**Title**
The Influence of the Availability Heuristic on Physicians in the Emergency Department



**Journal**
Annals of Emergency Medicine, 78(5)

**ISSN**
0196-0644

**Author**
Ly, Dan P

**Publication Date**
2021-11-01

**DOI**
10.1016/j.annemergmed.2021.06.012

Peer reviewed

# The Influence of the Availability Heuristic on Physicians in the Emergency Department

Dan P. Ly, MD, PhD*

*Corresponding Author. E-mail: dply@mednet.ucla.edu.

**Study objective:** Heuristics, or rules of thumb, are hypothesized to influence the care physicians deliver. One such heuristic is the availability heuristic, under which assessments of an event's likelihood are affected by how easily the event comes to mind. We examined whether the availability heuristic influences physician testing in a common, high-risk clinical scenario: assessing patients with shortness of breath for the risk of pulmonary embolism.

**Methods:** We performed an event study from 2011 to 2018 of emergency physicians caring for patients presenting with shortness of breath to 104 Veterans Affairs (VA) hospitals. Our measures were physician rates of pulmonary embolism testing (D-dimer and/or computed tomography scan) for subsequent patients after having a patient visit with a pulmonary embolism discharge diagnosis, hypothesizing that physician rates of pulmonary embolism testing would increase after having a recent patient visit with a pulmonary embolism diagnosis due to the availability heuristic.

**Results:** The sample included 7,370 emergency physicians who had 416,720 patient visits for shortness of breath. The mean rate of pulmonary embolism testing was 9.0%. For physicians who had a recent patient visit with a pulmonary embolism diagnosis, their rate of pulmonary embolism testing for subsequent patients increased by 1.4 percentage points (95% confidence interval 0.42 to 2.34) in the 10 days after, which is approximately 15% relative to the mean rate of pulmonary embolism testing. We failed to find statistically significant changes in rates of pulmonary embolism testing in the subsequent 50 days following these first 10 days.

**Conclusion:** After having a recent patient visit with a pulmonary embolism diagnosis, physicians increase their rates of pulmonary embolism testing for subsequent patients, but this increase does not persist. These results provide large-scale evidence that the availability heuristic may play a role in complex testing decisions. [Ann Emerg Med. 2021;■:1-8.]

Please see page XX for the Editor's Capsule Summary of this article.

0196-0644/$-see front matter

https://doi.org/10.1016/j.annemergmed.2021.06.012

## INTRODUCTION

Heuristics, or rules of thumb, are hypothesized to influence the care physicians deliver.[1,2] These heuristics include the availability heuristic, under which the assessment of an event's likelihood is influenced by how easily the event can be recalled. It is thought to be one of the most common heuristics influencing physician decisionmaking.[3,4] Recent diagnoses seen may be particularly salient to physicians.[5]

However, literature regarding heuristics affecting physician decisionmaking is largely limited to case vignettes,[6] small samples of patients,[1] or small-scale experiments.[2] Some studies that have examined the influence of heuristics using large databases have found evidence consistent with the availability heuristic after adverse events—that is, physicians changing their behavior after adverse events.[7-10] We are not aware of other literature examining heuristics in complex testing decisions using clinically rich electronic health record data containing information such as time-stamped vital signs and testing.

In this study, we used national Veterans Affairs (VA) electronic health record data from 2011 to 2018 to examine a common, high-risk clinical scenario: assessing patients in the emergency department (ED) with shortness of breath for the risk of pulmonary embolism. We examined whether physicians who recently had a patient with a pulmonary embolism diagnosis were more likely to test their subsequent patients for pulmonary embolism, controlling for pulmonary embolism risk factors found in the electronic health record, such as tachycardia, cancer history, and recent surgery. In sensitivity analyses, we then examined whether physician rates of pulmonary embolism testing changed after an unrelated diagnosis (pneumothorax) and whether rates of testing for conditions

**Editor's Capsule Summary**

*What is already known on this topic*

Physicians' recent experiences can alter subsequent clinical decisions independent of the clinical facts.

*What question this study addressed*

Does diagnosing a patient with pulmonary embolism alter emergency department (ED) testing in subsequent patient encounters?

*What this study adds to our knowledge*

Examining data for 416,720 ED patient visits for shortness of breath from 104 Veterans' Hospitals, a 15% increase in the rate of pulmonary embolism-specific testing was observed over the first 10 days after the physician's index case but no increase was observed over the next 50 days.

*How this is relevant to clinical practice*

Availability bias exists but may not be durable or profound; how this applies across other conditions is unclear.

unrelated to pulmonary embolism changed after seeing a patient with pulmonary embolism. Our VA setting allows us to reduce the influence of malpractice concerns because VA physicians cannot be sued in civil court for a malpractice claim.[11]

## MATERIALS AND METHODS

### Data Sources and Study Population

We used national electronic health record data from the VA Corporate Data Warehouse, which includes patient demographics, vital signs, diagnosis codes, tests ordered, and surgical procedures performed. These data have been used in prior studies.[12,13] We began our study in 2011, when the VA completed implementation of Emergency Department Integration Software.[14] We used ED visit data from Emergency Department Integration Software. In total, 121 VA EDs provided data. Of these 121 VA EDs, the 17 EDs that did not perform the 2 tests that compose our main outcome (D-dimer tests and computed tomography [CT] scans of the chest with contrast) throughout the examined time period were dropped.

We identified patients aged 21 and older who visited a VA ED with a presenting complaint of shortness of breath between 2011 and 2018. We excluded ED visits for patients on hospice or who had a status of "comfort measures only."

### Study Measures

We included clinical factors found in a validated clinical prediction rule that was commonly taught during the examined time period: Wells' score for pulmonary embolism (Table E1, available at http://www.annemergmed.com).[15-17] Using electronic health record data, we were able to observe 4 of the 7 clinical factors in the Wells' score: prior deep venous thrombosis or pulmonary embolism, a diagnosis of cancer within the prior 6 months, a surgery within the prior 4 weeks, and pulse rate higher than 100 beats/min. We also a priori included 4 other clinical covariates. The first was oxygen saturation less than 90%. The other 3 clinical factors were the presence of chronic conditions whose exacerbation may provide a possible alternative diagnosis for shortness of breath: ischemic heart disease, congestive heart failure, and chronic obstructive pulmonary disease. Other patient covariates included age, sex, and race and ethnicity. Finally, we included DNR/DNI (do not resuscitate/do not intubate) status.

Our main outcome of interest was a test for pulmonary embolism either within 8 hours of ED arrival or by ED departure, whichever came first. Eight hours was chosen to standardize across ED visits in order to take into account the possibility that a patient untested in the first 8 hours later decompensated such that the physician then decided to test. In a sensitivity analysis, we removed the 8-hour restriction. There are 2 main recommended tests for pulmonary embolism: a D-dimer blood test and a CT scan of the chest with contrast. Because we were missing 3 of the 7 clinical factors in the Wells' score that may make either a D-dimer test or a CT scan more appropriate, our outcome of interest was a composite measure of either or both tests. We did not include the use of a ventilation/perfusion (V/Q) scan because these were uncommonly ordered from the ED (0.2% of ED visits for shortness of breath), but we included such tests in a sensitivity analysis.

The unit of analysis was at the patient visit–physician level, with patient visits ordered by arrival time to the physician. A pulmonary embolism diagnosis was defined as a physician entering pulmonary embolism as the ED discharge diagnosis for a patient visit. The main independent variable was coded as the time relative to this pulmonary embolism diagnosis patient visit.

### Statistical Analysis

Our main empirical specification was an event study that compared physician rates of pulmonary embolism testing from 60 days before having a patient visit with a pulmonary embolism diagnosis to 60 days after. This was done by performing a multivariable regression using a linear probability model (Gaussian family and identity link) of our testing outcome as a function of time (in 10-day intervals) relative to a patient visit with a pulmonary embolism diagnosis, controlling for the clinical and demographic covariates listed above. The 10-day interval prior to the patient visit with a pulmonary embolism diagnosis was the reference time interval. Physicians were allowed to diagnose multiple pulmonary embolisms. However, if in the following 60 days, because of an increase in testing due to the availability heuristic, a pulmonary embolism was diagnosed, this pulmonary embolism remained in the data but did not reset the 60-day timer. A physician's next detected pulmonary embolism that was at least 60 days after the prior initial pulmonary embolism would then be another pulmonary embolism observation in the data. We included physician fixed effects, which essentially examines how testing changes for a physician before and after a patient visit with a pulmonary embolism diagnosis. These physician fixed effects control for differences across physicians, such as differences in testing thresholds and in specialty training (such as emergency medicine residency training versus other residency training). Because physicians usually work in one VA ED, the use of physician fixed effects also essentially controls for differences across VA EDs. However, we also included hospital fixed effects in a sensitivity analysis to more formally control for differences across VA EDs, such as in testing capacity. We also included weekend (versus weekday) fixed effects, month fixed effects, and year fixed effects to control for temporal trends. We clustered our standard errors at the hospital level. Physicians who did not have a patient visit with a pulmonary embolism diagnosis during the examined time period were included to help more precisely estimate the coefficients on the other covariates. In order to provide a more easily interpretable measure, we then replaced the event time variable with a single postpulmonary embolism diagnosis visit variable and examined the coefficient on this postpulmonary embolism diagnosis visit variable. This set of analyses relies on the assumption that patient characteristics and patient risk do not systematically differ for a physician before and after having a patient visit with a pulmonary embolism diagnosis. To test this assumption, we examined whether the composition of the patients seen (age, sex, race/ethnicity, and Wells' score based on observable clinical covariates) changed after having a patient visit with a pulmonary embolism diagnosis.

In sensitivity analyses, we examined whether pulmonary embolism testing increased after having a patient visit with an unrelated diagnosis that we chose a priori—pneumothorax. Rates of pulmonary embolism testing would not be expected to change after having a patient visit with a pneumothorax diagnosis due to the availability heuristic. We also examined whether our results may have been due to overall testing increases after having a patient visit with a pulmonary embolism diagnosis by performing event studies for 2 tests (1 blood test and 1 imaging test) unrelated to pulmonary embolism that we chose a priori—thyroid stimulating hormone test and hand radiographs. Rates of such testing would not be expected to change after a pulmonary embolism diagnosis due to the availability heuristic.

All *p*-values were from 2-sided tests, and results were deemed statistically significant at the $p<0.05$ level. Data were prepared using Microsoft SQL Server and analyzed using Stata version 15.1. The VA Boston Healthcare System Institutional Review Board approved the study. This study followed the Strengthening the Reporting of Observational Studies in Epidemiology guidelines.

## RESULTS

Our sample included 7,370 physicians who had 416,720 patient visits for shortness of breath across 104 VA hospitals (Figure E1 available at http://www.annemergmed.com). The average age of our sample of patient visits was 62.9 years; about 62% were White, and about 10% were women (Table). About 11% of this sample had a diagnosis of malignancy in the prior 6 months, about 6% had a prior deep venous thrombosis or pulmonary embolism, about 2% had a surgery in the prior 4 weeks, and about 18% had an increased pulse rate. Nine percent of this sample received at least 1 of the examined tests for pulmonary embolism; about 7% received a D-dimer test, and about 5% received a CT scan of the chest with contrast. About 1% of this sample had a pulmonary embolism diagnosed in the ED. The average number of years worked during the examined time period by physicians in our sample was 2.5 years (Table). The average number of patient visits during the examined time period for physicians was 56.5.

In our adjusted event study specification (Figure 1), controlling for other observable pulmonary embolism risk factors, there was a statistically significant increase in physician pulmonary embolism testing for subsequent patients of 1.38 percentage points (95% confidence interval [CI] 0.42 to 2.34) in the first 10 days after having a recent patient visit with a pulmonary embolism diagnosis compared to the 10 days prior, which is approximately

**Table.** Sample characteristics, 2011–2018.

| Characteristic | No. |
|---|---|
| Patient visits | |
| Age (years) | 62.9 |
| 21–30 (%) | 2.9 |
| 31–45 (%) | 9.5 |
| 46–60 (%) | 23.8 |
| 61–75 (%) | 45.2 |
| 76–90 (%) | 16.3 |
| 91+ (%) | 2.2 |
| Female (%) | 9.5 |
| Race | |
| American Indian or Alaska Native (%) | 0.8 |
| Asian (%) | 1.3 |
| Black (%) | 24.9 |
| Hispanic (%) | 7.0 |
| Other race or ethnicity (%) | 4.2 |
| White (%) | 61.8 |
| Malignancy within 6 months (%) | 11.4 |
| Past deep venous thrombosis or pulmonary embolism (%) | 5.9 |
| Surgery within 4 weeks (%) | 2.1 |
| Pulse rate >100 beats/min (%) | 17.6 |
| Oxygen saturation <90% (%) | 5.1 |
| Ischemic heart disease (%) | 29.0 |
| Congestive heart failure (%) | 18.5 |
| Chronic obstructive pulmonary disease (%) | 38.9 |
| DNR/DNI (%) | 4.1 |
| D-dimer (%) | 6.6 |
| CT scan with contrast (%) | 4.5 |
| D-dimer and/or CT scan with contrast (%) | 9.0 |
| Pulmonary embolism diagnosed in ED (%) | 1.2 |
| Physicians | |
| Number of years worked | 2.5 |
| Number of patient visits | 56.5 |

Author's calculation using VA data from 2011–2018.

15% relative to the mean rate of pulmonary embolism testing. We failed to find that the coefficients for the other 10-day intervals in the 120-day window around the patient visit with a pulmonary embolism diagnosis were statistically significantly different from 0 (Table E2, available at http://www.annemergmed.com), including for the subsequent 50 days following these first 10 days. Patients with recent malignancy, past deep venous thrombosis/pulmonary embolism, recent surgery, tachycardia, and low oxygen saturation were more likely to be tested for pulmonary embolism (Table E2, available at http://www.annemergmed.com). Results were unchanged when examining from 30 days before a patient visit with a pulmonary embolism diagnosis to 30 days after (Figure E2, available at http://www.annemergmed.com). Results were substantively unchanged when using a logistic model (Figure E3, available at http://www.annemergmed.com). We failed to find statistically significant changes in the composition of subsequent patients (as measured by age, sex, race/ethnicity, or Wells' score calculated using observable clinical factors) for a physician after having a recent patient visit with a pulmonary embolism diagnosis (Figure E4, available at http://www.annemergmed.com).

When replacing the event time variables with a single postpulmonary embolism diagnosis visit variable, pulmonary embolism testing increased 0.87 percentage points (95% CI 0.47 to 1.28) in the 60 days after having a recent patient with a pulmonary embolism diagnosis compared to the 60 days before (Table E3, available at http://www.annemergmed.com). Results were unchanged when removing the restriction of examining pulmonary embolism testing only in the first 8 hours (Figure E5 and Table E3, both available at http://www.annemergmed.com). Patterns were similar when examining D-dimer testing and CT scans separately (Figure E6 and Table E3, both available at http://www.annemergmed.com). Patterns were unchanged when including hospital fixed effects (Figure E7, available at http://www.annemergmed.com). Patterns were unchanged when including V/Q scans in our measure of testing (Figure E8, available at http://www.annemergmed.com).

We failed to find statistically significant changes in rates of pulmonary embolism testing after having a recent patient visit with a pneumothorax diagnosis (Figure 2). We failed to find that the coefficients for the 10-day intervals in the 120-day window around the patient visit with a pneumothorax diagnosis were statistically significantly different from 0. We failed to find statistically significant changes in rates of thyroid stimulating hormone testing and hand radiographs after having a recent patient visit with a pulmonary embolism diagnosis (Figure 3) (Table E3, available at http://www.annemergmed.com). We failed to find that the coefficients for the 10-day intervals in the 120-day window around the patient visit with a pulmonary embolism diagnosis were statistically significantly different from 0 for either thyroid stimulating hormone testing or hand radiographs.

## LIMITATIONS

This study has several limitations. First, this study was observational and there may be residual confounding. Second, we were not able to observe every clinical factor in

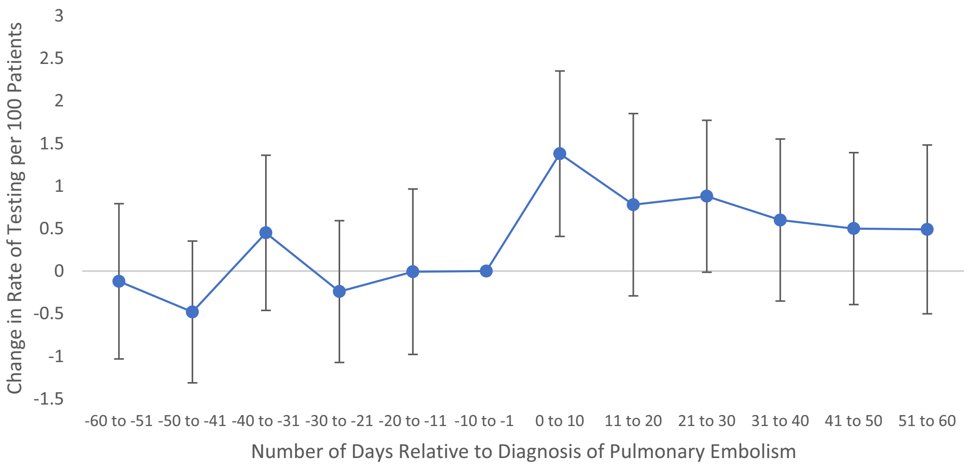


**Figure 1.** Change in testing for pulmonary embolism in subsequent patients after a diagnosis of pulmonary embolism, 2011–2018. Author's calculation using VA data from 2011–2018. The bands are 95% confidence intervals. Testing refers to D-dimer test and/or CT scan of the chest with contrast performed within the first 8 hours of patient arrival. Estimates are from a linear regression that includes physician fixed effects, year fixed effects, month fixed effects, weekend fixed effects, and controls for patient age, sex, race/ethnicity, malignancy within the prior 6 months, past deep venous thrombosis or pulmonary embolism, surgery within the prior 4 weeks, pulse rate >100 beats/min, oxygen saturation <90%, ischemic heart disease, congestive heart failure, chronic obstructive pulmonary disease, and DNR/DNI status. The comparison group is visits from days -10 to -1. Standard errors were clustered at the hospital level.

the Wells' score. Third, we can only provide evidence consistent with certain heuristics. Our results may instead be consistent with other explanations. Fourth, in our research design, the preperiod, by definition, does not have a patient visit with a pulmonary embolism diagnosis. Therefore, comparing the testing yield prepulmonary versus postpulmonary embolism diagnosis would mechanically result in a higher testing yield in the postperiod. Consequently, we are unable to determine whether increases in testing after a recent pulmonary embolism diagnosis represent on average overtesting or an improvement on undertesting. Fifth, we could not fully

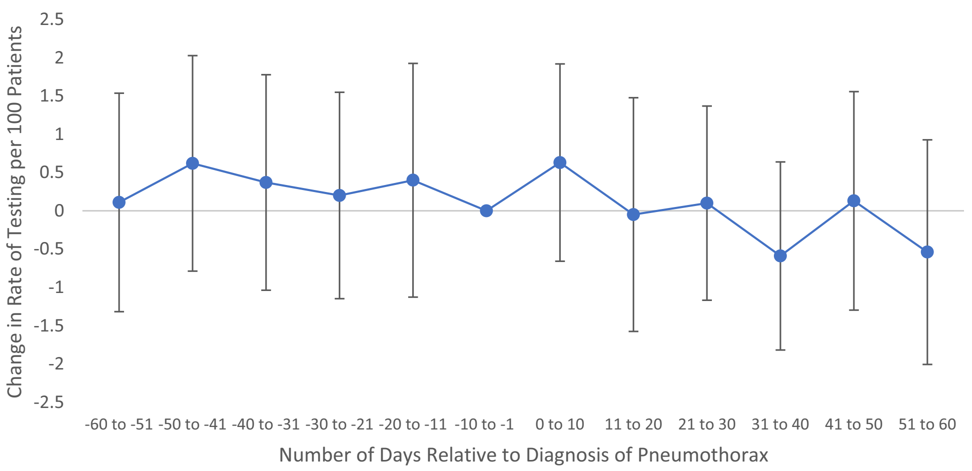


**Figure 2.** Change in testing for pulmonary embolism in subsequent patients after a diagnosis of pneumothorax, 2011–2018. Author's calculation using VA data from 2011–2018. The bands are 95% confidence intervals. Testing refers to D-dimer test and/or CT scan of the chest with contrast performed within the first 8 hours of patient arrival. Estimates are from a linear regression that includes physician fixed effects, year fixed effects, month fixed effects, weekend fixed effects, and controls for patient age, sex, race/ethnicity, malignancy within the prior 6 months, past deep venous thrombosis or pulmonary embolism, surgery within the prior 4 weeks, pulse rate >100 beats/min, oxygen saturation <90%, ischemic heart disease, congestive heart failure, chronic obstructive pulmonary disease, and DNR/DNI status. The comparison group is visits from days -10 to -1. Standard errors were clustered at the hospital level.

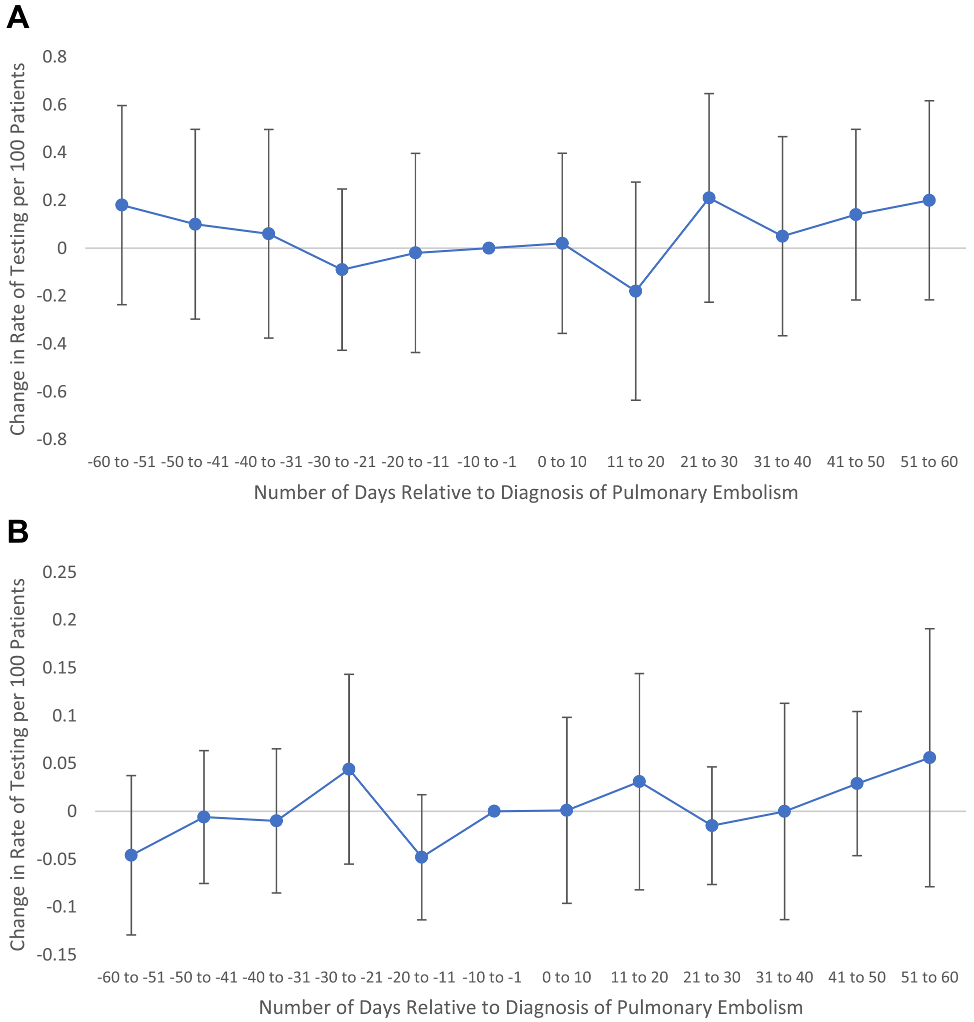


**Figure 3.** Change in thyroid stimulating hormone testing and hand radiographs in subsequent patients after a diagnosis of pulmonary embolism, 2011–2018. *A*, Thyroid stimulating hormone testing. *B*, Hand radiographs. Author's calculation using VA data from 2011–2018. The bands are 95% confidence intervals. Testing refers to each respective test performed within the first 8 hours of patient arrival. Estimates are from a linear regression that includes physician fixed effects, year fixed effects, month fixed effects, weekend fixed effects, and controls for patient age, sex, race/ethnicity, malignancy within the prior 6 months, past deep venous thrombosis or pulmonary embolism, surgery within the prior 4 weeks, pulse rate >100 beats/min, oxygen saturation <90%, ischemic heart disease, congestive heart failure, chronic obstructive pulmonary disease, and DNR/DNI status. The comparison group is visits from days -10 to -1. Standard errors were clustered at the hospital level.

capture the clinical complexity of each case, particularly the information that was conveyed during the history and physical examination. However, our use of electronic health record data represents an improvement on prior data used, allowing us to include clinical data, such as vital signs, that are important for physicians when evaluating patients. In addition, we failed to find that patient characteristics such as age, sex, race/ethnicity, and Wells' score change for physicians after a pulmonary embolism diagnosis. This provides evidence that the composition and risk of patients that physicians see do not appear to change after a visit with a pulmonary embolism diagnosis, and differences in the history conveyed by the patient also likely do not systematically differ after a visit with a pulmonary embolism diagnosis. For another factor to explain our results, that factor would need to change for a physician right after he or she has a patient visit with a pulmonary embolism diagnosis. Sixth, the vast majority of the VA patient population is male. Therefore, our results are specific to the VA. Our results may not generalize to non-VA physicians treating non-VA patient populations. Seventh, we focused on a single diagnosis. Eighth, although malpractice concerns may explain some of our results, these concerns are likely smaller in the VA because VA physicians cannot be sued in civil court for a malpractice claim.[11] Ninth, although we failed to find that any of the coefficients outside of the first 10 days after a patient visit with a pulmonary embolism diagnosis were statistically significantly different from 0, we may have been underpowered to find such a difference. Notably, the 95% confidence intervals for all of the 10-day intervals after the first 10 days after a patient visit with a pulmonary embolism diagnosis include the coefficient on these first 10 days, so this study cannot rule out practically important effects during these subsequent 10-day intervals at the 5% level. Tenth, our results do not extend to physicians who see patients infrequently.

## DISCUSSION

Using a national sample of almost half a million VA patient visits to the ED for shortness of breath, this study found that physicians had a statistically significant increase in their rate of pulmonary embolism testing of about 15% relative to the average level of testing immediately after having a recent patient visit with a pulmonary embolism diagnosis but failed to find that this increase persisted in later periods. These results may be consistent with physicians being influenced by the availability heuristic. That is, physicians, after having a recent patient visit with a pulmonary embolism diagnosis, may temporarily place higher probabilities of a pulmonary embolism in subsequent patients with shortness of breath and increase their rates of pulmonary embolism testing for a short period of time.

Some studies that have examined the influence of heuristics using large databases have found evidence consistent with left-digit bias,[18,19] or the tendency to focus on the left-most digit of numbers. Several studies have examined the availability heuristic in relation to adverse events. One study found that when patients suffered a bleeding event when on an anticoagulant for atrial fibrillation, their physicians were less likely to prescribe an anticoagulant to their subsequent patients with atrial fibrillation.[7] Another study examining cesarean and vaginal modes of delivery found that adverse events with one mode led to obstetricians switching to the other mode.[10] Another study found that reports of injury filed against physicians led their practice peers to increase their use of diagnostic imaging immediately after the report, but this increase was not sustained. This could be interpreted as the availability heuristic leading to defensive medicine.[9] Our study is the first that we know of using large, clinically rich data to examine heuristics in complex testing decisions. And we focus particularly on whether diagnoses themselves, rather than recent adverse events, influence physician testing for subsequent patients.

Although we focus on testing decisions after a single diagnosis, our results regarding the availability heuristic may extend to other clinical situations. They may extend to other diagnoses, particularly those that are relatively less frequent. The availability heuristic may be more pronounced in situations in which there are no clinical guidelines like the Wells' score. They may extend to treatment decisions; for example, recent positive experiences after a particular intervention may make it more likely for a physician to prescribe or perform that intervention for subsequent patients. And these results suggest that other common heuristics thought to influence individual decisionmaking may similarly affect physicians.

As the literature examining heuristics used by physicians grows, other evidence regarding whether increasing awareness of such heuristics changes individual behavior is mixed.[20] More promising is improving the decision environment for physicians through decision support tools.[21,22] Such decision support tools may improve the care physicians deliver, particularly when they may be influenced by heuristics.

In conclusion, we found that emergency physicians, after having a recent patient visit with a pulmonary embolism diagnosis, immediately increased their rates of pulmonary embolism testing for subsequent patients. However, we did not find that this increase persisted. These results are consistent with the availability heuristic influencing physician decisionmaking in relation to pulmonary embolism diagnoses. Further study is needed to understand the consequences of this and other heuristics.

*The author wishes to thank David Cutler, Thomas McGuire, Anupam Jena, Michael Barnett, Hannah Neprash, Aaron Schwartz, Zirui Song, Samuel Moy, and Daniel Prinz for helpful comments on the paper. This work was supported by the National Institute on Aging (Grant F32 AG060650-02). No funding source played a role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; or decision to submit the manuscript for publication.*

*Supervising editor:* Donald M. Yealy, MD. Specific detailed information about possible conflict of interest for individual editors is available at https://www.annemergmed.com/editors.

Author affiliations: From the VA Greater Los Angeles Healthcare System, Los Angeles, CA, the VA Boston Healthcare System, Boston, MA, and the Division of General Internal Medicine and

Health Services Research, David Geffen School of Medicine at UCLA, Los Angeles, CA.

*Author contributions:* DPL conceived the study, obtained research funding, analyzed the data, drafted the manuscript, and contributed substantially to its revision. DPL takes responsibility for the paper as a whole.

All authors attest to meeting the four ICMJE.org authorship criteria:(1) Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; AND (2) Drafting the work or revising it critically for important intellectual content; AND (3) Final approval of the version to be published; AND (4) Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

*Funding and support:* By *Annals* policy, all authors are required to disclose any and all commercial, financial, and other relationships in any way related to the subject of this article as per ICMJE conflict of interest guidelines (seewww.icmje.org). The author has stated that no such relationships exist. This work was supported by the National Institute on Aging (Grant F32 AG060650-02).

*Publication dates:* Received for publication April 13, 2021. Revision received May 15, 2021. Accepted for publication June 14, 2021.

The views expressed in this manuscript are those of the author and do not necessarily represent the views of the US Department of Veterans Affairs or the US government.

## REFERENCES

1. Graber ML, Franklin N, Gordon R. Diagnostic error in internal medicine. *Arch Intern Med*. 2005;165:1493-1499.
2. Mamede S, van Gog T, van den Berge K, et al. Effect of availability bias and reflective reasoning on diagnostic accuracy among internal medicine residents. *JAMA*. 2010;304:1198-1203.
3. Zagury-Orly I, Schwartzstein RM. Covid-19—a reminder to reason. *N Engl J Med*. 2020;383:e12.
4. Saposnik G, Redelmeier D, Ruff CC, et al. Cognitive biases associated with medical decisions: a systematic review. *BMC Med Inform Decis Mak*. 2016;16:138.
5. Groopman J. What's the Trouble? How doctors think.. Accessed July 28, 2021, https://www.newyorker.com/magazine/2007/01/29/whats-the-trouble.
6. Redelmeier DA. Improving patient care: the cognitive psychology of missed diagnoses. *Ann Intern Med*. 2005;142:115-120.
7. Choudhry NK, Anderson GM, Laupacis A, et al. Impact of adverse events on prescribing warfarin in patients with atrial fibrillation: matched pair analysis. *BMJ*. 2006;332:141-145.
8. Keating NL, O'Malley AJ, Onnela JP, et al. Assessing the impact of colonoscopy complications on use of colonoscopy among primary care physicians and other connected physicians: an observational study of older Americans. *BMJ Open*. 2017;7:e014239.
9. Ly DP. Rates of advanced imaging by practice peers after malpractice injury reports in Florida, 2009-2013. *JAMA Intern Med*. 2019;179:1140-1141.
10. Singh M. What passed is past? The role of recent adverse events in physician treatment decisions. Accessed July 28, 2021, https://drive.google.com/file/d/1TE2mkIvg3-g2ma6qUE3UCswN9gcuJJKP/view.
11. Veterans Health Administration. 20 Reasons doctors like working for the Veterans Health Administration. Veterans Health Administration. Accessed July 28, 2021, https://www.va.gov/HEALTH/docs/20ReasonsVHA_508_IB10935.pdf.
12. Barnett ML, Zhao X, Fine MJ, et al. Emergency physician opioid prescribing and risk of long-term use in the Veterans Health Administration: an observational analysis. *J Gen Intern Med*. 2019;34:1522-1529.
13. Vance MC, Wiitala WL, Sussman JB, et al. Increased cardiovascular disease risk in veterans with mental illness. *Circ Cardiovasc Qual Outcomes*. 2019;34:1522-1529.
14. Emergency department integration software (EDIS). Data.gov. Accessed July 28, 2021, https://catalog.data.gov/dataset/emergency-department-integration-software-edis.
15. Wells PS, Anderson DR, Rodger M, et al. Excluding pulmonary embolism at the bedside without diagnostic imaging: management of patients with suspected pulmonary embolism presenting to the emergency department by using a simple clinical model and D-dimer. *Ann Intern Med*. 2001;135:98-107.
16. Wells PS, Ginsberg JS, Anderson DR, et al. Use of a clinical model for safe management of patients with suspected pulmonary embolism. *Ann Intern Med*. 1998;129:997-1005.
17. Barbash IJ, Hibbert KA, Malhotra A. Venous thromboembolism. In: Sabatine MS, ed. *Pocket Medicine*. 5th ed. Lippincott Williams & Wilkins; 2014.
18. Olenski AR, Zimerman A, Coussens S, et al. Behavioral heuristics in coronary-artery bypass graft surgery. *N Engl J Med*. 2020;382:778-779.
19. Husain SA, King KL, Mohan S. Left-digit bias and deceased donor kidney utilization. *Clin Transplant*. Published online March 25, 2021.
20. O'Sullivan ED, Schofield SJ. Cognitive bias in clinical medicine. *J R Coll Physicians Edinb*. 2018;48:225-232.
21. Rhodes C, Tokazewski J, Christensen K, et al. Clinician decision support initiative to decrease outpatient high-risk medicine prescriptions in the elderly. *J Gen Intern Med*. 2020;35:2492-2494.
22. Patel MS, Volpp KG, Small DS, et al. Using active choice within the electronic health record to increase influenza vaccination rates. *J Gen Intern Med*. 2017;32:790-795.