. We do find some evidence that 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 pharmaceuticals.

The last possibility we consider is that access to expertise gives patients superior information or confidence, which can lead 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, among the major categories of guidelines we consider, the association between access to expertise and adherence 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. Another piece of evidence is that the adherence gap between those with and without access to expertise is greater for guidelines with weaker clinical support. Among pregnant women, access to expertise is associated with only one percentage point lower adherence to guidelines recommending against drugs classified in category D (which are contraindicated in pregnancy), but two percentage point lower adherence to 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 UpToDate as based on weaker evidence.

Our paper contributes 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. 2019a; 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 recent literature compares the health outcomes of doctors and their families to those of the general population (Chen et al. 2019b; 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 other U.S. military personnel to use various types of low-value and high-value medical care (as defined by the health policy community). They find that physicians are only slightly more adherent (i.e., more likely to avoid low-value care and 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. In contrast to Frakes et al. (2021), in a different setting and focusing on different guidelines, we find that doctors and their families tend to be less adherent to guidelines.

More broadly, our paper contributes to a literature comparing expert and non-expert behavior, including in the contexts of 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. Since 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, more informed patients may be overconfident or otherwise mistaken in deviating from guidelines. Abaluck et al. (2020), Cuddy and Currie (2020), and Currie and MacLeod (2020), among others, find evidence that practitioners’ departures from prescribing guidelines lead to worse patient outcomes.

The remainder of the paper is organized as follows. Section 2 presents our data and empirical

\[2\text{Relatedly, Abaluck et al. (2020) use data from clinical notes to argue that most departures from clinical guidelines do not stem from practitioners’ unawareness of these guidelines.}\]

\[3\text{Alpert (2010), for example, argues that evidence-based “guideline-directed therapy for a particular condition has been shown to lead to better clinical outcomes compared with ‘eminence-based,’ personally derived, therapeutic strategies.”}\]
approach. Section 3 presents our findings and discusses their interpretation. The last section concludes.

2 Data

2.1 Population and Characteristics

The backbone of our data is a population register consisting of all individuals residing in Sweden from 2005 through 2016. The register 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. The register also includes information linking each individual to his or her spouse or cohabiting partner with whom they have parented a child. Hereafter, we refer to this 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 administrative records (Statistics Sweden n.d.). From the education records within this database, we obtain information on each individual’s highest level of completed education 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 for our analysis. 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, and treating those with missing municipality information as a separate category. 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, for each individual and year, a measure of pre-transfer income, using the half the sum of parents’ 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. We construct a categorical variable indicating the (integer) percentile rank for those with positive income, with separate categories for those with zero income, negative income, and missing income.

2.2 Medical Records

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

For each individual in the register, 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 7-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 observe the mother’s due date and the baby’s gestational age at birth (in days); from these, we infer the date the pregnancy began (by subtracting 280 days from the due date), and the date the pregnancy ended (by adding the gestational age to the date of conception). To form control variables for sensitivity analysis, we follow Chen et al. (2019b) 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 guideline.

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 of 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.\textsuperscript{4} We analyze the 46 of these for which we can measure adherence in our data.\textsuperscript{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.\textsuperscript{6} Sweden’s national formulary (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.”\textsuperscript{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.

For some analyses, we group guidelines into one of four mutually exclusive and exhaustive categories: 6 guidelines covering the use of antibiotics, 20 covering medication use by the elderly, 20

\textsuperscript{4}We obtained this information from \url{www.vardenisiffror.se}, Indikatorer (indicators), Lakemedelsbehandling (drug treatment), and from Socialstyrelsen (2010).

\textsuperscript{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).


\textsuperscript{7}B-class drugs include those whose text indicates that prescribing during pregnancy should be done “only when clearly needed” or “with caution.” 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 \url{https://www.fass.se/LIF/menydokument?userType=0&menyrubrikId=124}. Translations via GoogleTranslate.
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.

For other analyses, 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 classify guidelines covering the use of antibiotics in this way, as they advocate taking one drug over another. Appendix Tables 2–4 provide additional details on how we classify “don’t take” and “do take” guidelines.

Lastly, we group 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 or not.\footnote{UpToDate uses the system of ratings developed by the Grading of Recommendations Assessment, Development and Evaluation working group; see \url{www.gradeworkinggroup.org}. For 13 guidelines we are unable to obtain a rating from UpToDate.} UpToDate is a US-based publisher of clinical decision support tools for practitioners. A recommendation given a 1A rating is a strong recommendation based on the highest possible quality of evidence. Appendix Tables 1–4 provide additional details on the classification of guideline strength.

### 2.4 Measuring Adherence

We use the medical records data to measure adherence to prescription drug guidelines. To do so, 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 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 26 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 in our data. 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 20 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.

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. For example, for the guideline against taking C-class opioids during pregnancy, the risk set consists of pregnancies in which the mother purchased C-class opioids during the 24 months prior to conception. Adherence is an indicator for not purchasing C-class opioids during the pregnancy.

### 2.5 Averaging across Guidelines

We will analyze and present results separately for each guideline. For many analyses it will also be useful to average results across guidelines into a single summary statistic. When we do so, 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 average across guidelines, weighting 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 genders. The resulting

\(^9\)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.
summary statistics on guideline adherence should be interpreted as reflecting the average, lifecycle experience of a (hypothetical) person who lives each age of life, from 0 through 85, during our sample period.

2.6 Descriptive Statistics

The sample for our analysis consists of individuals aged 85 or younger for whom we have valid information on completed education. Our data include 5,887,819 such individuals who fall into the risk set for at least one guideline over the 2005-2017 period during which we measure prescription drug purchases. Of these individuals, 149,407 have access to expertise at some point during the sample period.

The share of the population in the risk set ranges from 7.6 percent for the guideline that children should use penicillin V for their first antibiotic treatment against a respiratory tract infection (as opposed to starting with a broader-spectrum antibiotic), to 0.003 percent for the recommendation against using anti-epileptics during pregnancy. 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, which is not surprising, given the existence of elderly-specific guidelines as well as the greater share of medications consumed at older ages. Appendix Figure 1 shows the age and gender-specific patterns of guideline prevalence in more detail.

Non-adherence to guidelines is common in our data, but rates of adherence vary considerably across guidelines. Among those without access to expertise, adherence ranges from 20.4 percent for the recommendation for individuals age 50 and older to take osteoporosis medications in the 12 months after a fracture diagnosis, to 98.8 percent for the guideline against taking D-class tetracyclines (antibiotics) and progestogens (hormones) during pregnancy. On average, over their life cycle, an individual without access to expertise adheres 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.

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10 Requiring valid information on completed education excludes 2.4 percent of the individuals who fall into the risk set for at least one guideline.
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% 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 in each row is the set of patient-years in the risk set. Standard errors are clustered at the patient level for any guidelines for which a patient appears in the risk set more than once, and are heteroskedasticity-robust otherwise. The set of baseline controls are indicators for income percentile, the calendar year and month at which we start measuring adherence, and indicators for age in years, gender, highest level of education, municipality of residence, and the number of children previously born to the person (zero for males).\footnote{Individual-years for which income is missing, zero, or negative, which we include in the analysis and treat as separate categories, represent 7.5, 3.0, and 3.5 percent of the final analysis sample. Individual-years for which municipality of residence is missing, which we include in the analysis and treat as a separate category, represent 2.7 percent of the final analysis sample.}

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 the generally wider confidence intervals for lighter-colored estimates.

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 ages 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 percentage point lower adherence), 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 0.4 percentage point lower adherence), 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 during 12-18 months after 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

Figure 2 reports the prevalence-weighted average coefficient from Figure 1. The top, Baseline row shows that, on average across the guidelines, individuals with access to expertise are 3.8 percentage points less likely to adhere to guidelines; this estimate is highly statistically significant, with a 95 percent confidence interval spanning 4.1 to 3.5 percentage points lower adherence rates for those with access to expertise. 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 54.4 percent of guidelines, a demographically similar patient with access to expertise would adhere to only 50.6 percent.

Figure 2 also reports the average coefficient 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 3.0) and 4.4 percentage points lower for men (95 percent confidence interval 4.8 to 4.0); these estimates 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 the adherence rate among those without access to expertise averages 53.5 percent and those with access to expertise are on average 5.2 percentage points less likely to adhere (95 percent confidence interval 5.6 to 4.9 percentage points), or about about 9.8 percent. The adherence gap for antibiotics is statistically different
from the adherence gap for each of the other three guideline categories ($p$-values are 0.0005, < 0.0001, and < 0.0001 for tests of equality with elderly, diagnosis-specific, and pregnancy guidelines, respectively). The adherence gap is smallest (but still statistically significantly different from zero) for the pregnancy guidelines, where the adherence rate among those without access to expertise averages 86.4 percent, and those with access to expertise are on average 2.1 percentage points (about 2.5 percent) less likely to adhere (95 percent confidence interval 2.6 to 1.6 percentage points).

Panel C shows that the negative relationship between access to expertise and adherence attenuates if we broaden the definition of either “access” or “expertise.” Our baseline definition of access to expertise defines physicians as experts and access based on being a physician, partnering with one, or having one in the close family. 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 1.2 percentage point lower adherence rate (95 percent confidence interval: 1.4 to 1.0), compared to the 3.8 percentage point lower adherence (95 percent confidence interval 4.1 to 3.5) for our baseline definition. 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 interval 1.0 to 0.7).

Appendix Figure 2 shows a weak negative relationship across guidelines between the adherence gap for those with access to expertise and the rate of adherence among those without access to expertise. The line of best fit through this scatterplot has a slope of -0.036, indicating that a 10 percentage point increase in the adherence rate among those without access to expertise is associated with a 3.8 percentage point greater adherence gap for those with access to expertise; this relationship however is not statistically different from zero ($p$-value = 0.08).

### 3.3 Interpretation

We consider several possible explanations for the lower adherence to medication guidelines among those with access to expertise.
### 3.3.1 Socioeconomic Status

One explanation 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, thus accounting for measured variation in income and education.

Unmeasured variation in socioeconomic status (SES) might still account for a portion of the association we document. However, as 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 that any unmeasured variation in SES would tend to produce a 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 leads us to estimate 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 regression includes all of our baseline controls (including own income percentile), and a given case in the risk set may have access to multiple occupations. The $x$-axis variable is the average income percentile of those with access to the given occupation. In general, the association between adherence and access to a given occupation is greater (more positive or less negative) for occupations associated with higher-income individuals. Consistent with our findings in Figure 2, nurses and pharmacists are close to the line of best fit in the plot. By contrast, doctors are a major outlier in the plot; although those with access to doctors have very high incomes, access to doctors is associated with markedly lower adherence. Figure 1 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.
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 have better health and health behaviors (e.g., Chen et al. 2019b; Artmann et al. forthcoming; and Leuven et al. 2013). Consistent with this prior evidence, Panel A of Appendix Figure 3 shows that those with access to expertise are less likely to enter the risk set for the average guideline whose risk set is based on a diagnosis. If better health leads to lower adherence to prescription drug guidelines, for example because healthier patients are less concerned about the consequences of non-adherence, then variation in health could explain a portion of the relationship we estimate between adherence and access to expertise.

We think variation in health is unlikely to account for a large portion of the negative relationship we estimate between adherence and access to expertise. The sample for each of the regression models in our main analysis is restricted to those who fall within the risk set for a given guideline. We expect that making comparisons among patients in the same risk set reduces the scope for differences in health between those with and without access to expertise. Consistent with this expectation, Panel D of Figure 2 shows that controlling for indicators for five health conditions makes little difference to the estimated relationship between adherence and access to expertise.

3.3.3 Comfort with 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, and thus a greater propensity to take medications even in contradiction of guidelines. Consistent with this explanation, Panel B of Appendix Figure 3 shows that those with access to expertise are more likely to enter the risk set for the average guideline whose risk set is based on taking a particular medication.

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 4.1 to 2.7) 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 = 0.1179). Based on this finding, we do not think that comfort with pharmaceuticals accounts 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. In some cases this explanation has obvious surface plausibility. For example, guidelines to use narrower- rather than broader-spectrum antibiotics are motivated by public (rather than private) health considerations (Hyun 2017; Pichichero 2002; Sirota et al. 2017). A patient with access to information that clarifies the motivation for these guidelines might well advocate for more aggressive prescribing. As we saw in Panel B of Figure 2, the adherence gap is largest — by a considerable and statistically significant margin — for the antibiotic guidelines.

Panel F of Figure 2 provides some more direct evidence on this explanation by grouping guidelines according to the strength of the evidence behind them. We find a larger adherence gap where the evidence is weaker. For guidelines related to medication use in pregnancy, 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 = 0.0025).

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, 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 = 0.2427).12

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12 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 -4.9 to -3.6).
4 Conclusion

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 many of those that are emphasized in the literature — such as ignorance, complexity, or failures of patient-provider communication — which would be expected to diminish with access to expertise.

The negative relationship between access to expertise and guideline adherence is particularly pronounced when the guidelines are based on public (rather than private) health considerations — as in the case of restricting antibiotic prescription — and when the strength of the evidence behind the guideline is weaker. This suggests that lower guideline adherence among those with access to expertise may reflect these patients’ superior understanding of guidelines.

As of mid-2018, the US government’s 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).

An important avenue for further research is to identify whether and when non-adherence is in the patient’s best interest.  

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13See also Gerber et al. (2010) for evidence on the US public’s opinion about these tradeoffs.
References


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


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.


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. The sample for each regression is the set of patient-years in the corresponding risk set. Standard errors are clustered at the patient level for any guidelines for which a patient can appear in the risk set more than once. 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. We bootstrap the estimation with 20 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, with the number of guidelines in each category given in parentheses. In Panel C, we re-estimate the regressions described in Figure 1 expanding the definition of access to expertise in two ways, first by including patients with a doctor in their extended family, and second 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.
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. Specifically, for each guideline, we run an OLS regression of an indicator variable for adherence on indicators for access to each occupation, 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 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

<table>
<thead>
<tr>
<th>Guideline</th>
<th>Risk set</th>
<th>Adherence</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Definition</strong></td>
<td><strong>Share</strong></td>
<td><strong>Definition</strong></td>
</tr>
<tr>
<td>Initiate UTI treatment with recommended antibiotics, elderly</td>
<td>Elderly with first prescription for antibiotics against UTI in/after July 2007; age 75+</td>
<td>Indicator = 1 if individual’s first antibiotics prescription is for nitrofurantoin or pivmecillinam</td>
</tr>
<tr>
<td>Don’t initiate UTI treatment with quinolones, elderly</td>
<td>Elderly with first prescription for antibiotics against UTI in/after July 2007; age 75+</td>
<td>Indicator = 1 if individual’s first antibiotics prescription is not for quinolones</td>
</tr>
<tr>
<td>Initiate RTI treatment with penicillin V, children</td>
<td>Individuals with first prescription for antibiotic against RTI in/after July 2007; age 0–6</td>
<td>Indicator = 1 if individual’s first antibiotics prescription is for penicillin V</td>
</tr>
<tr>
<td>Don’t initiate UTI treatment with quinolones, women</td>
<td>Women with first prescription for antibiotics against UTI in/after July 2007; age 18–79</td>
<td>Indicator = 1 if individual’s first antibiotics prescription is not for quinolones</td>
</tr>
<tr>
<td>Initiate antibiotics treatment with penicillin V, children</td>
<td>Individuals with first prescription for antibiotics in/after July 2007; age 0–17</td>
<td>Indicator = 1 if individual’s first antibiotics prescription is for penicillin V</td>
</tr>
<tr>
<td>Initiate antibiotics treatment with penicillin V, adults</td>
<td>Individuals with first prescription for antibiotics in/after July 2007; age 18+</td>
<td>Indicator = 1 if individual’s first antibiotics prescription is for penicillin V</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td>.00076</td>
<td><strong>Average</strong></td>
</tr>
</tbody>
</table>

*Note: 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 prescription drug claims data. As we start observing prescription 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 mean 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.*
<table>
<thead>
<tr>
<th>Guideline</th>
<th>Risk set</th>
<th>Adherence</th>
<th>Do vs. don’t take</th>
<th>Strength of evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Don’t take hazardous drugs after ischemic heart disease &amp; heart failure diagnoses, elderly</td>
<td>Elderly with first inpatient or outpatient diagnosis for ischemic heart disease, with heart failure diagnosis; discharge in/after July 2005</td>
<td>Indicator = 1 if no prescription for diltiazem or verapamil in combination with beta blockers after discharge</td>
<td>.98</td>
<td>Ungraded</td>
</tr>
<tr>
<td>Don’t take hazardous drugs after ischemic heart disease &amp; Afib diagnoses, elderly</td>
<td>Elderly with first inpatient or outpatient diagnosis for ischemic heart disease, with Afib diagnosis; discharge in/after July 2005</td>
<td>Indicator = 1 if no prescription for diltiazem or verapamil in combination with beta blockers after discharge</td>
<td>.96</td>
<td>Ungraded</td>
</tr>
<tr>
<td>Take digoxin after heart failure &amp; Afib diagnoses, elderly</td>
<td>Elderly with first inpatient or outpatient diagnosis for heart failure, with Afib diagnosis; discharge in/after July 2005</td>
<td>Indicator = 1 if prescription after discharge</td>
<td>.35</td>
<td>Below 1A</td>
</tr>
<tr>
<td>Don’t take hazardous drugs after dementia diagnosis, elderly</td>
<td>Elderly with first inpatient or outpatient diagnosis for dementia; discharge in/after July 2005</td>
<td>Indicator = 1 if no prescription for drugs with anticholinergic effects, sleeping agents, or antipsychotic drugs not for severe psychotic symptoms</td>
<td>.32</td>
<td>Below 1A</td>
</tr>
<tr>
<td>Take recommended drugs after dementia diagnosis, elderly</td>
<td>Elderly with first inpatient or outpatient diagnosis for dementia; discharge in/after July 2005</td>
<td>Indicator = 1 if prescription for a recommended drug (one of tacrine, donepezil, rivastigmine, or memantine) after discharge</td>
<td>.62</td>
<td>Below 1A</td>
</tr>
<tr>
<td>Don’t take hazardous drugs after heart failure diagnosis, elderly</td>
<td>Elderly with first inpatient or outpatient diagnosis for heart failure; discharge in/after July 2005</td>
<td>Indicator = 1 if no prescription for NSAIDs, heart rate lowering calcium antagonists, disopyramide, propafenone, flecainide, dronedarone or sotalol after discharge</td>
<td>.78</td>
<td>Below 1A</td>
</tr>
<tr>
<td>Guideline (continued)</td>
<td>Risk set</td>
<td>Adherence</td>
<td>Do vs. don’t take</td>
<td>Strength of evidence</td>
</tr>
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<tr>
<td></td>
<td>Definition</td>
<td>Share</td>
<td>Definition</td>
<td>Share</td>
</tr>
<tr>
<td>Take ACE inhibitors or ARBs after heart failure diagnosis, elderly</td>
<td>Elderly with first inpatient or outpatient diagnosis for heart failure; discharge in/after July 2005</td>
<td>.00078</td>
<td>Indicator = 1 if prescription for either drug after discharge</td>
<td>.86</td>
</tr>
<tr>
<td>Take beta blockers &amp; ACE inhibitors or ARBs after heart failure diagnosis, elderly</td>
<td>Elderly with first inpatient or outpatient diagnosis for heart failure; discharge in/after July 2005</td>
<td>.00078</td>
<td>Indicator = 1 if prescription for beta blockers and one of ACE inhibitors or ARBs after discharge</td>
<td>.77</td>
</tr>
<tr>
<td>Don’t take antipsychotic drugs, elderly*</td>
<td>Elderly (age above 75) with prescription for antipsychotic drug at age 74</td>
<td>.00079</td>
<td>Indicator = 1 if no prescription for antipsychotic drug in a given year</td>
<td>.32</td>
</tr>
<tr>
<td>Don’t take antiplatelet drugs after Afib diagnosis, elderly</td>
<td>Elderly with first inpatient or outpatient diagnosis for Afib; discharge in/after July 2005</td>
<td>.001</td>
<td>Indicator = 1 if no prescription after discharge</td>
<td>.66</td>
</tr>
<tr>
<td>Take anticoagulants after Afib diagnosis, elderly</td>
<td>Elderly with first inpatient or outpatient diagnosis for Afib; discharge in/after July 2005</td>
<td>.001</td>
<td>Indicator = 1 if prescription after discharge</td>
<td>.86</td>
</tr>
<tr>
<td>Avoid drugs with certain interactions, elderly*</td>
<td>Elderly with claims for drugs of certain interactions (see the next column) in a quarter of the year they turn 74</td>
<td>.0011</td>
<td>Defined at patient-year level; Indicator = 1 if 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; diazepam and donepezil</td>
<td>.66</td>
</tr>
<tr>
<td>Guideline (continued)</td>
<td>Risk set</td>
<td>Adherence</td>
<td>Do vs. don’t take</td>
<td>Strength of evidence</td>
</tr>
<tr>
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</tr>
<tr>
<td><strong>Definition</strong></td>
<td><strong>Share</strong></td>
<td><strong>Definition</strong></td>
<td><strong>Share</strong></td>
<td></td>
</tr>
<tr>
<td>No polypharmacy w.r.t. psychotropic drugs, elderly*</td>
<td>Elderly with claims for 3 or more different psychotropic drugs in a quarter of the year they turn 74</td>
<td>.0022</td>
<td>Defined at patient-year level; Indicator = 1 if individual has claims for no more than 2 psychotropic drugs in the same quarter of a given year</td>
<td>.4</td>
</tr>
<tr>
<td>Take oxazepam conditional on anxiolytics, elderly</td>
<td>Elderly-years with prescription for anxiolytics, 2006-2017</td>
<td>.0065</td>
<td>Indicator = 1 if all anxiolytics prescriptions in a given year are for oxazepam</td>
<td>.28</td>
</tr>
<tr>
<td>No polypharmacy w.r.t. drugs in the same therapeutic group, elderly*</td>
<td>Elderly with claims for 2 or more drugs from the same therapeutic ATC group in a quarter of the year they turn 74</td>
<td>.0075</td>
<td>Defined at patient-year level; Indicator = 1 if individual has claims for no more than 1 drug from the same therapeutic ATC group in the same quarter of a given year</td>
<td>.61</td>
</tr>
<tr>
<td>No polypharmacy w.r.t. all drugs, elderly*</td>
<td>Elderly with claims for 10 or more different drugs in a quarter of the year they turn 74</td>
<td>.0088</td>
<td>Defined at patient-year level; Indicator = 1 if individual has claims for no more than 9 different drugs in the same quarter of a given year</td>
<td>.28</td>
</tr>
<tr>
<td>Don’t take NSAIDs, elderly*</td>
<td>Elderly with prescription for NSAID at age 74</td>
<td>.011</td>
<td>Defined at patient-year level; Indicator = 1 if no prescription for NSAID in a given year</td>
<td>.69</td>
</tr>
<tr>
<td>Don’t take specific drugs, elderly*</td>
<td>Elderly with prescription for drug that should be avoided at age 74</td>
<td>.013</td>
<td>Defined at patient-year level; Indicator = 1 if no prescription for diazepam, nitrazepam, flunitrazepam, tramadol, propiomazine, codeine and paracetamol or other non-opioid analgesics, glibenclamide, or drugs with anticholinergic effects in a given year</td>
<td>.49</td>
</tr>
<tr>
<td>Guideline (continued)</td>
<td>Risk set</td>
<td>Adherence</td>
<td>Do vs. don’t take</td>
<td>Strength of evidence</td>
</tr>
<tr>
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</tr>
<tr>
<td></td>
<td>Definition</td>
<td>Share</td>
<td>Definition</td>
<td>Share</td>
</tr>
<tr>
<td>Take zopiclone conditional on taking hypnotics and sedatives, elderly</td>
<td>Elderly-years with prescription for hypnotics and sedatives, 2006-2017</td>
<td>.013</td>
<td>Defined at patient-year level; indicator = 1 if all hypnotics and sedatives prescriptions in a given year are for zopiclone</td>
<td>.37</td>
</tr>
<tr>
<td>Don’t take hazardous sleep medication, elderly</td>
<td>Elderly-years with prescription for sleep medication, 2006-2017</td>
<td>.016</td>
<td>Defined at patient-year level; indicator = 1 if no sleep medication prescriptions in a given year for long-acting benzodiazepines (diazepam, nitrazepam, flunitrazepam), propiomazine, hydroxyzine, alimemazine or promethazine</td>
<td>.72</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td></td>
<td><strong>.00078</strong></td>
<td></td>
<td><strong>.53</strong></td>
</tr>
</tbody>
</table>

*Note: UTI: urinary tract infection; RTI: respiratory tract infection; Afib: atrial fibrillation; TIA: transient ischemic attack; NSAID: nonsteroidal anti-inflammatory drugs. Risk sets not defined by the Socialstyrelsen are marked with an asterisk (*). 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 mean 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. 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

<table>
<thead>
<tr>
<th>Guideline</th>
<th>Risk set</th>
<th>Adherence</th>
<th>Do vs. don’t take</th>
<th>Strength of evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Take anticoagulants 0–1m after TIA &amp; Afib diagnoses</td>
<td>Individuals with first inpatient diagnosis for TIA, with Afib diagnosis; discharge in/after July 2005; age 18+</td>
<td>Indicator = 1 if prescription within 0–1 month after discharge</td>
<td>.5</td>
<td>Do take</td>
</tr>
<tr>
<td>Take anticoagulants 12–18m after ischemic stroke &amp; Afib diagnoses</td>
<td>Individuals with first inpatient main diagnosis for ischemic stroke, with Afib diagnosis; discharge in/after July 2005, in/before June 2016; age 18–79</td>
<td>Indicator = 1 if prescription within 12–18 months after discharge</td>
<td>.55</td>
<td>Do take</td>
</tr>
<tr>
<td>Take anticoagulants 0–1m after ischemic stroke &amp; Afib diagnoses</td>
<td>Individuals with first inpatient diagnosis for ischemic stroke, with Afib diagnosis; discharge in/after July 2005; age 18+</td>
<td>Indicator = 1 if prescription within 0–1 month after discharge</td>
<td>.55</td>
<td>Do take</td>
</tr>
<tr>
<td>Take antipsychotics 12–18m after schizophrenia diagnosis</td>
<td>Individuals with first inpatient or outpatient diagnosis for schizophrenia; discharge in/after July 2005, in/before June 2016; age 18+</td>
<td>Indicator = 1 if prescription within 12–18 months after discharge</td>
<td>.46</td>
<td>Do take</td>
</tr>
<tr>
<td>Take antipsychotics 0–6m after schizophrenia diagnosis</td>
<td>Individuals with first inpatient or outpatient diagnosis for schizophrenia; discharge in/after July 2005; age 18+</td>
<td>Indicator = 1 if prescription within 0–6 months after discharge</td>
<td>.69</td>
<td>Do take</td>
</tr>
<tr>
<td>Take antiplatelet drugs 0–1m after TIA w/o Afib diagnoses</td>
<td>Individuals with first inpatient diagnosis for TIA, without Afib diagnosis; discharge in/after July 2005; age 18+</td>
<td>Indicator = 1 if prescription within 0–1 month after discharge</td>
<td>.71</td>
<td>Do take</td>
</tr>
<tr>
<td>Take RAAS inhibitors or beta blockers 12–18m after heart failure diagnosis</td>
<td>Individuals with first inpatient main diagnosis for heart failure; discharge in/after July 2005 and in/before June 2016; age 20+</td>
<td>Indicator = 1 if prescription for either drug within 12–18 months after discharge</td>
<td>.66</td>
<td>Do take</td>
</tr>
<tr>
<td>Guideline (continued)</td>
<td>Risk set</td>
<td>Adherence</td>
<td>Do vs. don’t take</td>
<td>Strength of evidence</td>
</tr>
<tr>
<td>----------------------</td>
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</tr>
<tr>
<td>Take statins 0–1m after TIA diagnosis</td>
<td>Individuals with first inpatient diagnosis for TIA; discharge in/after July 2005; age 18+</td>
<td>.00078</td>
<td>Indicator = 1 if prescription within 0–1 month after discharge</td>
<td>.5</td>
</tr>
<tr>
<td>Take antihypertensives 0–1m after TIA diagnosis</td>
<td>Individuals with first inpatient diagnosis for TIA; discharge in/after July 2005; age 18+</td>
<td>.00078</td>
<td>Indicator = 1 if prescription within 0–1 month after discharge</td>
<td>.32</td>
</tr>
<tr>
<td>Take antiplatelet drugs 0–1m after ischemic stroke w/o Afib diagnoses</td>
<td>Individuals with first inpatient diagnosis for ischemic stroke, without Afib diagnosis; discharge in/after July 2005; age 18+</td>
<td>.00086</td>
<td>Indicator = 1 if prescription within 0–1 month after discharge</td>
<td>.74</td>
</tr>
<tr>
<td>Take RAAS inhibitors &amp; beta blockers 0–6m after heart failure diagnosis</td>
<td>Individuals with first inpatient main diagnosis for heart failure; discharge in/after July 2005; age 20</td>
<td>.00088</td>
<td>Indicator = 1 if prescription for both drugs within 0–6 months after discharge</td>
<td>.6</td>
</tr>
<tr>
<td>Take ADP receptor blocker 0–1m after myocardial infarction diagnosis</td>
<td>Individuals with first inpatient diagnosis for myocardial infarction; discharge in/after July 2005 and at age 18–79</td>
<td>.0011</td>
<td>Indicator = 1 if prescription within 0–1 month after discharge</td>
<td>.78</td>
</tr>
<tr>
<td>Take statins 0–1m after ischemic stroke diagnosis</td>
<td>Individuals with first inpatient diagnosis for ischemic stroke; discharge in/after July 2005; age 18+</td>
<td>.0011</td>
<td>Indicator = 1 if prescription within 0–1 month after discharge</td>
<td>.56</td>
</tr>
<tr>
<td>Take antihypertensives 0–1m after acute stroke diagnosis</td>
<td>Individuals with first inpatient diagnosis for TIA; discharge in/after July 2005; age 18+</td>
<td>.0013</td>
<td>Indicator = 1 if prescription within 0–1 month after discharge</td>
<td>.44</td>
</tr>
<tr>
<td>Guideline (continued)</td>
<td>Risk set</td>
<td>Adherence</td>
<td>Do vs. don’t take</td>
<td>Strength of evidence</td>
</tr>
<tr>
<td>-----------------------</td>
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</tr>
<tr>
<td><strong>Definition</strong></td>
<td>Share</td>
<td><strong>Definition</strong></td>
<td>Share</td>
<td><strong>Do vs. don’t take</strong></td>
</tr>
<tr>
<td>Take statins 12–18m after myocardial infarction diagnosis</td>
<td>Individuals with first inpatient main diagnosis for myocardial infarction; discharge in/after July 2005, in/before June 2016; age 40–79</td>
<td>.0014</td>
<td>Indicator = 1 if prescription within 12–18 months after discharge</td>
<td>.53</td>
</tr>
<tr>
<td>Take statins 12–18m after cerebral infarction diagnosis</td>
<td>Individuals with first inpatient main diagnosis for cerebral infarction; discharge in/after July 2005, in/before June 2016; age 18+</td>
<td>.0014</td>
<td>Indicator = 1 if prescription within 12–18 months after discharge</td>
<td>.44</td>
</tr>
<tr>
<td>Take osteoporosis drugs 0–12m after fracture diagnosis</td>
<td>Individuals with first inpatient diagnosis for fracture; discharge in/after July 2005; age 50+</td>
<td>.0022</td>
<td>Indicator = 1 if prescription within 0–12 months after discharge</td>
<td>.2</td>
</tr>
<tr>
<td>Take anticoagulants 0–6m after Afib diagnosis with high stroke risk</td>
<td>Individuals with first inpatient diagnosis for Afib and stroke risk score above 2; discharge in/after July 2005; age 18+</td>
<td>.0026</td>
<td>Indicator = 1 if prescription within 0–6 months after discharge</td>
<td>.62</td>
</tr>
<tr>
<td>Take RAAS inhibitors &amp; beta blockers 0–24m after heart failure diagnosis</td>
<td>Individuals with first inpatient or outpatient diagnosis for heart failure; discharge in/after July 2005, in/before December 2015; age 18+</td>
<td>.0042</td>
<td>Indicator = 1 if prescription for both drugs within 0–24 months after discharge</td>
<td>.78</td>
</tr>
<tr>
<td>Continue with antidepressant treatment</td>
<td>Individuals with first prescription for antidepressant in/after January 2006; age 18+</td>
<td>.071</td>
<td>Indicator = 1 if the patient has another claim within 60–150 days after the first claim</td>
<td>.54</td>
</tr>
</tbody>
</table>

**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 mean 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). 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. 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

<table>
<thead>
<tr>
<th>Guideline</th>
<th>Share in risk set</th>
<th>Share adhering</th>
<th>Do vs. don’t take</th>
<th>Strength of evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Don’t take D-class antiepileptics, pregnancy</td>
<td>.000032</td>
<td>.66</td>
<td>Don’t take</td>
<td>D-drug</td>
</tr>
<tr>
<td>Don’t take D-class immunosuppressants, pregnancy</td>
<td>.000044</td>
<td>.7</td>
<td>Don’t take</td>
<td>D-drug</td>
</tr>
<tr>
<td>Don’t take D-class macrolides, lincosamides or streptogramins, pregnancy</td>
<td>.000092</td>
<td>.98</td>
<td>Don’t take</td>
<td>D-drug</td>
</tr>
<tr>
<td>Don’t take C-class psychostimulants, pregnancy</td>
<td>.000095</td>
<td>.76</td>
<td>Don’t take</td>
<td>C-drug</td>
</tr>
<tr>
<td>Don’t take other D-drugs, pregnancy</td>
<td>.00018</td>
<td>.93</td>
<td>Don’t take</td>
<td>D-drug</td>
</tr>
<tr>
<td>Don’t take C-class hypothalamic hormones, pregnancy</td>
<td>.00033</td>
<td>.85</td>
<td>Don’t take</td>
<td>C-drug</td>
</tr>
<tr>
<td>Don’t take C-class hypnotics and sedatives, pregnancy</td>
<td>.0004</td>
<td>.87</td>
<td>Don’t take</td>
<td>C-drug</td>
</tr>
<tr>
<td>Don’t take D-class progestogens, pregnancy</td>
<td>.00053</td>
<td>.99</td>
<td>Don’t take</td>
<td>D-drug</td>
</tr>
<tr>
<td>Don’t take C-class corticosteroids (systemic use), pregnancy</td>
<td>.00056</td>
<td>.89</td>
<td>Don’t take</td>
<td>C-drug</td>
</tr>
<tr>
<td>Don’t take D-class tetracyclines, pregnancy</td>
<td>.00062</td>
<td>.99</td>
<td>Don’t take</td>
<td>D-drug</td>
</tr>
<tr>
<td>Don’t take C-class antibiotics (other), pregnancy</td>
<td>.00068</td>
<td>.86</td>
<td>Don’t take</td>
<td>C-drug</td>
</tr>
<tr>
<td>Don’t take C-class anxiolytics, pregnancy</td>
<td>.00072</td>
<td>.93</td>
<td>Don’t take</td>
<td>C-drug</td>
</tr>
<tr>
<td>Don’t take C-class corticosteroids, pregnancy</td>
<td>.00076</td>
<td>.88</td>
<td>Don’t take</td>
<td>C-drug</td>
</tr>
<tr>
<td>Don’t take C-class opioids, pregnancy</td>
<td>.00099</td>
<td>.85</td>
<td>Don’t take</td>
<td>C-drug</td>
</tr>
<tr>
<td>Don’t take C-class antidepressants, pregnancy</td>
<td>.011</td>
<td>.68</td>
<td>Don’t take</td>
<td>C-drug</td>
</tr>
<tr>
<td>Don’t take other C-drugs, pregnancy</td>
<td>.013</td>
<td>.72</td>
<td>Don’t take</td>
<td>C-drug</td>
</tr>
<tr>
<td>Don’t take C-class NSAIDs, pregnancy</td>
<td>.017</td>
<td>.97</td>
<td>Don’t take</td>
<td>C-drug</td>
</tr>
<tr>
<td>Average</td>
<td>.00000484</td>
<td>.86</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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 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 mean 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: 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 2: 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. The rate of adherence among those without access to expertise is computed as in Appendix Tables 1-4. The red dashed line, the slope 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 3: Prevalence and Access to Expertise, by Guideline

(A) Risk Sets Based on Diagnoses

- Had heart failure diagnosis, observe all prescriptions 0-24m post discharge
- Had heart failure diagnosis, elderly
- Had myocardial infarction diagnosis, observe all prescriptions 12-18m post discharge
- Had heart failure diagnosis, observe all prescriptions 0-6m post discharge
- Had fracture diagnosis, observe all prescriptions 0-12m post discharge
- Had heart failure diagnosis, observe all prescriptions 12-18m post discharge
- Had heart failure & Afib diagnoses, elderly
- Had TIA diagnosis, observe all prescriptions 0-1m post discharge
- Had heart failure & Afib diagnoses, observe all prescriptions 0-1m post discharge
- Had ischemic stroke & Afib diagnoses, observe all prescriptions 12-18m post discharge
- Had myocardial infarction diagnosis, observe all prescriptions 12-18m post discharge
- Had Afib diagnosis, elderly
- Had ischemic stroke & Afib diagnoses, observe all prescriptions 0-1m post discharge
- Had TIA & Afib diagnoses, observe all prescriptions 0-1m post discharge
- Had ischemic stroke & Afib diagnoses, observe all prescriptions 12-18m post discharge
- Had TIA diagnosis, observe all prescriptions 0-1m post discharge
- Had TIA & no Afib diagnoses, observe all prescriptions 0-1m post discharge
- Had Afib diagnosis, observe all prescriptions 0-6m post discharge
- Had Afib diagnosis, elderly
- Had heart failure diagnosis, elderly
- Had TIA & no Afib diagnoses, observe all prescriptions 0-6m post discharge
- Had heart failure diagnosis, observe all prescriptions 0-6m post discharge
- Had ischemic heart disease & heart failure diagnoses, elderly
- Had schizophrenia diagnosis, observe all prescriptions 0-6m post discharge
- Had ischemic heart disease & Afib diagnoses, elderly
- Had acute stroke diagnosis, observe all prescriptions 0-1m post discharge
- Had schizophrenia diagnosis, observe all prescriptions 12-18m post discharge
- Had ischemic stroke diagnosis, observe all prescriptions 0-1m post discharge
- Had ischemic stroke diagnosis, observe all prescriptions 12-18m post discharge
- Had ischemic stroke diagnosis, observe all prescriptions 0-1m post discharge
- Had ischemic stroke & Afib diagnoses, observe all prescriptions 0-1m post discharge
- Had ischemic stroke diagnosis, observe all prescriptions 0-1m post discharge
- Had dementia diagnosis, elderly
- Had myocardial infarction diagnosis, observe all prescriptions 0-1m post discharge
- Had ischemic stroke & no Afib diagnoses, observe all prescriptions 0-1m post discharge
- Had TIA & Afib diagnoses, observe all prescriptions 0-1m post discharge
- Had ischemic stroke & Afib diagnoses, observe all prescriptions 12-18m post discharge
- Had TIA diagnosis, observe all prescriptions 0-1m post discharge
- Had TIA & no Afib diagnoses, observe all prescriptions 0-1m post discharge
- Had Afib diagnosis, observe all prescriptions 0-6m post discharge
- Had Afib diagnosis, elderly

Difference in prevalence
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. Risk sets marked with an asterisk are not defined by the Socialstyrelsen. 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. The average difference in prevalence is the simple average of all the coefficients in each panel. 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.