Pre-post Evaluation of Automated Reminders May Improve Detection and Management of Post-stroke Depression

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BACKGROUND: Post-stroke depression (PSD) occurs in at least one-third of stroke survivors, is associated with worse functional outcomes and increased mortality, and is frequently underdiagnosed and undertreated.

OBJECTIVE: To evaluate the effectiveness of an electronic medical record-based system intervention to improve the proportion of veterans screened and treated for PSD.

DESIGN: Quasi-experimental study comparing PSD screening and treatment among veterans receiving post-stroke outpatient care one year prior to the intervention (the control group) to those receiving outpatient care during the intervention period (the intervention group); contemporaneous data from non-study sites included to assess temporal trends in depression diagnosis and treatment.

PARTICIPANTS: Veterans hospitalized for ischemic stroke and/or receiving primary care (PC) or neurology outpatient follow-up within six months post-stroke at two (Veterans Affairs) VA Medical Centers.

INTERVENTIONS: We formed clinical improvement teams at both sites. Teams developed PSD screening and treatment reminders and designed tailored implementation strategies for reminder use in PC and neurology clinics.

MAIN MEASURES: Proportion screened for PSD within 6 months post-stroke; proportion screening positive for PSD who received an appropriate treatment action within 6 months post-stroke.

KEY RESULTS: In unadjusted analyses, PSD screening was performed within 6 months for 85% of intervention (N=278) vs. 50% of control (N=374) patients (OR 6.2, $p < 0.001$), and treatment action was received by 83% of intervention vs. 73% of control patients who screened positive (OR 1.8 $p = 0.13$). After adjusting for intervention, site and number of follow-up visits, intervention patients were more likely to be screened (OR 4.8, $p < 0.001$) and to receive a treatment action if screened positive (OR 2.45, $p = 0.05$). Analyses of temporal trends in non-study sites revealed no trend toward general increase in PSD detection or treatment.

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CONCLUSIONS: Automated depression screening in primary and specialty care can improve detection and treatment of PSD.

KEY WORDS: depression; stroke; quality improvement; computerized reminders.

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INTRODUCTION

Evidence indicates that 25-40% of stroke patients suffer from post-stroke depression (PSD), equally divided between major depression and other depressive disorders.¹⁻⁴ Given that there are at least 795,000 ischemic strokes yearly in the U.S.,⁵ a conservative estimate is that almost 180,000 U.S. stroke survivors develop PSD annually.

PSD is associated with worse functional outcomes, quality of life, and increased post-stroke mortality.⁶⁻⁹ Our prior work has demonstrated that these effects are present in veterans with PSD, as we found that those with a new depression diagnosis post-stroke had a 25% increase in mortality⁹ and health care utilization¹⁰ post-stroke.

Although effective treatments for PSD exist,¹¹⁻¹⁴ VA (Veterans Affairs) and non-VA studies have documented that a significant proportion of patients with PSD do not receive consistent treatment.^{15,16} Even though the VA has effectively implemented annual depression screening in primary care (PC) clinics, with recent composite behavioral screening rates above 90% in all VA regions,¹⁷ and the majority of veterans with diagnosed depression receive an antidepressant,^{18,19} the duration and follow-up of antidepressant treatment is frequently inadequate.¹⁸⁻²⁰ Despite their higher risk of depression, veterans with recent ischemic stroke, have not been targeted for depression screening. Some studies suggest that disease-specific quality improvement efforts are likely necessary to achieve improvements in depression care and outcomes,²¹ and our prior data show that veterans and VA providers report unique difficulties with depression recognition and treatment post-stroke.²²

Based on this prior work, we developed this study to improve PSD screening among veterans with recent ischemic stroke and to support providers in taking action when PSD is identified. The primary objectives of this study were to: 1)

develop automated PSD screening and treatment reminders; and 2) test the effect of reminder use on PSD screening and treatment prevalence.

METHODS

This study used a quasi-experimental design to assess pre-post change in depression screening and treatment in veteran ischemic stroke survivors receiving care at two VA Medical Centers (VAMCs) over approximately four years (Fig. 1). The pre-intervention (control) period included patients admitted for ischemic stroke at both facilities from 9/14/05 to 9/14/06. The intervention period included those admitted during the period 9/15/06 through 12/31/08; a longer time period was chosen to maximize case ascertainment. All stroke cases during both periods were followed for 6 months post-discharge to ascertain PSD screening and treatment. As temporal controls, we also analyzed PSD diagnosis and treatment data from national VA databases for all non-intervention facilities in the same Veteran Integrated Service Networks (VISNs) as the two intervention facilities. Temporal controls were ascertained for the identical time periods (9/14/05-9/14/06 for control case ascertainment with follow-up through 3/14/07 and intervention case ascertainment 9/15/06 through 12/31/08 with follow-up through 6/1/09). This study was approved by the local institutional review boards and the local VA Research and Development Committees.

Setting/participants. This study was conducted at the Roudebush VAMC in Indianapolis and the Malcom Randall VAMC in Gainesville, Florida. Both sites are large, tertiary VAMCs in the highest VA complexity level (i.e. high-risk patient population, high involvement in teaching and research activities, large number and breadth of specialists, high volume, and presence of level five intensive care units) that have inpatient and outpatient neurology services and PC and neurology trainees.^{23,24} The study involved development of a clinical team at each site, and subsequent development and implementation of a depression screening reminder for nurses and a depression treatment reminder for providers in the primary care (PC) and neurology clinics. Since the intervention was at the facility level, all veterans receiving post-stroke care within 6 months of stroke discharge during the study period

and the control period were included. Those whose last neurology or PC clinic visit within the follow-up period was on or after the date the reminder was implemented in that clinic (i.e. they had a clinic visit where they were eligible to be screened with the intervention PSD screener) were included in the intervention group (Fig. 1). Those whose last follow-up visit was prior to the date of reminder implementation or whose follow up visits were not in PC or neurology were included in the control group.

We identified participants using a modification of the Reker high specificity algorithm²⁵ that included veterans with primary position discharge ICD9 codes 433.x1, 434.x, and 436.x, and veterans with these codes added at the time of an outpatient PC or neurology visit during the study period. We conducted chart review of all cases identified to determine their eligibility for study inclusion and to collect data on depression screening, depression treatment, and follow-up.

Clinical team development. The research team facilitated the formation of local clinical teams at both sites consisting of a provider clinical champion from neurology or PC, a nurse leader, and other staff involved in the outpatient PC and neurology clinics as identified by the clinical champions.²⁶ The teams met to discuss current depression screening strategies in use, special requirements for implementation of depression screening for stroke patients, adapting the existing PC depression screener (the two-item Patient Health Questionnaire, or PHQ-2),²⁷ and the development of a provider-specific PSD treatment reminder.

Intervention development. At both sites, the screening and treatment reminders were based on three of the four major elements of the Chronic Care Model (Delivery System, Decision Support, Clinical Information System),²⁸ with local tailoring for specific organizational structure and existing screening, referral, and prescribing systems. Both sites were using the PHQ2 for annual depression screening, but the PSD screener used the PHQ-9,²⁹ based on clinician feedback on perceived increased validity of adding the seven additional items post-stroke. Other modifications to the existing annual depression screener implemented at both sites included: 1) PSD reminder launched in veterans with a primary position stroke ICD9 discharge diagnosis code; 2) Screening triggered at PC and/or neurology clinic visits for six months following the stroke discharge date; and 3) Screening not triggered if depression

Figure 1. Study temporal schematic.

screening present in the prior 30 days. Language introducing the PHQ9 screener and the PHQ9 items were identical at both sites.

When the screening result was positive (PHQ9 score ≥ 10), it triggered the electronic PSD treatment reminder. At both sites, the provider treatment reminder displayed the patient's PHQ9 responses, gave identical information about PSD and its impacts, included a link to treatment evidence, prompted a variety of actions (e.g. medication ordering, mental health consult ordering), and provided a means of identifying when a patient declined treatment. The decision support elements were identical at the sites, but consultation ordering instructions and medication ordering options differed slightly according to the local practice options available. Although both sites developed the intervention to launch during follow-up in either PC or neurology clinics, one site was only able to operationalize the screening reminder in PC due to changes in the local care delivery system.

Outcome assessments. We used electronic reminder reports and chart reviews to document PSD screening and treatment actions. Reports were automatically generated when either the PHQ2 or the PSD reminder were used. Reminder use was verified by chart review of the automated text inserted in the electronic nurses note, and provider notes were also reviewed to document screening and treatment as described above. The primary outcomes were the subject-level PSD screening prevalence and, for those who screened positive, the PSD treatment prevalence.

PSD screening was defined as use of any formal screening tool (PHQ9, PHQ2) or evidence of informal screening via review of provider notes. Chart abstractors were trained to use a standard list of terms that identified provider documentation of questions about depression symptoms. The subject level depression screening prevalence was calculated as the proportion of subjects receiving PC or neurology follow-up who had any PSD screening within 6 months after discharge. The PSD screening denominator included all stroke patients seen in the target clinics within 6 months of stroke discharge. The PSD screening numerator was defined as use of: 1) the PSD screening reminder, 2) use of the PHQ-2, 3) use of the PHQ-9 (non-stroke related PC screener used in some clinics during the study), or 4) any other provider indication of informal depression screen (narrative text documenting presence or absence of depression symptoms, depression diagnosis or treatment, new order for antidepressant medication without mention of another indication, placing a consult to a mental health provider, or documentation that the patient declined depression treatment in the provider note).

PSD treatment was intentionally defined as a provider taking any one of several potentially appropriate actions in response to a positive PSD screen. Actions counted as PSD treatment included: prescribing a new antidepressant, adjusting a current antidepressant, continuing an antidepressant without change if it had been started within 6 weeks of the visit, or submitting a consult to a mental health specialist. Documentation of a patient declining offered treatment was an action that counted as PSD treatment. The subject level treatment prevalence was calculated as the proportion of subjects screening positive for PSD at least once during 6 months of follow-up (the denominator) who

received at least one treatment (appropriate provider action) in response to a positive PSD screening (the numerator).

Other measured covariates. We also assessed the number of outpatient visits to PC and neurology clinics during the six months post-stroke. We computed the proportion of all stroke patients in the intervention and control groups who had a PC visit during this period to describe the general practice patterns over time.

Assessment of temporal trends. To determine whether temporal trends in depression diagnosis and treatment could contribute to differences in screening and treatment rates observed across study groups, we analyzed national VA administrative data for the 12 non-intervention facilities in the same VISNs as the two intervention sites. We designated the control period and the intervention period using the same dates as for the control and intervention study groups (Fig. 1). We also used the same ICD9 codes to identify the temporal trend cohort as were used to identify the study cases and controls. For depression diagnosis prevalence we included all subjects with at least one outpatient visit in PC, neurology, or mental health clinics during the first 6 months post-stroke as the denominator and those with diagnosis of depression as the numerator (see online [Appendix](#)). We assessed outpatient prescription data for antidepressant medications in the same 6 month period, excluding low dose tricyclic and other antidepressants commonly used for non-depression indications.¹⁸ We computed prevalence of treatment among those with at least one diagnosis of depression in the denominator and those with at least one antidepressant prescription or mental health visit in the numerator.

Analyses. Our primary analyses were performed at the subject level. Continuous variables were compared between the intervention group and the control group at the two intervention sites using two-sample t tests. All the analyses were performed using SAS® 9.2 (Cary, NC).

Differences in the screening rates, depression rates, and treatment rates between intervention and control groups were compared using odds ratios with 95% confidence intervals and Chi-square tests. We used logistic regression models to estimate the adjusted intervention effect on screening and treatment. Based on the bivariate analyses, independent variables included in the models were intervention group, site, and number of outpatient visits.

RESULTS

The intervention cohort included 278 veterans; the control cohort included 374 veterans. More than 98% were male, 71% were Caucasian, 17% African American, mean age was 65 years (SD 11.1). No differences in demographic characteristics were observed between the intervention and the control cohorts (Table 1). The intervention group had slightly more visits within 6 months of discharge (mean 2.8 visits vs. 2.3 in the control group ($p < 0.001$), but the proportion of patients with PC follow-up was similar.

Table 1. Demographic and Outpatient Follow-up Characteristics

	Control Group (N=374)	Intervention Group (N=278)	P
% Male	366 (98.1%)	273 (98.2%)	0.94
% Caucasian	265 (70.9%)	196 (70.5%)	0.63
Mean (SD) Age	64.6 (10.9)	65.8 (11.2)	0.16
Outpatient follow-up			
Mean (SD) # visits	2.3 (1.3)	2.8 (1.6)	<.0001
% with PC follow-up	356 (95.2%)	256 (92.1%)	0.10

Depression screening and treatment results. In unadjusted analyses, depression screening was accomplished in 86% of the intervention group vs. 50% of the control group (OR 6.2, $p<0.001$, Table 2). The majority of the formal screening done in the intervention group was done with the PSD reminder. 42% of the intervention group screened positive at least once during 6 month follow-up compared to 32% of the control group ($p=0.03$). Action was taken in 83% of the positive screens in the intervention group vs. 73% in the control group (OR 1.8, $p=0.13$). The most common action was prescribing, changing, or continuing an appropriate antidepressant medication. Approximately 14% of patients in each group declined recommended treatment.

In the adjusted PSD screening model (Table 3), intervention group and number of outpatient visits were independently associated with screening. In the adjusted treatment model, the intervention was the only variable independently associated with treatment. Site was not associated with either model, and both sites demonstrated significant improvement in screening in the intervention compared to the control cohort (Site 1: 87% vs. 61%, $p<0.001$; Site 2: 82% vs. 46%, $p<0.001$). We did not adjust for patient demographics in either model as demographics did not differ between the two groups.

Table 2. Unadjusted Depression Screening and Treatment Outcomes

	Control Group (N=374)	Intervention Group (N=278)	P	OR (95% CI)
PSD screening N (%)	188 (50.3%)	240 (86.3%)	<.0001	6.2 (4.2, 9.3)
Used PSD screening reminder	NA	194 (69.8%)		
Used other formal screener	136 (36.4%)	137 (49.3%)		
Informal screen	81 (74.3%)	89 (80.9%)		
Positive screening N (%)	60 (31.9%)	102 (42.5%)	0.03	
Used PSD treatment reminder	NA	33 (32.4%)		
Action taken N (%)	44 (73.3%)	85 (83.3%)	0.13	1.8 (0.8, 3.9)
Any treatment	38 (86.4%)	73 (85.9%)		
Antidepressant prescribed or continued	31 (70.4%)	64 (75.3%)		
Mental Health referral only	6 (13.6%)	5 (5.9%)		
Declined recommended treatment	6 (13.6%)	12 (14.1%)		

NA=not applicable

Table 3. Multivariate Models of PSD Screening and Treatment

	PSD Screening Model		PSD Treatment Model	
	OR (95% CI)	P	OR (95% CI)	P
Intervention	4.78 (3.04, 7.52)	<.0001	2.45 (1.00, 6.99)	0.05
Site 1 vs. Site 2	0.71 (0.47, 1.08)	0.11	2.02 (0.74, 5.54)	0.17
Number of Outpatient Follow Up Visits	1.40 (1.20, 1.63)	<.0001	1.05 (0.82, 1.34)	0.72
Model C-statistic	0.75		0.60	

Temporal trend analyses. Data from non-intervention VAMCs demonstrated 502 subjects with ischemic stroke in the control period and 1390 in the intervention period. In VISN 8 (six non-intervention VAMCs), PSD diagnosis was present in 42% of subjects during the control period vs. 34% during the intervention period ($p=0.009$) and 97% of those with a CPRS ICD-9 depression diagnosis received some intervention for depression during the control period vs. 92% in the intervention period ($p=0.03$). In VISN 11 (6 non-intervention VAMCs), 36% were diagnosed with PSD during the control period vs. 37% during the intervention period ($p=0.89$) and 94% were treated during the control period vs. 89% in the intervention period ($p=0.45$). These data suggest there was no temporal trend favoring general increased detection or treatment of PSD in VA facilities during the time our study was conducted.

DISCUSSION

This study demonstrates that automated depression screening can be successfully extended to a high-risk group of veterans and to a specialty clinic setting. We observed a sixfold increase in the odds of PSD screening in the intervention cohort. This is important since routine annual depression screening is a well-established part of VA care; thus the degree of improvement in screening beyond the "chance" screening that would take place during the six months post-stroke is one important metric with which to measure the impact of this study. Despite a high rate of annual depression screening, this study documents that many veterans still are not screened in a timely manner at a period of high risk, that more than one-third screen positive for PSD, and that significant gains in identification of PSD can be made by targeted depression screening in both PC and neurology clinics in the immediate post-stroke period.

We also observed an increased rate of appropriate treatment actions in the intervention group, although this difference was statistically significant only in the adjusted model. Of note, PSD prevalence was slightly higher in the intervention group than the control group. This could be due to an increased number of visits in the intervention group or to differences in screeners used (PHQ9 vs. PHQ2). However, our prior work has shown that the PHQ-9 and the PHQ2 are both quite accurate compared to a structured psychiatric interview in stroke survivors.³⁰ We found that 33% of the intervention group were on an antidepressant medication at the time of their positive screen compared to 41% of the control group. Since some subjects still screened positive while on treatment, and since

only a small proportion were referred to Mental Health, another important avenue to improve PSD treatment and outcomes may be to promote collaborative depression care for these medically complex veterans. This approach has been shown to improve PC-based depression care in VA and non-VA settings, and can be effective for complex patients like those with recent stroke.^{31–36}

Study limitations. This study is limited by its pre-post design, although we did include temporal controls that did not identify any ongoing changes in depression care during the study period. It is important to note that depression recognition and treatment is generally better in the VHA than in other settings.^{19,20} We observed a slight decline in PSD treatment over time in the temporal trend cohort, but were not able to assess medications obtained outside the VA or conduct chart in this group to assess other provider actions. This is important since as many as half of depressed patients in VA PC use non-VA care for some aspect of their overall healthcare.³⁷ Although treatment rates we observed in this study are relatively high, other VA studies have noted that duration of antidepressant use and adequacy of follow-up are elements of guideline-adherent depression treatment that may have more room for improvement in VA. 18–20 Since other studies of decision support interventions for depression care have also generally shown improvement in screening but less impact on treatment,^{38–40} added systems changes such as care manager support may be necessary to improve depression treatment processes and outcomes.³⁵ Finally, as an implementation study with local tailoring, only one site successfully implemented the reminders in both neurology and PC clinics.

Seeking to implement screening and treatment reminders for PSD in two VAMCs resulted in many observations that may be useful in planning future implementation efforts. For example, the involvement of local teams in building and tailoring the reminders helped engage the providers to use and promote the reminder. However, clinic personnel changes limited implementation in one setting, suggesting that greater administrative buy-in by multiple key providers at the start would be helpful. Provider feedback after the intervention suggested that ensuring that the PSD screening reminder electronically “counted” as annual depression screening and so did not result in duplicate work helped reduce fear of “reminder overload.” Providers also identified the automatic documentation of treatment orders as an important factor that promoted reminder use.

Ultimately, this study demonstrates that automated depression screening targeting a high-risk group and including specialty care can be accomplished in the outpatient setting and can improve detection and treatment of depression. Since depression is linked to worse vascular risk factor control, worse functional recovery, and increased utilization and mortality post-stroke, timely identification and treatment of PSD has special clinical urgency so that recovery and secondary risk prevention may be maximized.

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Conflicts of Interest Statement: There are no known conflicts of interest with any of the authors that relate to the work done in this project.

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