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Supplementary Information for

Patient-Physician Gender Concordance and Increased Female Mortality Among Heart Attack Patients

Brad N. Greenwood
University of Minnesota-Twin Cities

Seth Carnahan
Washington University in St. Louis

Laura Huang
Harvard University

Corresponding Author: Brad N. Greenwood
Email: wood@umn.edu

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Supporting Information

Data Description

As described, we draw on data from the Florida Agency for Healthcare Administration (AHCA). Access to these data are available via Limited Data Set Use Agreement with the State of Florida Agency for Health Care Administration and the Florida Center for Health Information and Transparency. These data grant us access to a census of patients admitted to hospitals in the State of Florida between 1991 and 2010. In addition to bed level information about the patient (e.g. co-morbidities, age, race, gender), these data provide detailed physician level data (e.g. name, date of licensure). These data provide an ideal context for examining our questions. Not only is Florida a large and economically diverse state, with almost 20 million residents and more than 1.3 million heart attacks over the course of the sample, but these data allow us access to detailed information about the treatment and condition of patients and outcomes.

We focus on heart attacks, or AMIs, for three reasons. First, coronary arterial disease, the underlying cause of AMIs, is the leading cause of death in the United States, accounting for almost a quarter of all fatalities (25). It is also the leading cause of death for both men and women across the socio-economic spectrum, unlike other diseases which disproportionately affect certain subpopulations (e.g. HIV/AIDS, breast cancer, Alzheimer's, prostatitis). Second, heart attack presentation is often inconsistent both within and across gender. Although presentation with chest pain is common for both men and women, women are more likely to present with “atypical” symptoms like fatigue, abdominal discomfort, cold sweats, or displaced pain manifesting in other locations in their body (e.g. jaw, back, shoulders, legs) (26, 27). As a result, we are able to see how different physicians react to, and treat, patients who do not present consistently. Finally, since heart attacks happen suddenly, they do not allow the patient to plan ahead and to easily select a particular physician for treatment. A formal discussion of this assumption can be found below.

Using these data, we construct a sample of patients who experience AMIs. We make two restrictions. First, we exclude all patients who are not admitted through the Emergency Department. This bolsters our claim that admittance to the hospital is an unexpected event, and was not a result of ongoing episodic care on the part of the patient and physician. Second, we exclude all patients who are not in the initial episode of care for their heart attack. This is captured by the second post zero digit of the patient’s ICD-9 AMI diagnosis. Subsequent episodes of care are defined as those which are 8 weeks or less from the initial onset of the AMI, but do not occur concurrently with the initial admittance. This restriction should lessen the possibility that the patient has been treated by the physician before. However, since the data lack stable patient identifiers, it is possible that the physician has seen the patient in the past. Summary statistics, broken down by physician-patient gender dyads, are in Table S2.

Variable Definitions

Survival. The primary dependent variable for this study is a 0/1 indicator $Survives_{ijt}$. This measure indicates whether or not a patient treated by physician *j*, at hospital *i*, in time *t*, survives their heart attack. This variable is set to 0 if the patient expires, and 1 if the patient lives. We also consider alternative measures of performance, such as *Length of Stay* (28), which measures the time to discharge from the hospital.

Gender Concordance. We measure gender concordance as a dichotomous indicator set to 1 if the patient and the physician share the same biological sex (e.g. female patient being treated by female physician). Data on patient gender is retrieved directly from the AHCA. Physician gender is not directly recorded in our data. To address this problem, we follow prior literature and code physician gender using physician first name and data on gender frequency from the US Social Security Administration and the Gender Checker Directory (29, 30). Physicians with unclassified or unisex names are excluded from the sample. Summary statistics for the roughly 175k patients treated by unclassified physicians are available in Table S2, where we note similarity in terms of gender, survival, and other covariates, as compared with the remainder of the sample. This bolsters our confidence that our inability to classify physician gender is unrelated to patient characteristics.

Controls. We include a robust set of controls, including *Age* and *Race* fixed effects, to account for the fact that heart attacks and heart attack survival occur with different frequency among some sub-populations (e.g. African Americans or the elderly). To account for the non-linear relationship between age and survival each calendar age receives its own dummy. *Race* includes seven indicators [American Indian or Alaska Native, Asian, Black or African American, Native Hawaiian or Other Pacific Islander, White, Other, Unknown]. White serves as the base case. Prior to 1992, race is zero filled. To account for the relative health of the patient, we further include *comorbidity* fixed effects. Comorbidities include the 43 most common co-morbidities to a heart attack observed over the course of the sample. A full listing is available in Table S1. Two comorbidities, respiratory failure and congestive heart failure, were removed from the original sample of 45 as they are likely a result of the heart attack, rather than a symptom. Results are consistent in the presence and absence of these two controls. Finally, we include *hospital-quarter* (i.e. a fixed effect for each hospital-quarter combination) or *physician* fixed effects, depending on the model.

Matching Between Patient and Physician

An unbiased match between the physician and the patient is critical to our ability to identify the effect of gender concordance. To bolster this possibility, we rely on patients who are in their initial episode of care and are admitted through the ED (31). Although an individual may know that they are at greater or lesser risk for an AMI, it is unlikely that a patient would be able to predict the precise moment of an AMI. The reason being that if they, or their healthcare provider, was aware that they were at sufficient risk for an AMI to occur at any moment, preventative measures would be taken (e.g. cardiac catheterization, the implantation of a coronary stent, coronary artery bypass grafting). Moreover, patients admitted through the ED often arrive via ambulance, and assignments of emergency admittances to attending physicians is usually done in a quasi-random format, where attending physicians who are least busy are assigned newly arriving patients. Thus, it may be possible treat the assignment of a patient to a physician as occurring quasi-randomly. In what follows, we delve more deeply into this assumption.

Theoretically, two explanations exist as to why physician-patient sorting may not be quasi-random. First, patients (physicians) may be arriving (practicing) at different times based on gender. If true, patient survival may not be due to the gender match of the physician and patient, but instead might be due to the busyness of the hospital at the time that particular patient-physician gender matches are more likely to occur (32). Second, patients may be purposefully allocated to physicians, either as a result of hospital administration or patient self-advocacy. As a result, the gender match that we observe between the physician and the patient may be correlated with physician and/or patient characteristics which will also correlate with the probability that the patient survives the AMI. For example, if female patients prefer to be matched to female physicians, very sick female patients who are unable to advocate for themselves might be more likely to receive a male physician and also more likely to expire from the AMI.

To assess the degree heterogeneity in physician and patient arrival time, we explore the data visually. Arrival time data is only available from 2006 onwards. In Figure S1 we plot the hours of the day that each combination of physician and patient gender is realized in the data. As can be seen, the distribution of arrival times is similar across the various gender combinations, and does not suggest that male physicians are likely to treat female patients at particularly challenging moments in the day. Table S2 displays information about arrival times for each physician-patient gender group and also shows similarity in arrival times across groups.

Table S2 also provides information on the *ex ante* probability of survival for each physician-patient gender group. We calculate predicted probability of survival using a regression framework, where we first regress the survival indicator on the covariates of Equation S1, excluding the hospital-quarter and physician fixed effect and indicators of patient or physician gender. Formally, this is done with Equation S1:

$$y_{ijt} = \alpha + M'\theta_1 + X'\delta_1 + K'\xi_1 + \varepsilon \tag{S1}$$

All indicators are consistent with Equation 1. The estimator is a logistic regression, in order to ensure that predicted probabilities are bounded by zero and one. Results are consistent with an LPM. From these estimates we predict the probability ($\hat{y}$) of each patient surviving based on all observable covariates (absent physician and patient gender). These distributions are displayed visually in Figure S2 and, within patient gender, indicate similarity in the *ex-ante* probability of survival for patients in each of the four quadrants. Notably, patients assigned to female physicians appear to have *lower* ex ante survival probabilities, which casts doubt on the idea that the most challenging female patients are assigned to male physicians. Further, when physician gender (male / female) is regressed upon ($\hat{y}$), conditional upon controls, there is no significant correlation between ex ante probability of survival and the gender of the physician.

Alternate Dependent Variable

As discussed, mortality is not the only measure by which extant research quantifies quality of care. Although this is usually a function of data availability, i.e. the inability to observe patient level outcomes, many researchers use alternate measures such as case mixed adjusted mortality or 30-day hospital readmittance (33). To ensure the consistency of our results, we next validate our findings using an alternate dependent variable, patient length of stay (LOS), i.e. the number of days between when the patient is admitted to, and discharged from, the hospital. Used extensively in literature as a quality metric (28, 34), and currently a component of Medicare's prospective payment system for reimbursement, LOS offers the opportunity to further validate our findings.

We therefore regress LOS on concordance, as well as the decomposed gender dyads. Results are in Table S4. The estimator is an OLS with robust standard errors clustered on the hospital-quarter. Results are consistent using a Poisson or other count estimator. Consistent with prior estimations using survival, results indicate that patients are in the hospital for less time when treated by physicians who share their gender. In Columns 4-7, we decompose the concordance variable into its component dyads using interaction terms and dummy variables. We see that female patients treated by male physicians stay in the hospital significantly longer than any other dyad. These estimates broadly corroborate the survival estimates.

Fig. S1

Distribution of patient arrival times for each combination of physician and patient gender. HR_ARRIVAL indicates 24-hour clock time the patient entered the hospital through the emergency room.

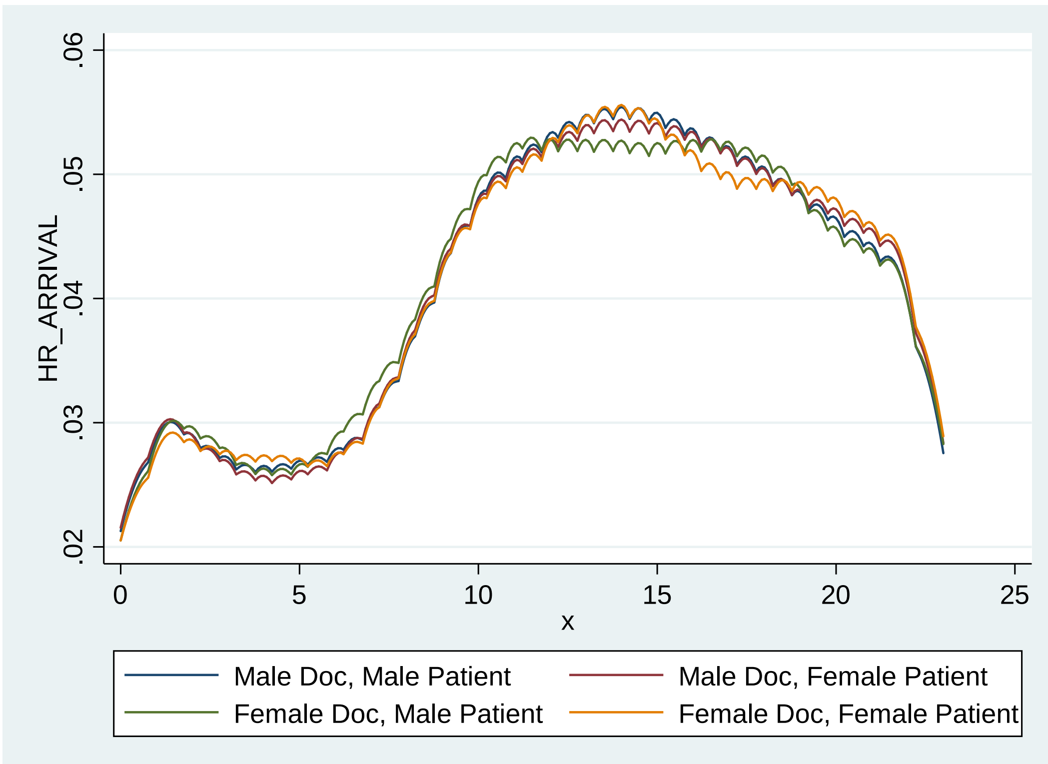

Fig. S2

Distribution of predicted probability of survival for each combination of physician and patient gender. Based on Equation S1.

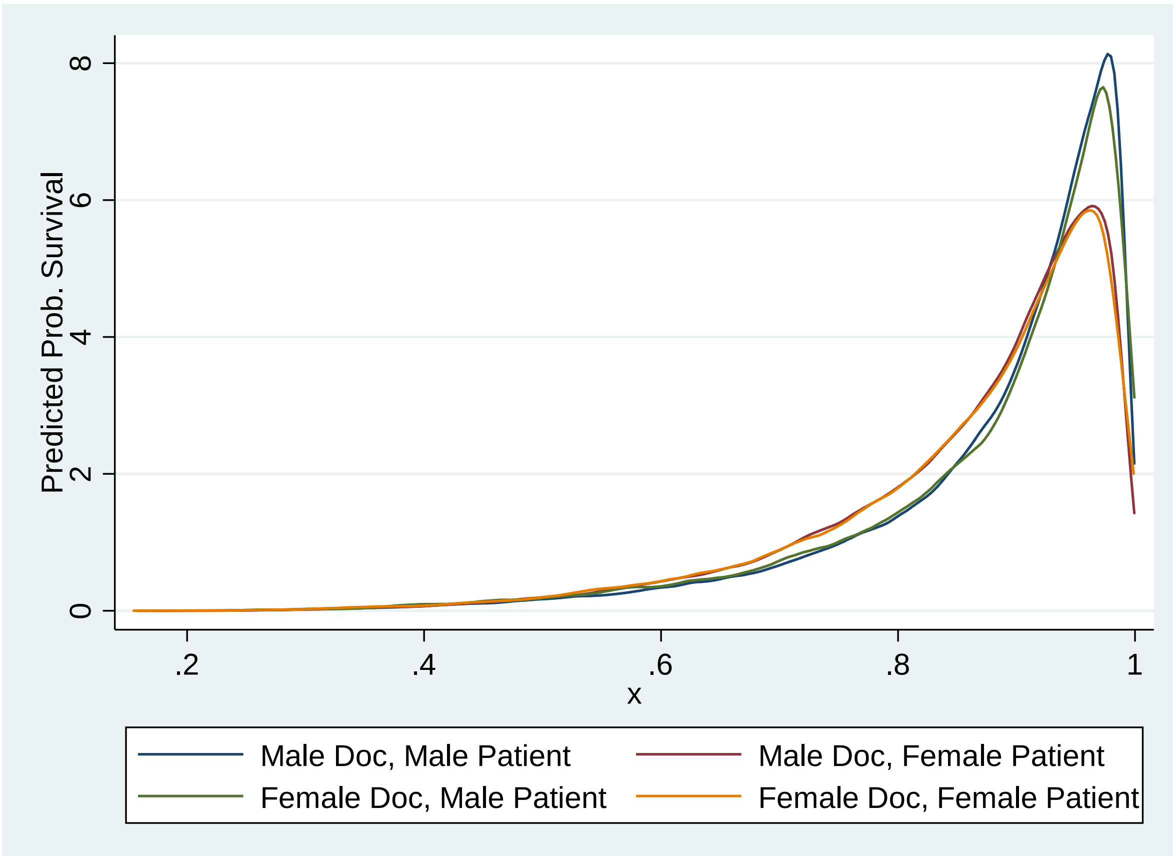

Table S1.

Co-Morbidities Controls Included in Estimates.

Coronary Atherosclerosis	Percutaneous Angioplasty Status	Pulmonary Collapse
Essential Hypertension	Hypothyroidism	Postop Cardiac Dysrhythmia
Atrial Fibrillation	Hyposmolality or Hyponatremia	Osteoarthrosis
Diabetes Mellitus	Chest Pain	Unspecified Pleural Effusion
Chronic Airway Obstruction	Esophageal Reflux	Pneumonitis
Tobacco Use	Hypopotassemia	Hyperpotassemia
Urinary Tract Infection	Chronic Kidney Disease	Prinzmetal Angina
Hypercholesterolemia	Specified Cardiac Dysrhythmias	Hemorrhage of GI Tract
Mitral Valve Disorders	Hypotension	Renal Sclerosis
Anemia Pneumonia	Peripheral Vascular Disease	Thrombocytopenia
Paroxysmal Ventricle Tachycardia	Intermediate Coronary Syndrome	Chronic Kidney Disease
Aortocoronary Bypass Status	Obstructive Chronic Bronchitis	Diseases of Tricuspid Valve
Other Primary Cardiomyopathies	Aortic Valve Disorders	Atrial Flutter
Old Myocardial Infarction	Disorder of Kidney and Ureter	
Other Chronic Heart Disease	Overweight or obesity	

Table S2.

Summary Statistics by Physician-Patient Gender Concordance, Full Sample

	Male Physician – Male Patient			Male Physician – Female Patient			Female Physician – Female Patient			Female Physician – Female Patient			Physician's Name is Gender Ambiguous		
	N	mean	sd	N	mean	sd	N	mean	sd	N	mean	sd	N	mean	sd
Male physician	305,440	1	0	214,055	1	0	33,202	0	0	29,148	0	0	N/A	N/A	N/A
Female physician	305,440	0	0	214,055	0	0	33,202	1	0	29,148	1	0	N/A	N/A	N/A
Male patient	305,440	1	0	214,055	0	0	33,202	1	0	29,148	0	0	174,644	0.586	0.493
Female patient	305,440	0	0	214,055	1	0	33,202	0	0	29,148	1	0	174,644	0.414	0.493
Patient survives	305,440	0.883	0.321	214,055	0.854	0.353	33,202	0.888	0.316	29,148	0.866	0.340	174,644	0.862	0.345
Length of stay	305,440	6.723	7.655	214,055	7.360	8.525	33,202	6.653	8.370	29,148	7.132	8.007	174,644	7.259	7.851
Patient age	305,440	68.59	13.82	214,055	74.56	13.04	33,202	68.51	14.19	29,148	74.58	13.21	174,644	70.63	13.60
Patient black	305,440	0.0631	0.243	214,055	0.0878	0.283	33,202	0.0848	0.279	29,148	0.109	0.312	174,644	0.0666	0.249
Patient predicted survival	305,440	0.881	0.114	214,055	0.859	0.112	33,202	0.877	0.120	29,148	0.857	0.116	174,644	0.862	0.109
% female physicians	305,440	0.105	0.0683	214,055	0.106	0.0701	33,202	0.161	0.0904	29,148	0.161	0.0901	126,700	0.127	0.124
# female physicians	305,440	4.589	3.566	214,055	4.490	3.478	33,202	5.915	3.605	29,148	5.795	3.470	174,644	3.116	3.645
# female patients, qtr	305,440	1.811	2.516	214,055	2.759	2.460	33,202	1.822	2.531	29,148	2.668	2.351	174,644	7.636	15.93
# female patients, year	305,440	6.572	8.101	214,055	7.254	7.866	33,202	6.233	7.824	29,148	6.601	7.131	174,644	19.83	42.64
Physician experience	305,397	14.28	8.904	214,050	14.68	9.197	33,202	10.34	6.977	29,148	10.71	7.151	114,293	11.85	8.280
# beds in hospital	297,953	410.6	251.9	208,395	395.8	243.5	32,621	406.9	272.6	28,553	387.9	256.7	167,672	384.4	250.4
Major teaching hospital	305,440	0.0771	0.267	214,055	0.0671	0.250	33,202	0.0846	0.278	29,148	0.0709	0.257	174,644	0.0614	0.240
Hospital with residency program	305,440	0.441	0.496	214,055	0.425	0.494	33,202	0.456	0.498	29,148	0.426	0.494	174,644	0.416	0.493
Hour of arrival	49,245	13.68	11.17	35,506	13.64	10.88	8,291	13.35	9.955	7,053	13.47	10.05	25,211	13.66	10.67
# unique physicians	12,415			11,934			2,397			2,330			6,258		

There are 16,654 unique physicians in the estimation sample.

Table S3.

Summary Statistics by Physician-Patient Gender Concordance, Matched Sample

	Male Physician – Male Patient			Male Physician – Female Patient			Female Physician – Female Patient			Female Physician – Female Patient		
	N	mean	sd	N	mean	sd	N	mean	sd	N	mean	sd
Male physician	59,652	1	0	59,652	1	0	7,561	0	0	7,561	0	0
Female physician	59,652	0	0	59,652	0	0	7,561	1	0	7,561	1	0
Male patient	59,652	1	0	59,652	0	0	7,561	1	0	7,561	0	0
Female patient	59,652	0	0	59,652	1	0	7,561	0	0	7,561	1	0
Patient survives	59,652	0.874	0.332	59,652	0.852	0.355	7,561	0.872	0.334	7,561	0.869	0.338
Length of stay	59,652	6.841	7.992	59,652	7.386	9.333	7,561	6.907	8.607	7,561	7.034	7.146
Patient age	59,652	69.84	13.79	59,652	74.49	13.01	7,561	69.52	14.00	7,561	74.20	13.16
Patient black	59,652	0.0643	0.245	59,652	0.0832	0.276	7,561	0.0861	0.281	7,561	0.106	0.308
Patient predicted survival	59,651	0.870	0.124	59,651	0.861	0.121	7,561	0.867	0.130	7,561	0.862	0.122
% female physicians	59,652	0.106	0.0697	59,652	0.105	0.0700	7,561	0.164	0.0939	7,561	0.164	0.0940
# female physicians	59,652	4.491	3.481	59,652	4.489	3.487	7,561	5.841	3.487	7,561	5.853	3.498
# female patients, qtr	59,652	1.278	1.681	59,652	2.002	1.618	7,561	1.292	1.697	7,561	1.990	1.595
# female patients, year	59,652	4.411	5.024	59,652	4.773	5.016	7,561	4.167	4.745	7,561	4.527	4.712
Physician experience	59,649	14.81	9.204	59,649	14.81	9.204	7,561	10.68	7.281	7,561	10.67	7.271
# beds in hospital	57,984	394.7	245.9	57,984	394.7	245.9	7,424	388.1	264.7	7,424	388.2	264.7
Major teaching hospital	59,652	0.0678	0.251	59,652	0.0678	0.251	7,561	0.0775	0.267	7,561	0.0775	0.267
Hospital with residency program	59,652	0.440	0.496	59,652	0.440	0.496	7,561	0.442	0.497	7,561	0.442	0.497
Hour of arrival	10,331	13.68	11.01	10,330	13.72	11.02	1,971	13.35	10.80	1,972	13.47	9.990
# unique physicians	8,769			8,769			1,683			1,683		

There are 10,436 unique physicians in the estimation sample.

Observations are matched exactly on physician, hospital, and year.

Table S4.

Replication of LPM Estimates of Relationship between Gender Concordance and Patient Survival using Length of Stay. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Sample	Full sample	Full sample	Matched sample	Full sample	Full sample	Matched sample	Full sample
Physician-patient gender concordance	-0.506***	-0.190***	-0.253***				
	(0.0222)	(0.0210)	(0.0437)				
Male physician*Female patient				0.165**	0.117*	0.315**	
				(0.0711)	(0.0672)	(0.123)	
Female patient				0.473***	0.117*	-0.0297	
				(0.0669)	(0.0637)	(0.114)	
Male physician				0.0633			
				(0.0517)			
Male doctor, female patient							0.392***
							(0.0468)
Male doctor, male patient							0.172***
							(0.0455)
Female doctor, female patient							0.140**
							(0.0611)
Constant	7.265***	9.796***	9.555***	6.659***	9.569***	9.277***	5.337**
	(0.0239)	(0.633)	(1.075)	(0.0521)	(0.634)	(1.077)	(2.324)
Observations	581,845	581,797	134,420	581,845	581,797	134,420	581,797
R-squared	0.001	0.251	0.272	0.001	0.251	0.272	0.223
Model	OLS	OLS	OLS	OLS	OLS	OLS	OLS
Physician Experience Control	No	Yes	Yes	No	Yes	Yes	Yes
Patient Age Dummies	No	Yes	Yes	No	Yes	Yes	Yes
Patient Race Dummies	No	Yes	Yes	No	Yes	Yes	Yes
Comorbidity Dummies	No	Yes	Yes	No	Yes	Yes	Yes
Fixed Effect	None	Physician	Physician	None	Physician	Physician	Hospital-Qtr
Cluster	Hospital-Qtr	Hospital-Qtr	Hospital-Qtr	Hospital-Qtr	Hospital-Qtr	Hospital-Qtr	Hospital-Qtr

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