Cancer Evaluations During the COVID-19 Pandemic: An Observational Study Using National Veterans Affairs Data

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**Introduction:** Fewer cancer diagnoses have been made during the COVID-19 pandemic. Pandemic-related delays in cancer diagnosis could occur from limited access to care or patient evaluation delays (e.g., delayed testing after abnormal results). Follow-up of abnormal test results warranting evaluation for cancer was examined before and during the pandemic.

**Methods:** Electronic trigger algorithms (“e-triggers”) were applied to Department of Veterans Affairs’ electronic health record (EHR) data to assess follow-up of abnormal test results before (March 10, 2019–March 7, 2020) and during (March 8, 2020–March 6, 2021) the pandemic.

**Results:** E-triggers were applied to 8,021,406 veterans’ EHRs to identify follow-up delays for abnormal results warranting evaluation for 5 cancers: bladder (urinalysis with high-grade hematuria), breast (abnormal mammograms), colorectal (positive fecal occult blood tests/fecal immunochemical tests [FOBT/FIT] or results consistent with iron deficiency anemia [IDA]), liver (elevated alpha-fetoprotein), and lung (chest imaging suggestive of malignancy). Between pre-pandemic and pandemic periods, test quantities decreased by 12.6%–27.8%; and proportions of abnormal results lacking follow-up decreased for urinalyses (~0.8%), increased for FOBT/FIT (+2.3%) and chest imaging (+1.8%), and remained constant for others. Follow-up times decreased for most tests; however, control charts suggested increased delays at 2 stages: ‘Early’ (pandemic beginning) for urinalyses, mammograms, FOBT/FIT, IDA, and chest imaging; and ‘Late’ (30–45 weeks into pandemic) for mammograms, FOBT/FIT, and IDA.

**Conclusions:** While early pandemic delays in follow-up may have led to reduced cancer rates, the significant decrease in tests performed is likely a large driver of these reductions. Future emergency preparedness efforts should bolster essential follow-up and testing procedures to facilitate timely cancer diagnosis.
INTRODUCTION

Reductions in both early and overall new cancer diagnoses have been found during the COVID-19 pandemic.¹ Since cancer rates are unlikely to have changed, these findings suggest increased numbers of patients experiencing delayed cancer diagnoses.² Some decreases in cancer diagnoses may derive from reductions in healthcare services observed during the pandemic for everything from routine preventive care, like screening,³ ⁴ ⁵ to treatment for more serious medical issues, including chemotherapy and surgery.⁶ ⁷ However, one hypothesis is that the pandemic also impacted cancer diagnosis by reducing timeliness of follow-up of abnormal test results that warrant evaluation for cancer. To examine this hypothesis, national data from the Department of Veterans Affairs (VA) was leveraged to compare delays in follow-up of abnormal test results prior to and during the first year of the COVID-19 pandemic. To measure these delays, recently developed metrics that employ electronic triggers (“e-triggers”) were used to estimate the frequency of missed follow-up of abnormal tests.

METHODS

Study Sample

National electronic health record (EHR) data from VA’s data warehouse was used to assess follow-up care received by veterans throughout the U.S. before and during the COVID-19 pandemic. While the VA population is predominantly male and has more comorbidities than the general population,⁸ the VA is a relatively closed system (about one-third of VA veterans also use community care),⁹ providing a fairly accurate perspective on care received by a large cohort of patients. The WHO’s pandemic declaration date¹⁰ was used to delineate 1 year each of pre-
pandemic and pandemic data (March 10, 2019–March 7, 2020 and March 8, 2020–March 6, 2021, respectively). This study had VA IRB approval with exempted informed consent.

**Measures**

Previously developed and validated e-trigger algorithms, which scan vast amounts of clinical data from the EHR to identify patients with potential safety events were used.\(^{11}\) E-triggers used in this study identified abnormal test results (i.e., red-flags) that warrant diagnostic evaluation for 5 cancers, including bladder (urinalysis with high-grade hematuria), breast (abnormal mammograms), colorectal (positive fecal occult blood tests/fecal immunochemical tests \([FOBT/FIT]\) or results consistent with iron deficiency anemia \([IDA]\)), liver (elevated alpha-fetoprotein \([AFP]\)), and lung (chest imaging suggestive of malignancy).\(^{12–15}\)

Follow-up action was identified using Current Procedural Terminology codes or appropriate follow-up appointments and considered delayed after 60 days, except for mammograms with BI-RADS 3 and chest imaging (where action after 7 months and 30 days was considered delayed, respectively). Appropriate follow-up actions (e.g., specialist visit or biopsy) and delay cut-offs were determined by literature review and expert consensus. E-trigger development, validation, and detailed criteria are described elsewhere.\(^{11–15}\) Outcome measures for each time period included overall test quantity, abnormal test results quantity, proportion of abnormal test results lacking appropriate and timely follow-up, and time (days) to follow-up.

**Statistical Analysis**

Pre-pandemic versus pandemic data were compared for each test type, including overall and abnormal test result quantities using descriptive statistics, proportions of abnormal test results
with delayed follow-up using tests of proportions, and times to follow-up using Kaplan-Meier survival analyses. Multiple comparisons were controlled for using family-wise Bonferroni adjustments (each analysis type was treated as one “family”, resulting in significance levels of $p<0.05/6=0.0083$). Statistical process control charts were used to examine whether the pandemic resulted in significant increases in delayed follow-up proportions at particular points throughout the study period (March 10, 2019–March 6, 2021). Significant increases were defined as datapoints exceeding upper control limits of 3 SDs above the mean. Analyses were conducted using StataMP 15.

**RESULTS**

E-triggers were applied to 8,021,406 veterans’ EHRs. Between pre-pandemic and pandemic periods, overall test quantities decreased by 12.6%–27.8% depending on test type, and numbers of tests with abnormal results decreased by 12.5%–22.6% depending on test type (Table 1). Proportions of abnormal test results lacking follow-up decreased from the pre-pandemic to the pandemic period for urinalyses (−0.8%, $p<0.001$), increased for FOBT/FIT (+2.3%, $p<0.001$) and chest imaging (+1.3%, $p<0.001$), and remained constant for others (Table 1). Survival analyses showed median time to follow-up of abnormal test results decreased significantly during the pandemic for all cancer-related test types examined, except AFP (Table 1).

Control charts suggested significant increases in proportions of tests with delayed follow-up at 2 stages: ‘Early’ (around the transition from pre-pandemic to pandemic periods) for urinalyses, mammograms, FOBT/FIT, laboratory results consistent with IDA, and chest imaging; and ‘Late’
(30–45 weeks into the pandemic) for mammograms, FOBT/FIT, and laboratory results consistent with IDA (Figure 1).

**DISCUSSION**

Compared to pre-pandemic levels, numbers of tests performed and resultant abnormal test results warranting additional testing for the 5 cancers studied were significantly reduced during the COVID-19 pandemic. Follow-up of such results, however, was similar except for brief periods around the beginning of the pandemic and around 30–45 weeks. This suggests that tracking of such results was not a primary issue. These findings further suggest imminent increases in late-stage diagnoses of cancers might be expected. It is thus imperative for healthcare organizations to quickly initiate outreach to patients needing evaluation to prevent collateral damage from undiagnosed conditions, like cancer. Furthermore, because it remains uncertain how long the pandemic will continue or what future national or international health crises await, organizations should take action to ensure essential follow-up and testing procedures are reliably maintained. This could include patient-directed campaigns to highlight the importance of avoiding postponing essential evaluations.

Lack of follow-up of abnormal test results had a bi-phasic pattern during the pandemic. While delayed follow-up was expected early in the pandemic due to diverted attention and overburdened systems,16 the later period of delayed follow-up suggests increased strain on healthcare services as patients reentered the healthcare system. Also, contrary to expectations, time to follow-up decreased between these early and late peaks, resulting in an overall decreased
median time to follow-up. This could relate to increased availability of diagnostic testing between these 2 peaks due to low demand.

This study’s findings are consistent with reports that cancer rates have dropped 13%–23% in the same population in a similar timeframe.\textsuperscript{17,18} These findings also show how national EHR data and algorithms to detect care gaps can elucidate temporal impacts of the pandemic on care, including collateral care processes.\textsuperscript{19}

**Limitations**

This study is limited by the pre versus post study design and an inability to directly assess causal effects of the COVID-19 pandemic on test result follow-up. Additionally, this study is limited by use of e-triggers that have inherent limitations (e.g., e-trigger positive predictive values ranged from 56%–82%\textsuperscript{12–15}). Furthermore, VA is a relatively closed system, and these findings may not generalize to other healthcare systems. Additionally, the bi-phasic delays were interpreted post-hoc and future work is needed to confirm their significance. Lastly, use of WHO’s pandemic declaration date may not exactly correspond to changes in clinical care. Nonetheless, a sensitivity analysis conducted in which each period started and ended 2 weeks earlier showed no substantive changes from these findings.

**CONCLUSIONS**

Diagnostic testing was significantly impacted by the COVID-19 pandemic, potentially leading to reductions in both early and overall new cancer diagnoses and resulting increases in delayed cancer diagnoses. While early pandemic delays in follow-up of abnormal test results warranting
evaluation for cancer may have led to some reduction in some of these cancer diagnoses, the
significant decrease in overall tests performed is likely a larger driver. Future emergency
preparedness efforts should bolster essential follow-up and testing procedures to facilitate timely
cancer diagnosis.

Ashley N.D. Meyer: Conceptualization, Methodology, Validation, Formal Analysis, Investigation, Writing – Original Draft, Visualization. Hardeep Singh: Resources, Supervision, Writing – Review and Editing, Funding Acquisition. Andrew J. Zimolzak: Conceptualization, Methodology, Validation. Li Wei, MS Software, Validation, Investigation, Data Curation. Debra T. Choi, PhD: Conceptualization, Methodology. Abigail Marinez: Project Administration. Daniel R. Murphy: Conceptualization, Methodology, Validation, Supervision, Writing – Review and Editing.
ACKNOWLEDGMENTS

The views expressed in this article are those of the authors and do not necessarily reflect the position or policy of the Department of Veterans Affairs or the U.S. government.

This work is supported in part by the Houston Veterans Administration (VA) Health Services Research and Development (HSR&D) Center for Innovations in Quality, Effectiveness and Safety (CIN 13–413). In addition, Dr. Meyer is supported by a VA HSR&D Career Development Award (CDA-17-167) and Dr. Singh is supported by the VA HSR&D Service (IIR17-127 and the Presidential Early Career Award for Scientists and Engineers 14-274), the VA National Center for Patient Safety, AHRQ (R01HS27363), the CanTest Research Collaborative funded by a Cancer Research UK Population Research Catalyst award (C8640/A23385), and the Gordon and Betty Moore Foundation (GBMF 5498 and GBMF 8838). This study has VA and Baylor College of Medicine IRB Approval (H-30995).

These data were presented at the Society to Improve Diagnosis in Medicine's 14th International Diagnostic Error in Medicine Conference on October 26, 2021, which took place virtually.

No financial disclosures were reported by the authors of this paper.
REFERENCES


https://doi.org/10.1016/S1470-2045(21)00713-0.

LIST OF FIGURES

Figure 1. For test results that warrant further evaluation for cancer, control charts show significant deviations in proportions lacking follow-up prior to and during the COVID-19 Pandemic.

Notes: Black lines indicate proportions of tests with delayed follow-up over time. Gray lines represent upper and lower control limits, which are shown without stabilization, (i.e., limits change as the sample size at each point changes). Vertical line at 0 of each x-axis indicates the transition from pre-pandemic to pandemic periods.
Table 1. Test Quantities and Follow-Up for Abnormal Results Warranting Evaluation for Cancer Before and During COVID-19

<table>
<thead>
<tr>
<th>Test type (potential cancer)</th>
<th>Number of overall tests</th>
<th>Number of tests with abnormal results</th>
<th>Proportion of abnormal results without follow-up</th>
<th>Median time to follow-up (days)</th>
<th>Significance of Difference (p-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urinalysis (Bladder)</td>
<td>7,048, 5,088, 3552</td>
<td>133,5, 66, 34,42 27.8%</td>
<td>8.7%</td>
<td>140</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Mammogram (Breast)</td>
<td>237,94, 200,01, 3</td>
<td>34,42, 5, 8 15.9%</td>
<td>19.7%</td>
<td>119</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Fecal occult blood tests or fecal immunochromotests (Colorectal)</td>
<td>479,49, 419,29, 3 12.6%</td>
<td>50,05, 9, 7 12.5%</td>
<td>31.4%</td>
<td>111</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Laboratory results consistent with iron deficiency anemia (Colorectal)</td>
<td>11,580, 8,905, 1,170 23.1%</td>
<td>158,6, 37, 37 22.6%</td>
<td>22.6%</td>
<td>149</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Alpha-fetoprotein (Liver)</td>
<td>130,37, 101,64, 1 22.0%</td>
<td>7,84, 6,073, 3 3.1%</td>
<td>3.4%</td>
<td>111</td>
<td>0.06</td>
</tr>
<tr>
<td>Chest imaging (Lung)</td>
<td>2,082, 1,566, 428 24.8%</td>
<td>49,25, 8, 38, 1 22.6%</td>
<td>33.0%</td>
<td>98</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Notes: Boldface indicates statistical significance after family-wise Bonferroni adjustment (each column of significance tests is treated as 1 “family”, resulting in a significance level of p<0.05/6 or p<0.0083).

bPandemic: March 08, 2020 to March 06, 2021.
Fig. 1