

A Appendix: For Online Publication

Table A.1: Distribution of test thresholds and misweighting under alternative estimation strategies: Robustness to varying definition of marginal tested patient

	Strict definition	Baseline definition	Lax definition
	(1)	(2)	(3)
Fraction of tested patients defined as marginal	5%	10%	15%
Mean of τ_d	0.0492	0.0563	0.0620
Standard deviation of τ_d	0.0497	0.0540	0.0582
Average absolute value of PE misassessment	0.0228	0.0226	0.0227
Standard deviation of PE misassessment	0.0344	0.0347	0.0353
Number of observations	1,890,660	1,890,660	1,890,660

Notes: Recall that the test yield among each doctor’s marginal tested patients (those just barely worth testing) is used to estimate the doctor’s test thresholds and form exclusion restrictions that identify the model. Each column of this table reports estimation results under an alternative definition of the marginal tested patient. The baseline results, reported in column 2 for easy comparison, define a patient as marginal if they are in the bottom 10% of tested patients on the basis of their estimated testing propensity index. Column 1 employs a stricter definition, allowing only the bottom 5% of tested patients to be counted as marginal; column 3 employs a weaker definition, allowing the bottom 15% of tested patients to be counted as marginal. Each column reports the estimated posterior mean and standard deviation of physician testing thresholds τ_d from the model, after applying the Bayesian shrinkage described in Appendix F. Recall that τ_d is the threshold probability of a positive test at which a physician determines it is worthwhile to test a patient. The average absolute value of PE risk misassessment calculates the absolute value of the difference between physicians’ assessment of the patient’s PE probability and the estimated risk associated with the patient’s comorbidities, and then averages this value across all patients. The standard deviation of PE misassessment describes how the total amount of misweighting varies across patients.

Table A.2: Comorbidities with no significant misweighting:
Impact of comorbidity on testing decisions and estimated misassessment of PE risk (continued)

	Marginal effect from testing eqn (1)	Misassessment of PE risk (2)	Std. error of misassessment (3)	T statistic of misassessment (4)
<i>Other comorbidities</i>				
History of hip fracture (CCW)	-0.0035	0.0192	0.0116	1.6552
Alzheimer's related dementias (CCW)	-0.0060	0.0077	0.0047	1.6383
Anemia (CCW)	-0.0023	0.0038	0.0024	1.5833
Depression (CCW)	-0.0008	0.0042	0.0031	1.3548
Hypertension (CCW)	0.0008	0.0033	0.0025	1.3200
Solid tumor w/o metastasis (Elixhauser)	-0.0066	0.0145	0.0112	1.2946
Benign prostatic hyperplasia (CCW)	-0.0014	0.0046	0.0038	1.2105
Hypothyroidism (Elixhauser)	-0.0009	0.0068	0.0060	1.1333
Liver disease (Elixhauser)	-0.0066	0.0219	0.0195	1.1231
Prior surgery within 1 year	0.0136	0.0239	0.0215	1.1116
Blood loss anemia (Elixhauser)	-0.0044	0.0126	0.0118	1.0678
Breast cancer (CCW)	0.0066	0.0046	0.0049	0.9388
Stroke / Transient ischemic attack (CCW)	-0.0099	0.0035	0.0046	0.7609
Chronic kidney disease (CCW)	-0.0091	0.0024	0.0042	0.5714
Psychoses (Elixhauser)	-0.0057	0.0046	0.0126	0.3651
Congestive heart failure (Elixhauser)	-0.0022	0.0018	0.0056	0.3214
Congestive heart failure (CCW)	-0.0006	0.0008	0.0028	0.2857
Drug abuse (Elixhauser)	0.0059	0.0060	0.0304	0.1974
Alcohol abuse (Elixhauser)	0.0008	0.0020	0.0149	0.1342
Pulmonary circulation disease (Elixhauser)	-0.0035	0.0009	0.0107	0.0841
Acute myocardial infarction (CCW)	-0.0058	0.0002	0.0090	0.0222
Lymphoma (Elixhauser)	-0.0174	-0.0005	0.0220	-0.0227
Coagulation deficiency (Elixhauser)	-0.0001	-0.0006	0.0109	-0.0550
Weight loss (Elixhauser)	-0.0054	-0.0021	0.0119	-0.1765
Prior surgery within 30 days	0.0151	-0.0047	0.0191	-0.2461
Arthritis (Elixhauser)	0.0044	-0.0032	0.0096	-0.3333
Fluid & electrolyte disorders (Elixhauser)	-0.0013	-0.0022	0.0047	-0.4681
Acquired hypothyroidism (CCW)	0.0022	-0.0020	0.0035	-0.5714
Hyperlipidemia (CCW)	0.0054	-0.0017	0.0024	-0.7083
Hypertension (CCW)	0.0012	-0.0051	0.0040	-1.2750
Diabetes w/chronic complications (Elixhauser)	-0.0080	-0.0176	0.0115	-1.5304
Glaucoma (CCW)	-0.0003	-0.0047	0.0029	-1.6207
Diabetes w/o chronic complications (Elixhauser)	-0.0023	-0.0085	0.0051	-1.6667
Lung cancer (CCW)	-0.0142	-0.0198	0.0113	-1.7522
Cataracts (CCW)	-0.0010	-0.0037	0.0021	-1.7619
Valvular disease (Elixhauser)	-0.0031	-0.0116	0.0060	-1.9333

Notes: Results continued from Table 4; this table includes only covariates without significant evidence of misweighting. Column 1 reports marginal effects from coefficient estimates of the testing equation (i.e. equation 2); for example, patients with hip fracture history are 0.35 percentage points less likely to be tested, after controlling for included PE risk factors and physicians' testing thresholds. Column 2 reports estimates of physicians' misweighting of these PE risk factors estimated from equation 14; for example, physicians' observed testing patterns suggest they are overestimating the PE risk associated with hip fracture history by 1.92 percentage points. Column 3 reports standard errors for coefficients in column 3. Column 4 reports t-statistics. Variables are sorted by statistical significance.

Table A.3: Part 1: Assessment of misweighting with varying included covariates

	<i>All comorbidities</i>		<i>Excluding Elixhauser comorbidities</i>		<i>Excluding Elixhauser comorbidities and demographics</i>	
	Misassessment of PE risk	Standard error	Misassessment of PE risk	Standard error	Misassessment of PE risk	Standard error
	(1)	(2)	(3)	(4)	(5)	(6)
<i>Underweighted risk factors</i>						
Prior hospital visit w/in 30 days	0.1070	0.0121	0.1025	0.0125	0.1045	0.0125
Prior hospital visit w/in 7 days	0.1128	0.0130	0.1091	0.0133	0.1105	0.0133
Prostate cancer (CCW)	0.0298	0.0048	0.0311	0.0048	0.0318	0.0046
Cancer metastasis (Elixhauser)	0.0726	0.0128	0.0843	0.0134	0.0892	0.0134
History of deep vein thrombosis	0.0571	0.0114	0.0560	0.0113	0.0570	0.0113
History of pulmonary embolism	0.0666	0.0145	0.0800	0.0142	0.0827	0.0141
Rheumatoid arthritis, osteoarthritis (CCW)	0.0091	0.0024	0.0097	0.0025	0.0108	0.0024
Endometrial cancer (CCW)	0.0547	0.0153	0.0438	0.0154	0.0405	0.0153
Obesity (Elixhauser)	0.0218	0.0076				
Paralysis (Elixhauser)	0.0331	0.0117				
Other neurological conditions (Elixhauser)	0.0194	0.0075				
Any prior admission history	0.0102	0.0041	0.0033	0.0029	0.0028	0.0029
Alzheimer's disease (CCW)	0.0152	0.0064	0.0158	0.0065	-0.0036	0.0092
Colorectal cancer (CCW)	0.0136	0.0067	0.0166	0.0067	0.0163	0.0067
<i>Overweighted risk factors</i>						
Ischemic heart disease (CCW)	-0.0226	0.0023	-0.0233	0.0023	-0.0226	0.0023
Chronic obstructive pulmonary disease (CCW)	-0.0182	0.0036	-0.0158	0.0037	-0.0159	0.0037
Atrial fibrillation (CCW)	-0.0156	0.0036	-0.0172	0.0036	-0.0175	0.0036
Depression (Elixhauser)	-0.0208	0.0069				
Peripheral vascular disease (Elixhauser)	-0.0214	0.0071				
Diabetes (CCW)	-0.0087	0.0029	-0.0115	0.0028	-0.0105	0.0028
Osteoporosis (CCW)	-0.0087	0.0033	-0.0079	0.0033	-0.0075	0.0032
Deficiency anemias (Elixhauser)	-0.0142	0.0056				
Asthma (CCW)	-0.0088	0.0040	-0.0086	0.0040	-0.0072	0.0040
Chronic pulmonary disease (Elixhauser)	-0.0094	0.0048				
<i>Demographic factors</i>						
Black	0.0257	0.0044	0.0189	0.0045		
Asian	-0.0386	0.0118	-0.0392	0.0118		
Hispanic	-0.0168	0.0097	-0.0142	0.0100		
Female	0.0000	0.0024	0.0000	0.0024		
Age 65-69	0.0119	0.0037	0.0103	0.0037		
Age 70-74	0.0129	0.0052	0.0092	0.0053		
Age 75-79	0.0140	0.0038	0.0122	0.0038		
Age 80-84	0.0166	0.0039	0.0133	0.0039		
Age 85-89	0.0208	0.0042	0.0181	0.0042		
Age 90-94	0.0132	0.0078	0.0075	0.0081		

Notes: Table continued on next page. Column 1 reports estimates of physicians' misweighting of these PE risk factors estimated from equation 14 under the baseline specification with full set of included covariates. Column 2 reports standard errors on these misweighting terms. (Columns 1 and 2 replicate results reported in Table 4 for purposes of comparison.) Columns 3 and 4 also report misweighting terms and standard errors, now from the model that excludes the Elixhauser comorbidity set. Columns 5 and 6 report results from the model that excludes both Elixhauser comorbidities and demographic factors.

Table A3 Part 2: Assessment of misweighting with varying included covariates

	<i>All comorbidities</i>		<i>Excluding Elixhauser comorbidities</i>		<i>Excluding Elixhauser comorbidities and demographics</i>	
	Misassessment of PE risk	Standard error	Misassessment of PE risk	Standard error	Misassessment of PE risk	Standard error
<i>Other comorbidities</i>	(1)	(2)	(3)	(4)	(5)	(6)
History of hip fracture (CCW)	0.0192	0.0116	0.0025	0.0118	0.0042	0.0117
Alzheimer's related dementias (CCW)	0.0077	0.0047	0.0070	0.0048	0.0070	0.0049
Anemia (CCW)	0.0038	0.0024	0.0014	0.0024	0.0024	0.0024
Depression (CCW)	0.0042	0.0031	-0.0006	0.0029	-0.0010	0.0029
Hypertension (CCW)	0.0033	0.0025	0.0042	0.0024	0.0052	0.0024
Solid tumor w/o metastasis (Elixhauser)	0.0145	0.0112				
Benign prostatic hyperplasia (CCW)	0.0046	0.0038	0.0062	0.0038	0.0070	0.0035
Hypothyroidism (Elixhauser)	0.0068	0.0060				
Liver disease (Elixhauser)	0.0219	0.0195				
Prior surgery within 1 year	0.0239	0.0215	0.0352	0.0217	0.0293	0.0218
Blood loss anemia (Elixhauser)	0.0126	0.0118				
Breast cancer (CCW)	0.0046	0.0049	0.0089	0.0049	0.0095	0.0049
Stroke / Transient ischemic attack (CCW)	0.0035	0.0046	0.0027	0.0047	0.0050	0.0047
Chronic kidney disease (CCW)	0.0024	0.0042	0.0031	0.0044	0.0014	0.0044
Psychoses (Elixhauser)	0.0046	0.0126				
Congestive heart failure (Elixhauser)	0.0018	0.0056	-0.0053	0.0056	-0.0055	0.0056
Congestive heart failure (CCW)	0.0008	0.0028	0.0007	0.0028	0.0020	0.0028
Drug abuse (Elixhauser)	0.0060	0.0304				
Alcohol abuse (Elixhauser)	0.0020	0.0149				
Pulmonary circulation disease (Elixhauser)	0.0009	0.0107				
Acute myocardial infarction (CCW)	0.0002	0.0090	-0.0026	0.0092	0.0153	0.0066
Lymphoma (Elixhauser)	-0.0005	0.0220				
Coagulation deficiency (Elixhauser)	-0.0006	0.0109				
Weight loss (Elixhauser)	-0.0021	0.0119				
Prior surgery within 30 days	-0.0047	0.0191	-0.0066	0.0192	-0.0031	0.0192
Arthritis (Elixhauser)	-0.0032	0.0096				
Fluid & electrolyte disorders (Elixhauser)	-0.0022	0.0047				
Acquired hypothyroidism (CCW)	-0.0020	0.0035	0.0007	0.0030	0.0013	0.0030
Hyperlipidemia (CCW)	-0.0017	0.0024	-0.0005	0.0025	-0.0013	0.0025
Hypertension (CCW)	-0.0051	0.0040				
Diabetes w/complications (Elixhauser)	-0.0176	0.0115				
Glaucoma (CCW)	-0.0047	0.0029	-0.0043	0.0029	-0.0023	0.0029
Diabetes w/o complications (Elixhauser)	-0.0085	0.0051				
Lung cancer (CCW)	-0.0198	0.0113	-0.0219	0.0117	-0.0266	0.0116
Cataracts (CCW)	-0.0037	0.0021	-0.0029	0.0021	-0.0017	0.0020
Valvular disease (Elixhauser)	-0.0116	0.0060				

Notes: Table continued from previous page. Column 1 reports estimates of physicians' misweighting of these PE risk factors estimated from equation 14 under the baseline specification with full set of included covariates. Column 2 reports standard errors on these misweighting terms. (Columns 1 and 2 replicate results reported in Table 4 for purposes of comparison.) Columns 3 and 4 also report misweighting terms and standard errors, now from the model that excludes the Elixhauser comorbidity set. Columns 5 and 6 report results from the model that excludes both Elixhauser comorbidities and demographic factors.

Table A.4: Part 1: Assessing the costs of misweighting by variable

	<i>Net Benefits</i>	<i>Change in net benefits</i>
Original	13.279	
Age 65-69	12.323	-0.956
Age 70-74	12.078	-0.245
Age 75-79	11.580	-0.498
Age 80-84	11.988	0.408
Age 85-89	13.560	1.572
Age 90-94	13.695	0.135
Black	15.486	1.791
Asian	15.707	0.221
Hispanic	15.802	0.095
Acute myocardial infarction (CCW)	15.802	0.000
Alzheimer's disease (CCW)	16.712	0.910
Chronic obstructive pulmonary disease (CCW)	18.879	2.167
Congestive heart failure (CCW)	18.815	-0.064
History of hip fracture (CCW)	18.980	0.165
Anemia (CCW)	19.164	0.184
Asthma (CCW)	19.343	0.179
Hyperlipidemia (CCW)	19.516	0.173
Benign prostatic hyperplasia (CCW)	19.591	0.075
Hypertension (CCW)	19.432	-0.159
Acquired hypothyroidism (CCW)	19.426	-0.006
Alzheimer's related dementias (CCW)	19.644	0.218
Atrial fibrillation (CCW)	20.498	0.854
Cataracts (CCW)	20.625	0.127
Chronic kidney disease (CCW)	20.611	-0.014
Diabetes (CCW)	21.392	0.781
Glaucoma (CCW)	21.484	0.092
Ischemic heart disease (CCW)	23.516	2.032
Depression (CCW)	23.616	0.100
Osteoperosis (CCW)	23.677	0.061
Rhumatoid arthritis, osteoarthritis (CCW)	24.503	0.826
Stroke / Transient ischemic attack (CCW)	24.603	0.100
Breast cancer (CCW)	24.664	0.061
Colorectal cancer (CCW)	25.079	0.415
Prostate cancer (CCW)	26.588	1.509
Lung cancer (CCW)	26.541	-0.047
Endometrial cancer (CCW)	27.117	0.576

Notes: This table is continued on the next page. This table reports results of a series of simulation exercises where we test the welfare impact of correcting for physician misweighting of observed risk factors, one variable at a time. This exercise allows us to assess which specific risk factors are the biggest contributors to the welfare costs associated with misweighting. We proceed in the order listed in the table and show how the total net benefits of testing (in \$ millions) change from their observed value of 13.279 to the final value 49.132 in the absence of any misweighting, by correcting one additional variable in each row. Note that because we continue to allow physician thresholds to vary and do not correct for all risk factors at once, correcting a single additional risk factor occasionally leads to a small decline in net benefits. The results of this exercise may be sensitive to the order in which risk factors are corrected.

Table A3 Part 2: Assessing the costs of misweighting by variable

	<i>Net Benefits</i>	<i>Change in net benefits</i>
Prior surgery within 30 days	26.311	-0.806
Prior surgery within 1 year	30.794	4.483
Any prior admission history	32.632	1.838
Valvular disease (Elixhauser)	32.534	-0.098
Pulmonary circulation disease (Elixhauser)	32.546	0.012
Peripheral vascular disease (Elixhauser)	32.496	-0.050
Paralysis (Elixhauser)	32.927	0.431
Other neurological conditions (Elixhauser)	33.271	0.344
Diabetes w/o chronic complications (Elixhauser)	33.100	-0.171
Diabetes w/chronic complications (Elixhauser)	33.058	-0.042
Hypothyroidism (Elixhauser)	33.195	0.137
Liver disease (Elixhauser)	33.287	0.092
Lymphoma (Elixhauser)	33.286	-0.001
Solid tumor w/o metastasis (Elixhauser)	33.518	0.232
Arthritis (Elixhauser)	33.509	-0.009
Coagulation deficiency (Elixhauser)	33.504	-0.005
Obesity (Elixhauser)	33.840	0.336
Weight loss (Elixhauser)	33.825	-0.015
Fluid & electrolyte disorders (Elixhauser)	33.770	-0.055
Blood loss anemia (Elixhauser)	33.866	0.096
Deficiency anemias (Elixhauser)	33.668	-0.198
Alcohol abuse (Elixhauser)	33.673	0.005
Drug abuse (Elixhauser)	33.675	0.002
Psychoses (Elixhauser)	33.687	0.012
Depression (Elixhauser)	33.706	0.019
Hypertension (Elixhauser)	33.176	-0.530
History of deep vein thrombosis	34.174	0.998
History of pulmonary embolism	35.186	1.012
Prior hospital visit w/in 30 days	43.135	7.949
Prior hospital visit w/in 7 days	47.871	4.736
Female	47.871	0.000
Chronic pulmonary disease (Elixhauser)	47.903	0.032
Congestive heart failure (Elixhauser)	47.914	0.011
Cancer metastasis (Elixhauser)	49.132	1.218

Notes: This table is continued from the previous page. This table reports results of a series of simulation exercises where we test the welfare impact of correcting for physician misweighting of observed risk factors, one variable at a time. This exercise allows us to assess which specific risk factors are the biggest contributors to the welfare costs associated with misweighting. We proceed in the order listed in the table and show how the total net benefits of testing (in \$ millions) change from their observed value of 13.279 to the final value 49.132 in the absence of any misweighting. Note that because we continue to allow physician thresholds to vary and do not correct for all risk factors at once, correcting a single additional risk factor occasionally leads to a small decline in net benefits. The results of this exercise may also be sensitive to the order in which risk factors are corrected.

Table A.5: Sensitivity of welfare simulations to calibration parameters

A. Counterfactual with no overtesting			
	<i>Percent tested</i>	<i>Test yield</i>	<i>Change in net benefits</i>
<i>False positive rate</i>			
0.00	0.037	0.071	0.093
0.03	0.026	0.083	3.802
0.04	0.019	0.090	8.144
<i>Value of a statistical life</i>			
\$500,000	0.005	0.137	15.748
\$1,000,000	0.019	0.090	8.144
\$1,500,000	0.025	0.081	5.249
<i>Test sensitivity</i>			
0.75	0.019	0.090	8.080
0.83	0.019	0.090	8.144
0.90	0.018	0.090	8.191
<i>Financial cost of testing</i>			
\$0	0.033	0.075	0.725
\$300	0.019	0.090	8.144
\$500	0.012	0.104	16.872
B. Counterfactual with no misweighting			
	<i>Percent tested</i>	<i>Test yield</i>	<i>Change in net benefits</i>
<i>False positive rate</i>			
0.00	0.043	0.090	44.134
0.03	0.043	0.090	38.094
0.04	0.043	0.090	35.853
<i>Value of a statistical life</i>			
\$500,000	0.043	0.090	13.184
\$1,000,000	0.043	0.090	35.853
\$1,500,000	0.043	0.090	58.522
<i>Test sensitivity</i>			
0.75	0.043	0.090	36.120
0.83	0.043	0.090	35.853
0.90	0.043	0.090	35.660
<i>Financial cost of testing</i>			
\$0	0.043	0.090	38.882
\$300	0.043	0.090	35.853
\$500	0.043	0.090	33.834

Notes: This table supplements Tables 7 and 8 and displays the simulated welfare benefits of changing physician practice patterns under a range of calibration parameters. Each row represents a separate simulation exercise; bold rows indicate the baseline parameter values used for our main welfare analysis. The changes in net benefits (column 3) are reported in millions of dollars, compared to welfare under observed testing thresholds and misweighting. In any given row, all parameters aside from the one in question are kept constant at the values listed in Table 6. Panel A displays testing behavior and the improvement in social welfare under simulations assuming all physicians with thresholds below the calibrated optimum are reassigned to the optimal testing threshold of $\tau_d = \tau^*$ (but maintaining the observed degree of misweighting). Panel B displays testing behavior and the improvement in social welfare under simulations assuming that physicians target testing to patients with the highest expected probability of a positive test based on observable demographics and comorbidities (but maintaining the observed degree of overtesting).