Changes in Electronic Notification Volume and Primary Care Provider Burnout

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ABSTRACT

OBJECTIVES: Electronic health record (EHR) inbox notifications can be burdensome for primary care providers (PCPs), potentially contributing to burnout. We estimated the association between changes in the quantities of EHR inbox notifications and PCP burnout.

STUDY DESIGN: In this observational study, we tested the association between the percent change in daily inbox notification volumes and PCP burnout after an initiative to reduce low-value notifications at the Veterans Health Administration (VHA).

METHODS: The VHA initiative resulted in increases and decreases in notification volumes for PCPs. For each facility, the proportion of PCPs reporting burnout was estimated using VHA All Employee Survey responses before and after the initiative in 2016 and 2018, respectively. Survey responses were aggregated for 6459 PCPs (physicians, nurse practitioners, and physician assistants) at 138 VHA facilities. Fixed effects regression models estimated the association of small and large increases and small and large decreases in notifications on burnout.

RESULTS: Daily inbox notifications per PCP decreased by a mean (SD) of 5.9% (30.1%) across study facilities, from a mean (SD) of 128 (52) notifications to 114 (44) notifications after the initiative. Fifty-one percent of facilities experienced reductions in notifications, 30% experienced no change, and 20% experienced increased notifications. PCP burnout was not significantly associated with any level of increase or decrease in notifications.

CONCLUSIONS: Changes in notification volumes alone did not predict PCP burnout. Future research to reduce burnout might still address EHR notification volumes, but as part of a broader set of strategies that consider the other stressors that PCPs experience.

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Although electronic health records (EHRs) improve data management and communication within health care, they can be a source of stress and job dissatisfaction for health care providers.[1-6] For primary care providers (PCPs), the EHR inbox is important for communication of test results, referrals, medication refills, and messages.[2] PCPs spend approximately 1 to 2 hours or more per day managing asynchronous EHR inbox notifications.[7-9] EHR tasks can be time intensive and inefficient and can compete with direct patient care; they may also spill into personal time and could contribute to burnout.[1,4,10-13]

Burnout—typified by physical, mental, and emotional responses to stressors at work—is common among PCPs, affecting half of physicians in primary care and up to one-third of nurse practitioners (NPs) and physician assistants (PAs).[4,14-17] Optimizing complex and cumbersome EHR systems could potentially improve the working environment for PCPs, who are among the highest users of EHRs. Decreasing the stress and fatigue related to managing inbox notifications might improve PCP well-being.[12] In the Veterans Health Administration (VHA), 87% of PCPs reported that inbox notification levels were unmanageable, potentially risking patient safety via care delays from missed test result notifications.[18] However, evidence on inbox notifications and burnout is equivocal. The concurrent measurement of notifications and burnout in recent studies also limits inference on the effect of notification volume on burnout.[3,9,19,20] Although notifications are notably burdensome, one study found that notification process time did not predict burnout in physicians.[9] Other studies correlated high notification volumes with provider burnout[20] and emotional exhaustion.[19]

It is unclear whether reducing inbox notification burden could reduce burnout. In 2017, the VHA launched a nationwide initiative to address unmanageable notification volumes by optimizing notifications received by PCPs (also called view alerts).[21] During the initiative, each facility formatted its EHR interface to include a mandatory set of notifications based on VHA and facility priorities (eg, critical laboratory values), trained PCPs in EHR customization of optional notifications, and tracked preinitiative and postinitiative notification levels for samples of PCPs at each facility.[21-23] After the

TAKEAWAY POINTS

Automated notifications in the electronic health record (EHR) are a pervasive source of digital workload and fatigue for primary care providers (PCPs). We tested whether provider burnout changed after an initiative was implemented at the Veterans Health Administration to optimize electronic inbox notification volumes.

- We did not find any association between increases or decreases in notification volumes and burnout.
- Reducing notifications alone is likely insufficient to improve burnout.
- Future research should consider multiple aspects of EHR inbox design, in addition to volume, when considering the effects of notification burden on PCPs.

initiative, large shifts in daily notification volume were observed within some VHA facilities (ie, increases or decreases of up to 100 notifications per PCP per day) but not at others.[21] Assessing the dose-response relationship between notifications and burnout can help determine whether reducing inbox notification volume is sufficient to reduce EHR-related stress. For this study, the initiative served as a natural experiment to test the association between burnout and changes in inbox notification volumes.

METHODS

Study Design and Setting

In this observational study, we linked estimates of inbox notification volumes before and after the VHA's EHR initiative with serial cross-sectional survey-based estimates of PCP burnout for 138 VHA facilities. The VHA is among the largest health care systems in the United States, and each VHA facility is composed of a local network of a medical center and multiple community clinics. At the time of the inbox notification initiative, the VHA employed the Computerized Patient Record System (CPRS) to manage patient care within the VistA system, the VHA's integrated EHR. Inbox notifications within the CPRS alert staff to clinical workflow tasks, including laboratory and imaging results, medication refills, messages from colleagues and patients, referral follow-up, and signature requests.[22] In some cases, these notifications address critical items needing providers' attention, such as abnormal imaging results. Other notifications are of lower value for providers, such as notification of a patient no-show for an appointment. These notifications may be better handled by someone other than the provider.[21] PCPs manage dozens to hundreds of inbox notifications daily.[7,21] The CPRS inbox allows for user customization, such as through enabling or disabling nonmandatory notifications.[5,24] Mandatory notifications generally require action and were further described by Shah and colleagues.[21]

Data and Study Population

Inbox notification data were collected by VHA operations during the inbox notification initiative and were measured before and after the initiative for a subset of PCPs for each facility. A team at the Michael E. DeBakey Veterans Affairs Medical Center in Houston, Texas, performed an evaluation of the initiative; notification volume data were provided by this study team. Although the inbox notification initiative affected providers across specialties, PCPs managed the most inbox notifications[7] and were the focus of the initiative. The initiative resulted in a mean decrease in notifications,[21,25] and approximately 97% of PCPs were trained on EHR inbox optimization.[21]

For the present study, notification data were limited to VHA facilities with primary medical centers located in the United States. In the original data, some facilities were split into subfacilities. In these few instances, notification volumes for the main medical center were measured independently of other clinics within the facility. These facilities were also omitted because burnout was measured across facilities as a whole. The final sample included 138 facilities.

PCP burnout was estimated for each VHA facility using aggregated responses to the VHA's annual workforce survey, the All Employee Survey (AES), which is collected each spring.[26] This anonymous survey assesses employee attitudes and the workplace environment through questions on topics including job satisfaction, social support, turnover intentions, and burnout. Within each facility, individual AES responses were aggregated for respondents who indicated being a PCP (physician, NP, or PA) and working in primary care (ie, a member of a patient-aligned care team) on the survey. Aggregate responses were reported as proportions (eg, the proportion of PCPs at a facility who were women or who reported burnout). AES response rates for VHA staff were 57% in 2016, 60% in 2017, and 62% in 2018.[26-28]

Aggregate AES data were combined into a serial cross-sectional data set from 2016 to 2018 using facility identifiers. Notification volume data were linked to aggregate AES data for 2016 (preinitiative) and 2018 (post initiative). The 2017 AES collection overlapped with the inbox notification initiative, so to ensure a valid exposure timeline, AES data for 2018 were used to estimate postinitiative burnout. The 2017 AES data were used for the description of burnout trends but omitted for inferential analyses. As per data use agreements, we complied with a minimum aggregation requirement of 10 AES respondents for facility-level measures. This resulted in the exclusion of 15.8% of facility-level observations, primarily from smaller VHA facilities. Also, for some facilities, data were used only for either 2016 or 2018 due to the minimum aggregation requirements. The final sample included 6459 PCP survey respondents aggregated for 138 VHA facilities in 2016 and 2018.

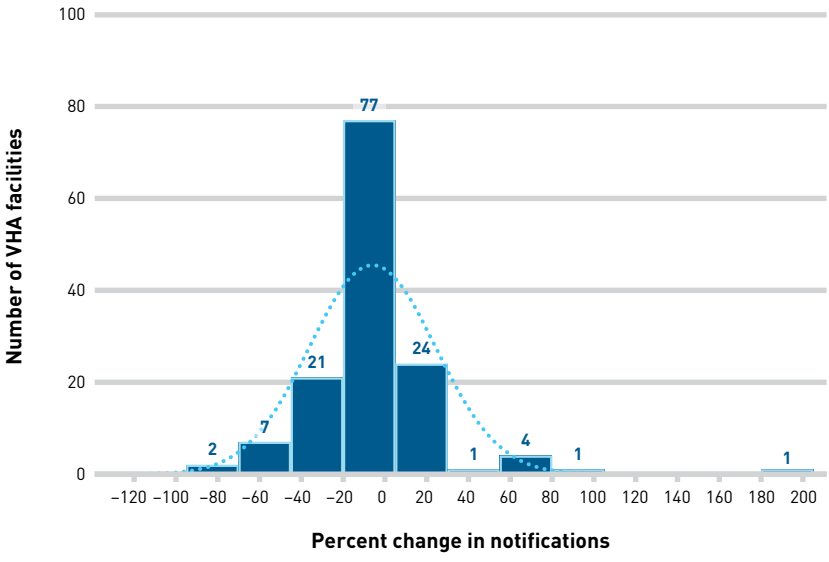
Measures

VHA facilities were categorized into 5 groups based on their postinitiative change in notification volume. Using the distribution of the percent change in the mean number of inbox notifications per PCP per day for facilities, we differentiated the facility groups with cut points of ± 0.25 SD and ± 1 SD away from the mean change in

notification volume for all VHA facilities. The 5 groups were composed of facilities with (1) a large decrease (> −1 SD of the distribution of percent change in notifications), (2) a small decrease (−0.25 to −1 SD), (3) no change (−0.25 to +0.25 SD), (4) a small increase (+0.25 to +1 SD), and (5) a large increase (> +1 SD) in the percent change in notification volume. Facility group was the primary exposure in this study.

The primary outcome was the prevalence of burnout among PCPs at each facility. The AES includes 3 questions based on each of the 3 dimensions of burnout characterized within the Maslach Burnout Inventory[29,30]: emotional exhaustion, depersonalization, and reduced achievement. Consistent with previous literature, we constructed a composite measure of burnout from the emotional exhaustion ("I feel burned out from my work") and depersonalization ("I worry that this job is hardening me emotionally") questions.[30-32] These questions were assessed on a 7-point Likert scale of the frequency of burnout symptoms, ranging from never to every day. We defined burnout as answering "once a week," "a few times a week," or "every day" to the emotional exhaustion and/or the depersonalization questions.[14,31] Burnout was calculated as the proportion of PCP survey respondents at a facility who screened positively for burnout.

FIGURE 1. Histogram of VHA Facilities (N = 138) by Percent Change in Mean Daily Inbox Notifications per PCP After the Inbox Notification Initiative[a]



PCP, primary care provider; VHA, Veterans Health Administration.
[a]There was a mean (SD) decrease of 5.9% (30.1%) in daily inbox notifications.

Characteristics of the PCP samples at each facility were determined from aggregate AES measures of PCP respondent gender, age, and VHA tenure. Gender (ie, the proportion of PCP respondents who were women), age (ie, the proportion of PCP respondents younger than 50 years), and short VHA tenure (ie, the proportion of PCP respondents with a VHA tenure of less than 5 years) were used as precision variables. Younger age, female gender, and shorter tenure were previously associated with burnout in providers.[33,34]

Statistical Analyses

Characteristics of PCPs in each of the 5 facility groups were described using AES data for the number, age, gender, and tenure of PCP survey respondents. Inbox notification volume was described for each of the 5 facility groups pre- and post initiative. To describe burnout levels pre- and post initiative, mean PCP burnout proportions were plotted from 2016 to 2018 for the facility groups.

Fixed effects (FE) linear regression models were used to estimate the effect of the level and direction of changes in inbox notification volume on the proportion of PCP burnout at the facility level. FE models are useful for limiting bias from confounding in panel data, and they rely on variability in the exposure over time to estimate the effect of the exposure on an outcome.[35] For this study, the base FE model (model 1) estimated the effect of the changes in notification volume on PCP burnout for facilities that experienced small and large increases and small and large decreases in notification volume. The base and adjusted models included an indicator for year to assess secular trends in PCP burnout due to unobserved factors over the study period. The adjusted FE model (model 2) of changes in notification volume and burnout included age, gender, and short tenure as precision variables in addition to the year indicator. A fixed effect for VHA facility accounted for time-invariant confounding, or the bias associated with unobserved heterogeneity among VHA facilities. Effectively, each facility served as its own control by estimating the burnout–notification volume relationship in comparison with its own preinitiative PCP burnout prevalence.[36] We used robust SEs, clustered by facility, in both models. This study was approved by the VA Puget Sound Health Care System and University of Washington institutional review boards. All analyses were performed using Stata version 17 (StataCorp), and reporting followed STROBE guidelines (**eAppendix** [available at **ajmc.com**]).

RESULTS

After the inbox notification initiative, mean (SD) daily inbox notifications for VHA facilities decreased from 128 (52) inbox notifications preinitiative (range, 31-378) to 114 (44) inbox notifications post initiative (range, 40-329). Daily inbox notifications decreased by a mean (SD) of 5.9% (30.1%) post initiative, ranging from a 71% decrease to a 200% increase in notifications (**Figure 1**). Based on the distribution of percent change in inbox notifications, ±1 SD equated to a ±30% change in notifications and ±0.25 SD equated to a ±7% change in notifications.

TABLE 1. Summary Statistics for PCP All Employee Survey Respondents and the Inbox Notification Initiative at VHA Facilities (n = 138)

	Facility group				
	Facilities with no change in notifications (within ±7%) n = 41	Facilities with a reduction in notifications of > 30% n = 20	Facilities with a reduction in notifications between 7% and 30% n = 51	Facilities with an increase in notifications between 7% and 30% n = 19	Facilities with an increase in notifications of > 30% n = 7
PCP All Employee Survey respondents in 2016, mean (SD)					
Number of PCP respondents per facility	25 (13)	23 (11)	28 (15)	23 (14)	20 (10)
Proportion with short VHA tenure (< 5 years)	0.43 (0.16)	0.41 (0.16)	0.44 (0.15)	0.43 (0.14)	0.39 (0.14)
Proportion aged < 50 years	0.41 (0.14)	0.35 (0.12)	0.39 (0.13)	0.35 (0.12)	0.43 (0.12)
Proportion female	0.56 (0.12)	0.51 (0.12)	0.55 (0.13)	0.54 (0.16)	0.46 (0.17)
Inbox notification initiative[a] results, mean (SD)					
Preinitiative daily inbox notifications[b] (2016)	123 (45)	159 (69)	132 (51)	113 (40)	83 (30)
Postinitiative daily inbox notifications[b] (2018)	122 (44)	83 (32)	111 (44)	130 (44)	142 (40)

PCP, primary care provider; VHA, Veterans Health Administration.

[a]The inbox notification initiative occurred in 2017.

[b]Daily inbox notifications were estimated as the mean number of inbox notifications per PCP per day.

The 5 facility groups were distributed as follows: (1) large decrease facilities, which had a reduction in inbox notifications greater than 30% (14.5% of facilities; n = 20); (2) small decrease facilities, with a 7% to 30% reduction in inbox notifications (37.0% of facilities; n = 51); (3) no change facilities, with a change in inbox notifications within ± 7% (reference category; 29.7% of facilities; n = 41); (4) small increase facilities, with a 7% to 30% increase in inbox notifications (13.8% of facilities; n = 19); and (5) large increase facilities, with an increase in inbox notifications greater than 30% (5.1% of facilities; n = 7).

Table 1 describes PCP sample characteristics and inbox notification volume results for these 5 facility groups. Across the groups, 46% to 56% of PCPs at VHA facilities were women, 35% to 41% were younger than 50 years, and 39% to 44% had VHA tenures shorter than 5 years. Facilities with a large decrease in inbox notifications (> 30%) had both the highest levels of preinitiative notifications (mean [SD], 159 [69]) and the lowest levels of postinitiative notifications (mean [SD], 83 [32]). Facilities with a large increase in inbox notifications (> 30%) had both the lowest levels of preinitiative notifications (mean [SD], 83 [30]) and the highest levels of postinitiative notifications (mean [SD], 142 [40]).

From 2016 to 2018, PCP burnout decreased for all VHA facilities (**Figure 2**). Burnout in facilities that experienced no change in inbox notifications decreased from 51.1% in 2016 to 43.8% in 2018. PCP burnout was initially highest for facilities that had a large increase in notifications (>30%), at a mean (SD) of 61.3% (11.9%), although burnout in these facilities decreased to 46.3% (14.2%) by 2018.

In both the base and adjusted models (**Table 2**), neither small nor large increases or decreases in notification volume were significantly associated with facility-level PCP burnout. However, PCP burnout decreased significantly over the study period. In 2018, PCP burnout was 7.3 percentage points lower (95% CI, −11.4 to −3.3) in the base model compared with 2016 and 6.4 percentage points lower (95% CI, −10.4 to −2.4) in the adjusted model compared with 2016.

DISCUSSION

A VHA-wide initiative to improve its EHR-based inbox notification system resulted in large changes in inbox notification volume at VHA facilities. However, neither increases nor decreases in notification volumes were associated with PCP burnout. To our knowledge, this is the first study to go beyond cross-sectional associations and test burnout in response to a change in EHR notification volume in primary care. Although previous findings on notification-related work burden and burnout are mixed,[9,19,20] our finding suggests that reducing inbox notification volume was not sufficient to have a measurable effect on burnout.

Notification volumes observed in this study were comparable with previous estimates at the VHA.[7,21] Although the inbox notification initiative focused on reducing burdensome EHR messages, inbox optimization did not always result in a reduction in notification volume. Almost 20% of facilities in this study saw an increase in their notification volume post initiative. Although compliance with the initiative was high across VHA facilities, notification volumes varied widely among facilities, even with the initiative's mandatory notification guidelines and PCP training.[21] The multisite nature of this study demonstrates the wide range in notification volumes that PCPs may experience, depending on personal and organizational preferences. Also, some VHA facilities had already made substantive improvements to their inbox systems, reducing notifications prior to the initiative. These facilities may have increased their notification

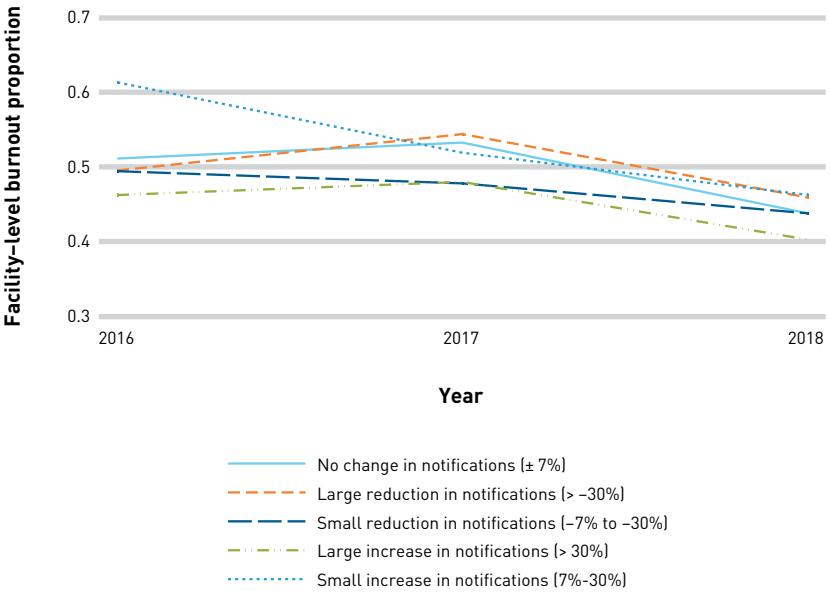
volumes because they were required to comply with the initiative.[21]

Although our findings contrast with those of recent research relating message volume to increased PCP burnout,[19,20] these prior studies relied on concurrent cross-sectional measurement of message volume and burnout. By assessing change in notification volume within facilities, we controlled for confounding and questions of temporality, which are problematic in cross-sectional research. Our findings support the position that there may not be an optimal number of notifications to minimize PCP burnout, at least at the levels observed in this study.

Although the VHA-wide inbox notification initiative was not specifically directed at reducing burnout, it was developed in recognition that EHR-related workload is a central facet of PCP work life. Patient and job-specific needs may dictate inbox optimization by PCPs. One prior study of missed test results in EHRs found that notification volume was limited in predicting information overload.[18] Another study identified numerous aspects of EHRs that may be associated with burnout, including excessive data entry and slow system response time.[6] Optimizing how and when notifications are displayed is important to the user's experience.

In this study, we did not differentiate among notification types. Despite contributing to notification volume, some types of notifications likely contributed little to notification-related workload, whereas others contributed more. For example, the initiative emphasized reducing duplicative notifications and notifications that required reading time but not additional PCP actions. These particular notifications may not have been time intensive. Also, the number of mandatory notifications was reduced by up to one-third for some facilities.[21] Some decrease in notifications may be attributed to turning off lower-value notifications that PCPs spent little time on or had previously ignored outright. Notification volume alone may be a poor measure of the actual effort required for inbox management. Although substantial increases and decreases in notification volume may reflect improved EHR utilization, changes in notification volume may not have influenced aspects of EHR-related workload that

FIGURE 2. Fit Plot of PCP Burnout Proportion From 2016-2018 for the 5 VHA Facility Groups Defined by Postinitiative Change in Inbox Notifications



PCP, primary care provider; VHA, Veterans Health Administration.

TABLE 2. Associations Between Change in Daily Inbox Notifications and Proportion of PCP Burnout at VHA Facilities

	Model 1: base model		Model 2: adjusted model	
	Coefficient[a]	95% CI	Coefficient[a]	95% CI
Facility group by percent change in notification volume				
Reduction of > 30%	0.041	–0.053 to 0.135	0.036	–0.057 to 0.129
Reduction between 7% and 30%	0.018	–0.041 to 0.078	0.011	–0.045 to 0.069
Increase between 7% and 30%	0.016	–0.076 to 0.109	–0.004	–0.102 to 0.094
Increase of > 30%	–0.051	–0.159 to 0.058	–0.072	–0.168 to 0.024
Year				
2016 (reference)	—		—	
2018	–0.073	–0.114 to –0.033	–0.064	–0.104 to –0.024
Short VHA tenure (< 5 years)[b]	—		–0.092	–0.333 to 0.150
Aged < 50 years[c]	—		–0.184	–0.446 to 0.079
Female[d]	—		0.035	–0.172 to 0.242
Constant	0.500	0.486-0.514	0.592	0.419-0.765

PCP, primary care provider; VHA, Veterans Health Administration.

[a]Coefficient represents the change in the proportion of PCPs reporting burnout at a VHA facility.

[b]Proportion of PCPs with a VHA tenure of less than 5 years. Coefficient estimate is the effect of having short tenure compared with a tenure of at least 5 years on PCP burnout.

[c]Proportion of PCPs younger than 50 years. Coefficient estimate is the effect of being younger than 50 years compared with 50 years or older on PCP burnout.

[d]Proportion of PCPs who were women. Coefficient estimate is the effect of female gender compared with male gender on PCP burnout.

are predictive of burnout.[37] Assessment of notification type, value, and cognitive burden may improve measures of EHR notification burden, which may then be associated with burnout. Further work is needed to understand how time spent on low-value notifications and sufficient work time to respond to notifications can influence PCP fatigue and burnout.[13]

Health systems are uniquely positioned to mitigate burdensome aspects of EHRs through improved EHR systems design.[20] Ensuring that EHR notifications are relevant and actionable rather than purely informational[2]; continually monitoring utilization patterns to identify low-value notifications or the efficacy of new and automated notifications[20,38]; innovating the design and visual display of notification systems; and ensuring that users can quickly navigate through EHR interfaces may all enhance EHR operability.[6,23,38] PCPs spend more time on inbox messaging than do clinicians in other medical or surgical specialties,[39] and interventions reducing EHR work burden should consider PCPs' specific needs. Collaboration between health system leaders and PCPs on EHR design, with a focus on staff well-being, is essential.[20,40]

Limitations

This study relied on annual surveillance of burnout among VHA PCPs. To reduce overlap between the AES collection and inbox notification initiative implementation, we used 2018 rather than 2017 burnout estimates post initiative. Notification levels at facilities may have changed in the time between the initiative and the 2018 AES collection, or the effect of the initiative may have waned in the interceding time. Survey response bias is also a concern and could lead to underreporting of burnout (eg, if PCPs experiencing higher burnout declined survey participation) and potential underestimation of burnout. Also, staffing information on full-time equivalency of PCPs, or the number of PCPs contributing to the mean measurement of daily notifications, was not available. This could affect accuracy of inbox notification measurement.

The VHA uses a unique EHR, and notification volume estimates used in this study were VHA specific. We categorized facilities into 5 facility groups based on the distribution of postinitiative percent change in notifications, although burnout was potentially affected by changes in notification levels for reasons other than the initiative. Facilities where inbox notification counts increased may have conducted previous EHR efficiency work. Also, unmeasured factors influencing PCP burnout occurring simultaneously at the VHA, such as other EHR improvements, could confound the relationship between notification volume changes and burnout. Lastly, the group of facilities in which notifications increased by more than 30% was small (n = 7) and potentially underpowered.

CONCLUSIONS

Asynchronous inbox notifications can be time-consuming and burdensome for PCPs. We hypothesized that decreasing inbox notifications would reduce PCP burnout; however, we did not observe any effect on burnout, even though the VHA's initiative resulted in substantial decreases in notifications in some facilities but not others. Other characteristics of inbox notifications that we did not measure may be important. Future research on burnout must evaluate characteristics such as notification type and value and time spent managing notifications, especially through use of causal study designs. As EHR systems evolve, health systems should work with PCPs to identify effective and efficient solutions that improve EHR use and support staff well-being. ■

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eAppendix. STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	4
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5-6
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	6-7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-8
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	7-8
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	N/A
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	8-9
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7-9
Bias	9	Describe any efforts to address potential sources of bias	10
Study size	10	Explain how the study size was arrived at	7-8
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8-10
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	10
		(*b*) Describe any methods used to examine subgroups and interactions	N/A
		(*c*) Explain how missing data were addressed	8
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	10
		(*e*) Describe any sensitivity analyses	N/A

Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	11
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	11
		(b) Indicate number of participants with missing data for each variable of interest	N/A
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	N/A
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	N/A
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	N/A
		Cross-sectional study—Report numbers of outcome events or summary measures	11-12
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	12
		(*b*) Report category boundaries when continuous variables were categorized	12
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	N/A
Discussion			
Key results	18	Summarise key results with reference to study objectives	12
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14-15
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12-14
Generalisability	21	Discuss the generalisability (external validity) of the study results	15
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	2-3

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.