Chronic Lower Limb Wound Outcomes Among Rural And Urban Veterans

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Abstract

Purpose: Veterans in rural areas generally have lower health care utilization than veterans in urban areas but the impact of this difference on health outcomes has received little study. Chronic wounds provide a model for studying access to complex chronic care since they often are related to underlying health conditions and require lengthy treatment. Our goals were to describe chronic wound care utilization among rural and urban veterans and to determine the association between rural residence and wound healing. *Methods:* We conducted a retrospective cohort study of 160 rural and 160 urban veterans in the Pacific Northwest with an incident chronic lower limb wound between October 1, 2006 and September 30, 2007. We followed individuals for up to one year, measuring wound care utilization within VHA and Medicare. We compared wound healing using a competing risks proportional hazards model accounting for amputation and death. *Findings:* Rural veterans had fewer outpatient wound care visits (6.8 versus 9.9) than urban veterans and a similar number of inpatient wound care stays (0.9 and 0.8, respectively). During follow-up, 234 veterans' wounds healed (77% rural, 69% urban). The adjusted hazard ratio for wound healing was 1.11 (95% CI: 0.84-1.47, p=0.45) for rural compared to urban veterans. The hazard of amputation was higher among rural veterans (HR=2.65, 95% CI: 1.02-6.87, p=0.045) and the hazard of death was lower (HR=0.35, 95% CI: 0.12-0.97, p=0.043). *Conclusions:* Despite lower wound care utilization, rural veterans' wounds were as likely to heal as urban veterans' wounds.

Bouldin, E., Taylor, L., Littman, A., Karavan, M., Rice, K., Reiber, G. (2015). Chronic Lower Limb Wound Outcomes Among Rural And Urban Veterans. *The Journal of Rural Health*; 31(4):410-20. Version of record available at: https://onlinelibrary.wiley.com/doi/10.1111/jrh.12115

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Disclosures
The authors have no conflicts of interest to report.

Funding
This research was funded by the Department of Veterans Affairs Health Services Research & Development, IBA 09-061. Dr. Littman's time was also supported by a VA Rehabilitation Research and Development Career Development Award (#6982). Dr. Reiber's time was supported by a HSR&D Senior Career Scientist Award (#VARCS 98-353). Support for VA/CMS data is provided by the Department of Veterans Affairs, Veterans

Health Administration, Office of Research and Development, Health Services Research and Development, VA Information Resource Center (Project Numbers SDR 02-237 and 98-004).

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Abstract

Purpose Veterans in rural areas generally have lower health care utilization than veterans in urban areas but the impact of this difference on health outcomes has received little study. Chronic wounds provide a model for studying access to complex chronic care since they often are related to underlying health conditions and require lengthy treatment. Our goals were to describe chronic wound care utilization among rural and urban veterans and to determine the association between rural residence and wound healing.

Methods We conducted a retrospective cohort study of 160 rural and 160 urban veterans in the Pacific Northwest with an incident chronic lower limb wound between October 1, 2006 and September 30, 2007. We followed individuals for up to one year, measuring wound care utilization within VHA and Medicare. We compared wound healing using a competing risks proportional hazards model accounting for amputation and death.

Findings Rural veterans had fewer outpatient wound care visits (6.8 versus 9.9) than urban veterans and a similar number of inpatient wound care stays (0.9 and 0.8, respectively). During follow-up, 234 veterans' wounds healed (77% rural, 69% urban). The adjusted hazard ratio for wound healing was 1.11 (95% CI: 0.84-1.47, p=0.45) for rural compared to urban veterans. The hazard of amputation was higher among rural veterans (HR=2.65, 95% CI: 1.02-6.87, p=0.045) and the hazard of death was lower (HR=0.35, 95% CI: 0.12-0.97, p=0.043).

Conclusions Despite lower wound care utilization, rural veterans' wounds were as likely to heal as urban veterans' wounds.

Key words: ulcer, lower limb, veterans, rural health, utilization

Background

Chronic lower limb wounds contribute to disability and reduce quality of life for thousands of individuals annually in the US.[1-7] Chronic wounds are a common precursor to lower limb amputations, many of which might be prevented if appropriate treatment interventions were received.[8-11] Veterans living in rural areas use fewer healthcare services than their urban counterparts,[12] often related to transportation, time, and cost barriers.[13-17] Rural veterans also receive less specialized care than urban veterans.[18-20] Coordinated, specialized wound care has been shown to improve chronic wound healing.[21-22] Together, this lower wound care utilization and, in particular, lower utilization of specialty wound care might lead to poorer wound outcomes among rural veterans.

Veterans in rural areas generally have poorer physical and mental health, as measured by the number of health conditions or health-related quality of life, than veterans living in urban areas.[23-27] Studies comparing specific health outcomes of rural and urban veterans are sparse and a number have found no differences between rural and urban veterans. For example, Egede et al. found no difference in diabetes control, as measured by hemoglobin A1c among rural compared to urban veterans.[28]

No previous studies have compared utilization and outcomes for chronic wounds among rural and urban veterans. The goals of this study were to describe wound care utilization among rural and urban veterans and to measure the association between rural residence and wound healing within the VA healthcare system (VHA). We hypothesized that rural veterans with chronic wounds

would have lower wound care utilization and less specialty care, consistent with previous studies. We expected to observe lower rates of wound healing among rural veterans compared to their urban peers.

Methods

Subject Selection

We used a set of 42 high-probability ICD-9 codes enumerated in previous studies[29-30] to identify veterans with at least one outpatient VHA encounter related to a LL wound between October 1, 2006 and September 30, 2007. We used the VHA's computerized patient record system to identify wounds and supplemented VHA treatment information with Medicare administrative files to capture wound care visits reimbursed through Medicare fee-for-service.

We assigned all potential subjects to either urban (n=3,220) or rural (n=1,818) residence based on the address in the VHA administrative data file at the time of the latest encounter with one of the ICD-9 codes of interest. To define urban and rural residence, we used the VA classification system used during the study period, based on United States Census Bureau-defined Urbanized Areas.[31] Specifically, Census blocks or block groups with a minimum density of 1,000 people per square mile and surrounding blocks with a minimum density of 500 people per square mile were considered urban. Any non-urban area was considered rural.

We screened potential subjects until we identified 160 rural and 160 urban veterans who met inclusion criteria. Sample size (n=320) was calculated based on the primary outcome time to healing with 0.80 power and 0.05 probability of a Type I error to detect a hazard ratio of 1.5 or greater. For this power calculation, we also assumed 60% of the pooled sample would have an event (heal) during the study period based on previous studies[33-33] and the investigators' expectations based on the specific inclusion/exclusion criteria used in this study. The power calculation also assumed that the healing curves would follow an exponential distribution.

This study was conducted in the VA's Northwest Health Network, VISN 20, and was reviewed and approved by the VA Puget Sound Health Care System's Human Studies Subcommittee (IRB #00253).

Inclusion and Exclusion Criteria

We considered a wound to be chronic if it persisted for at least 30 days after the baseline treatment visit, the Medicare-defined timeframe for a chronic wound.[34] Chronic LL wounds had to be treated during at least two VHA visits, at least one of which had to be an outpatient visit, to be included in the study. We did not restrict the wound etiology. For each veteran, we included only the first wound that met inclusion criteria.

Veterans with no chronic LL wounds in the study period (n=544), who began receiving treatment for a chronic LL wound before the study period (not incident; n=120), whose LL wounds were not chronic (healed within 30 days of first treatment encounter; n=439), who died within the first 30 days of wound treatment (n=7), who had the wound site amputated within the first 30 days of wound treatment (n=11), and who had no outpatient visit (n=31) or fewer than two total wound-related VHA visits (n=28) were excluded from the study. The proportion of rural and urban veterans excluded for each reason was similar.

Wound Characteristics and Resolution

For each wound, we recorded the location and etiology. We determined etiology based on ICD-9 diagnosis codes and VHA provider chart notes. Etiologic categories were arterial disease, diabetes, neuropathy, venous disease, pressure, infection, other (e.g., burns or trauma or dermatologic conditions), and mixed. If providers indicated more than one underlying factor substantially contributed to the wound's etiology, we classified the wounds as mixed etiology. At baseline, we recorded whether complex anatomy was present at the wound site, which included the presence of hardware or physical conditions like Charcot foot, or a previous amputation. To indicate severity at baseline we recorded whether the wound showed exposed bone, tendon, or joint, or whether there was evidence of osteomyelitis.

Wounds were considered healed at the visit when a provider documented they had completely re-epithelialized. If no healing was documented and the wound outcome was not stated but the wound was on a healing trajectory (n=19), we recorded the healed date as the date of the next visit if within 6 months of the last wound treatment visit, or as the midpoint between visits if the next visit was more than 6 months later. Veterans who were lost during follow-up (n=5) were censored at their last VHA wound care visit.

Wound Care Visits and Providers

As noted above, we used chart notes to assess VHA care and Medicare administrative files to measure Medicare-financed care. The content and structure of these data differ, so we used different methods to identify wound care visits within each system. For care delivered through VHA we abstracted the date and provider type from medical record notes for each outpatient visit when the wound was assessed and treated. Within Medicare, we included all outpatient visits with one of the 42 ICD-9 codes originally used to identify study subjects. We excluded fee basis and home health care visits from this study.

In both systems, we classified provider type as general practice (primary care, internal medicine, or emergency medicine provider), wound specialist (podiatry, vascular surgery, orthopedic surgery, plastic surgery, dermatology, physical medicine and rehabilitation, infectious disease, or certified wound care nurse), and non-wound specialist (e.g., cardiology, oncology). In VHA, we

used the medical record note to classify provider type. In Medicare, we used the provider's specialty code from the National Provider Index (NPI) database.

We recorded inpatient stays in hospitals or skilled nursing facilities from both systems. Within VHA, we relied on provider notes in the hospital or in a skilled nursing facility to identify stays. Within Medicare, we used the same set of ICD-9 codes referenced above and counted the number of unique inpatient and skilled nursing stays. If a patient was transferred from one system to another (e.g., VA to Medicare) we counted two unique stays, one in each system. This approach could overestimate inpatient stays but given our interest in assessing wound care in both systems we chose this approach over assigning stays to only one system or the other.

Baseline Health and Covariates

We collected information from the VHA medical record about the veteran's age, gender, marital status, residence, and health history at the baseline visit. We used Medicare to classify veterans' race and ethnicity; for veterans not enrolled in Medicare, we used the VHA record. We categorized age as under 50, 50-59, 60-69, 70-79, and 80 and older. We recorded the veteran's race/ethnicity as white, black, Asian, Native American/Alaska Native, Hispanic, other, or unspecified. We classified where veterans lived at baseline as living in a single family home versus not (living in an assisted living facility or skilled nursing facility, being

homeless, or residence unknown). We recorded marital status in several categories based on VHA records and categorized it as married versus not in the adjusted analyses as a marker for potential support or assistance.

We used physician notes or the "Problem List" available in the VHA medical record to assess whether or not the veteran had each of the following health conditions at baseline: diabetes, peripheral artery disease, hypertension, congestive heart failure, coronary artery disease, myocardial infarction, cerebrovascular disease, renal insufficiency or renal disease, liver disease, lower limb paralysis, connective tissue disease (e.g., rheumatoid arthritis, lupus), cancer, and HIV/AIDS. To adjust for baseline comorbidity, we summed the number of these conditions present at baseline and added one additional point if the veteran had a diabetes-associated complication (sensory neuropathy, renal disease, or retinopathy), similar to the Charlson-Deyo comorbidity index.[35] The maximum possible comorbidity score was 14. Also, we created a categorical variable to describe veterans' lower limb history: having neither a previous LL wound nor LL amputation, having a previous LL wound without amputation, or having a previous LL amputation (with or without a previous LL wound).

We recorded whether the veteran had an established VHA primary care provider at baseline. We recorded veteran's service connected disability (SCD) rating, which represents the average impairment in earning capacity resulting from a disease or injury related to military service.[36] We classified veterans as having a 50-100% SCD rating or not. Within VHA, veterans with a SCD rating of 50% or higher are eligible for free care for the condition while veterans with a SCD rating of 0-40% may be eligible for free care if

they are low income.[37] We considered veterans to be dual Medicare-VHA users if they had at least one inpatient or outpatient visit with a wound-related ICD-9 code in the Medicare file during follow-up.

Sensitivity Analyses

We planned three sensitivity analyses *a priori*. First, we analyzed data using a 60-day minimum wound duration rather than the 30-day minimum (n=277 wounds ≥60 days; 137 rural and 140 urban). Second, we considered whether the method of assigning the healed date for veterans with long intervals between the last treatment visit and the healed date influenced our results. Rather than using the midpoint between dates, we changed the healed date to 30 days after the last treatment visit (n=19; 15 rural and 4 urban). We chose 30 days because, among veterans with healed visits close to the last treatment visit, many occurred around 30 days apart. Finally, during the study period, the Walla Walla VAMC, which serves a largely rural area, was conducting an intervention to improve wound care and therefore may have provided different wound care during the study.[29-30] Our third sensitivity analysis excluded veterans who received care at the Walla Walla VA (n=19; all rural) to determine whether this concurrent intervention affected the results of this study.

Data Analysis

To describe the sample, we calculated proportions and 95% confidence intervals (CI) for demographic and health status variables by rural/urban status. To describe wound care utilization, we calculated the number of outpatient visits and the number of inpatient stays within VHA and within Medicare for each person. We report the mean number of each visit/stay type per person. We used t-tests to test for differences in mean or median values and chi-square tests to test for differences in categorical variables across rural and urban veterans.

To assess the association between rural residence and wound healing, we used a competing risks proportional hazards model that accounted for the competing risks of amputation and death.[38] We estimated hazard ratio (HR) for wound healing, comparing rural veterans to urban veterans). Because our chronic wound definition required 30 days of treatment without healing, amputation, or death, we excluded the first 30 days of follow-up from our competing risks analysis. We assessed the proportional hazards assumptions for the model using Schoenfeld residual plots for each variable included in the model and we used delta beta plots to identify influential subjects.[39] We adjusted for sociodemographic, baseline health, and wound characteristics associated with wound healing based on existing literature.[9,33,40-42] We did not include factors shown to be highly correlated with rural residence in other studies in the models, such as income or distance to VHA facilities, because we conceptualized rural residence influencing wound

outcomes through pathways including isolation from health services and economic deprivation. We therefore decided *a priori* not to include these variables in our model in order to avoid adjusting away the effect of rural residence itself.[42] Four veterans were missing a hemoglobin A1c value at baseline; because none of these veterans had a history of diabetes we presumed their A1c value was less than 7.0 for the comorbidity score calculation (i.e., did not add an additional point for A1c). There were no missing data for other variables included in the proportional hazards model. We used cumulative incidence curves to describe overall time to healing for subgroups of interest defined by rural status.[38,43] We also calculated the median days to healing for rural and urban veterans and used a t-test to test for differences between the two groups. All analyses were completed using STATA 12.1 (College Station, TX).

Results

Sample Characteristics

The majority of veterans included in this study were male (98%; Table 1) and the mean age at first wound treatment was 66 years. Most veterans were white and lived at home; about half were married. Rural veterans more frequently had coronary artery disease and cancer at baseline than urban veterans, while urban veterans had a higher prevalence of lower limb paralysis. The average summed comorbidity score was 3.9 (SD=2.4) among rural veterans and 3.6 (SD=2.2) among urban veterans and was not

significantly different. Half of rural veterans and 67% of urban veterans had a previous LL wound and 24% and 27%, respectively, had a LL amputation at baseline.

Wound Characteristics

The characteristics of study wounds were similar for rural and urban veterans (Table 2). About half of all wounds occurred below the ankle, with the heel or plantar surface of the foot (e.g., metatarsal heads) being the most frequent wound location for both rural (22%) and urban (25%) veterans. A small proportion of all wounds were at the site of a previous amputation (6% of rural and 9% of urban veterans' wounds). Wound etiology was similar for rural and urban veterans; diabetes (30% of rural and 31% of urban), venous disease (21% in each group), and arterial disease (13% of rural and 17% of urban) wounds occurred at the highest frequency. A small number of wounds were classified as mixed etiology (4% of rural and 6% of urban). At baseline, about 31% of veterans had complex anatomy at the wound site and approximately 8% of veterans had a wound with exposed bone, tendon, or joint.

Wound Care Utilization

Overall, the mean number of outpatient visits during the study period was 6.8 for rural veterans and 9.9 for urban veterans. The mean number of general practice VHA outpatient visits per person was similar for rural and urban veterans (Table 2); 59% of rural veterans and 63% of urban veterans had a general practice outpatient visit within VHA. Urban veterans had an average of 6.9 VHA wound specialty visits per person while rural veterans averaged 4.2 per person ($p<0.001$). Eighty-eight percent of both rural and urban veterans had at least one VHA wound specialty visit. There were 22 rural veterans (14%) and 19 urban veterans (12%) who used both VHA and Medicare for wound care (dual users). Rural dual users averaged 2.3 general practice and 1.1 wound specialty visits per person within Medicare and urban dual users averaged 3.6 and 0.9, respectively. There were very few non-wound specialty outpatient visits within VHA and none in Medicare.

The mean number of VHA hospital and skilled nursing inpatient stays per person was similar for rural and urban veterans and was less than 1. About 38% of veterans had a VHA hospital stay and 12% of rural veterans and 5% of urban veterans had a VHA skilled nursing stay. Among dual users, 36% of rural veterans and 32% of urban veterans had a Medicare-reimbursed hospital stay and 14% of rural veterans and 21% of urban veterans had a Medicare-reimbursed skilled nursing stay.

Wound Outcomes

During one year of follow-up, 234 veterans' wounds healed (123 rural and 111 urban; 73%), 27 veterans underwent amputation (16 rural and 11 urban; 8%), 20 veterans died with the wound present (7 rural and 13 urban; 6%), 5 veterans were lost to follow-up (2 rural and 3 urban; 2%), and 34 had ongoing wounds at the end of follow-up (12 rural and 22 urban; 11%). In the crude competing risks regression model, the estimated hazard ratio for wound healing comparing rural to urban veterans was 1.20 (95% CI: 0.93-1.55, p=0.16). After adjusting for baseline health, demographic, and wound-related factors, the hazard ratio estimate moved closer to the null and rural veterans had an estimated 11% higher hazard of wound healing during follow-up compared to their urban peers but the difference was not statistically significant (HR=1.11, 95% CI: 0.84-1.47, p=0.45; Table 3). We found no evidence that this association differed by wound etiology (i.e., p>0.05 for the interaction term between rural residence and each etiologic category). The cumulative incidence curves for wound healing among rural and urban veterans based on the adjusted competing risks model appear in Figure 1. These curves demonstrate, like the hazard ratio estimate, that wound healing was similar for rural and urban veterans. The median time to healing was 131 (95%CI: 104-150) days for rural veterans and 124 (95%CI: 105-135) days for urban veterans, with no statistically significant difference between the two healing times. The median healing time was generally similar across wound etiology groups and there were no statistically significant differences in the mean healing times for

rural and urban veterans within any category, though several estimates were imprecise because they were based on a small number of observations.

The hazard ratio estimates for the two competing risks – amputation and death – also appear in Table 3. In the adjusted model, rural veterans were significantly more likely than urban veterans to undergo amputation during follow-up (HR=2.65, 95% CI: 1.02-6.87, p=0.045). There were 16 amputations among rural veterans during follow-up and 11 among urban veterans. Nine (56%) rural and three (27%) urban veterans had a transtibial (below knee) or transfemoral (above knee) amputation; the remainder had toe or transmetatarsal amputations. Median time to amputation was 59 (95%CI: 39-207) days for rural veterans and 76 (95%CI: 47-289) days for urban veterans. Conversely, rural veterans were significantly less likely than their urban peers to die with an active wound (HR=0.35, 95% CI: 0.12-0.97, p=0.043). Median time to death was 114 (95%CI: 51-174) days for rural veterans and 126 (95%CI: 58-237) days for urban veterans.

Sensitivity Analysis Results

In all sensitivity analyses, the point estimates for wound healing were similar to the estimates based on the full study sample. When we excluded veterans with wound duration <60 days, the HR for wound healing comparing rural residents to urban was 1.07 (95% CI: 0.80-1.44, p=0.64). In this model, the HR for amputation was estimated to be 2.99 but no confidence interval was estimated

because of poor model fit. The HR for death was 0.57 (95% CI: 0.14-2.23, p=0.42). When we moved the resolution date to 30 days after the last treatment visit, the HR for wound healing was 1.16 (95% CI: 0.88-1.53, p=0.30) and the HR estimates for amputation and death were 2.65 (95% CI: 1.02-6.86, p=0.045) and 0.35 (95% CI: 0.12-0.97, p=0.043), respectively. When we excluded veterans who received wound care at the Walla Walla VA, the HR for healing was 1.09 (95% CI: 0.82-1.45, p=0.53), the HR for amputation was 2.27 (95% CI: 0.83-6.25, p=0.11), and the HR for death was 0.34 (95% CI: 0.11-1.01, p=0.052).

Discussion

Rural veterans had lower outpatient wound care utilization than their rural peers but we found no significant difference in wound healing hazards between the two groups. These results are based on a random sample of veterans utilizing the VHA in the Pacific Northwest for outpatient chronic wound care treatment and were similar when we used an alternate definition of a chronic wound (30-day versus 60-day minimum definition) and excluded veterans who may have been exposed to a wound treatment intervention during the study period. Based on the sensitivity analysis in which we assumed a shortened time to healing for veterans with a long duration between the last wound treatment date and the wound healed date, our abstraction rule may have biased the results slightly in favor of urban veterans since they had higher utilization and shorter times between appointments.

As expected, rural veterans used less VHA specialty wound care than urban veterans. This is consistent with a number of other studies that reported poorer specialty access for rural veterans.[12,17-18] The mean number of outpatient visits observed in this study was higher than in a study of VHA patients with an incident diabetic foot ulcer (average of 5 visits)[32] but similar to the non-intervention group in a study of diabetic foot ulcers set in a public hospital.[44] The proportion of veterans with a VHA hospitalization was the same as that reported by Reiber et al. in a diabetic foot ulcer study. [32] It is not clear from our data whether the higher specialty care utilization among urban veterans represents over-use. Additional research needs to be done to identify optimal utilization for wound healing. It is possible that rural veterans more frequently used other types of health care services, like home health, that we did not include in our study. Also, the observed utilization differences might result from social factors (e.g., availability of informal care at home) not explored in this study.

In this study, about three quarters of the wounds healed during one year of follow-up, with a median time to healing of around 18 weeks. This is similar to other studies, in which the proportion healed ranges between 63% and 87%.[22,32-33,40,45-46] It is more difficult to compare our observed time to healing with other studies since many have limited follow-up (e.g., 20 weeks when comparing different treatments) or include acute and chronic wounds. Reiber et al. reported a mean of 11 weeks to healing among VHA patients with incident foot ulcers (including both non-chronic and chronic wounds).[32] Although we hypothesized that rural

veterans would experience poorer wound outcomes than their urban peers, our finding that wound outcomes were similar is consistent with several recent studies that found similar mortality among rural and urban veterans.[47-49]

We found that rural veterans were more likely to undergo amputation and less likely to die with a wound than urban veterans; however these results need to be replicated in a sample with more events since our confidence intervals were wide. Rural veterans in the study more frequently had major amputations (at the transtibial or transfemoral level) than urban veterans. There is ongoing debate about the health and quality of life impacts of limb salvage versus amputation and whether all amputations are preventable.[50-54] The higher amputation rate among rural veterans in the study corresponded to a lower hazard rate for mortality, so while amputation is a poor wound outcome it presumably is preferable to death for patients with chronic wounds. Patient factors and/or health system variables not measured in this study might explain the differences in amputation and death observed in this study.

This study has several limitations. First, our inclusion criteria required that veterans utilize VHA for at least two wound care visits, one of which had to be an outpatient encounter. As a result, the study represents neither inpatient-only VHA users nor VHA users who use the system very infrequently. Likewise, the sample included mostly white men, which reflects the population served by the VA facilities included in the study but does not reflect all VA service areas and therefore these results may have limited generalizability in more racially and ethnically diverse settings. Second, this study was powered to compare wound healing. The

number of amputations and deaths was small and, as a result, the estimates for these competing risks are accompanied by wide confidence intervals. Third, although we included fee-for-service Medicare wound care visits in the utilization measures we did not include data from other non-VHA health systems in this analysis. Fourth, we did not collect information that could be used to account for the mental health of veterans included in the study and therefore confounding may exist. Fifth, because of the differences between VHA and Medicare data structures we used different methods to identify wound care visits. Within VHA we reviewed all provider notes to determine whether wound care was provided while in Medicare we relied on ICD-9 codes to identify wound care visits. Finally, these data reflect wound care practices during 2006-2007 and although VA has not implemented any systematic changes to wound care delivery since then, it is possible that these results do not reflect current practices and healing times.

Conclusion

More than one in three veterans enrolled in the VHA system lives in a rural area.[24,42] A disproportionate number of troops who served in recent conflicts – Operation Iraqi Freedom (OIF) and Operation Enduring Freedom (OEF) – were from rural areas, suggesting that a high proportion of veterans will continue to live in rural areas in the future.[24,42] It is therefore important to assess whether disparities exist between rural and urban veterans and to work to eliminate them if so. Chronic wounds provide a model for

studying access to complex chronic care since they often are related to underlying health conditions and require lengthy treatment. Based on these results, chronic lower limb wound care utilization was generally lower for rural veterans, yet wound healing was similar for rural and urban veterans. Additional research is needed to replicate these findings and to understand whether patient factors or health system variables explain the higher rate of amputation and lower rate of death with active wounds observed among rural veterans compared to their urban peers.

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Table 1. Baseline demographic and health characteristics of rural and urban veterans with chronic lower limb (LL) wounds.

Variable	**Categories**	**Rural Veterans** (n=160)		**Urban Veterans** (n=160)		**p-value for difference**
		Estimate	95% CI	Estimate	95% CI	
Age (years)	Under 50	5.6%	2.9-10.5	6.9%	3.8-12.1	0.16
	50-59	23.1%	17.2-30.4	31.3%	24.5-38.9	
	60-69	28.1%	21.6-35.7	31.9%	25.1-39.6	
	70-79	25.0%	18.8-32.4	18.7%	13.4-25.6	
	80+	18.1%	12.8-24.9	11.3%	7.1-17.2	
Gender	Male	98.1%	94.3-99.4	97.5%	93.5-99.0	0.70
	Female	1.9%	0.6-5.7	2.5%	0.9-6.5	
Marital status	Married	56.3%	48.4-63.8	48.1%	40.4-55.9	0.15
	Not married	43.7%	36.2-51.6	51.9%	44.1-59.6	
Race/ ethnicity	White	90.0%	84.2-93.8	80.0%	73.0-85.5	0.01
	Black	0%	--	9.4%	5.7-15.0	<0.001
	Asian	0%	--	1.3%	3.1-4.9	0.16
	Native American/ Alaska Native	0.6%	0.1-4.4	0.6%	0.1-4.4	1.0
	Hispanic	1.3%	3.1-4.9	0%	--	0.16
	Other	1.3%	3.1-4.9	1.9%	0.6-5.7	0.65
	Unspecified	6.9%	3.8-12.6	6.9%	3.8-12.6	1.0

Type of residence	Home (single family)	91.9%	86.4-95.3	78.7%	71.6-84.5	0.001
	Other or unknown	8.1%	4.7-13.6	21.3%	15.5-28.3	
Service-connected disability (SCD)	No SCD	49.4%	43.6-57.1	48.7%	41.0-56.5	0.75
	Not service connected or 0-40%	15.6%	10.7-22.2	13.1%	8.7-19.4	
	SCD rating 50-100%	35.0%	27.9-42.8	38.1%	30.9-46.0	
Body mass index (BMI, kg/m^2)	Normal weight (<25.0)	13.7%	9.2-20.1	19.4%	13.9-26.3	0.29
	Overweight (25.0-29.9)	31.9%	25.1-39.6	26.3%	19.9-33.7	
	Obese (≥30.0)	53.1%	45.3-60.8	51.3%	43.5-59.0	
	Missing	1.3%	0.3-4.9	3.1%	1.3-7.3	

Variable	**Categories**	**Rural Veterans** (n=160)		**Urban Veterans** (n=160)		**p-value for difference**
		Estimate	95% CI	Estimate	95% CI	
Health conditions	Diabetes	56.9%	49.0-64.4	60.6%	52.8-68.0	0.50
	Diabetes complication	46.9%	39.2-54.7	47.5%	39.8-55.3	0.91
	Peripheral artery disease	50.6%	42.8-58.4	43.7%	36.2-51.6	0.22
	Congestive heart failure	25.6%	19.4-33.0	20.6%	15.0-27.7	0.29

	Coronary artery disease	42.5%	35.0-50.4	31.9%	25.1-39.6	0.05
	Cerebrovascular disease	15.0%	10.2-21.5	18.7%	13.4-25.6	0.37
	Hypertension	85.6%	79.2-90.3	78.7%	71.6-84.5	0.11
	Myocardial infarction	18.7%	13.4-25.6	15.6%	10.7-22.2	0.46
	Renal disease	25.6%	19.4-33.0	20.0%	14.5-27.0	0.23
	Liver disease	1.9%	0.6-5.7	3.7%	1.7-8.2	0.31
	Connective tissue disease	1.9%	0.6-5.7	5.0%	2.5-9.7	0.13
	Lower limb paralysis	2.5%	0.9-6.5	8.7%	0.5-14.3	0.01
	Cancer	18.7%	13.4-25.6	8.1%	4.7-13.6	0.005
	HIV/AIDS	0%	--	0%	--	N/A
Comorbidity score	Mean number of conditions	3.9	3.5-4.3	3.6	3.3-4.0	0.25
LL history	Neither wound nor amputation	45.6%	38.0-53.5	30.6%	23.9-38.3	0.006
	Wound, without amputation	30.0%	23.3-37.6	41.9%	34.4-49.7	0.03
	Amputation, with or without wound	24.4%	18.3-31.7	27.5%	21.1-35.0	0.52
Had a VHA primary care provider	Yes	78.1%	71.0-83.9	72.5%	65.0-78.9	0.24
	No	21.9%	16.1-29.0	27.5%	21.1-35.0	

Received Medicare-financed wound care	Yes	13.7%	9.2-20.1	11.9%	7.6-17.9	0.62
	No	86.3%	80.0-90.8	88.1%	82.1-92.3	

CI: confidence interval

VHA: Veterans Health Administration

Table 2. Lower limb wound characteristics and utilization among rural and urban veterans.

Variable	Category	Rural Veterans (n=160)		Urban Veterans (n=160)		p-value for difference
WOUND CHARACTERISTICS						
Wound location %, 95% CI	First (great) toe	10.6	6.7-16.5	12.5	8.2-18.7	0.60
	2^{nd}-5^{th} toe	13.1	8.7-19.4	10.6	6.7-16.5	0.49
	Heel or plantar midfoot	21.9	16.1-29.0	25.0	18.8-32.4	0.51
	Dorsal foot	4.4	2.1-8.9	3.7	1.7-8.2	0.78
	Ankle	15.6	10.7-22.1	16.9	11.8-23.6	0.76
	Shin	12.5	8.2-18.7	10.6	6.7-16.5	0.60
	Calf	10.6	6.7-16.5	8.1	4.7-13.6	0.44
	Thigh	5.6	2.9-10.5	3.7	1.7-8.2	0.43
	Previous amputation site	5.6	2.9-10.5	8.7	5.2-14.3	0.28
Wound etiology %, 95% CI	Diabetes	31.3	24.5-38.9	30.0	23.3-37.6	0.81
	Venous disease	21.3	15.5-28.3	20.6	15.0-27.7	0.89
	Arterial disease	12.5	8.2-18.7	16.9	11.8-23.6	0.27
	Infection	12.5	8.2-18.7	5.0	2.5-9.7	0.02
	Pressure	7.5	4.3-12.8	9.4	5.7-15.0	0.55
	Other	7.5	4.3-12.8	10.0	6.2-15.8	0.43
	Neuropathy	3.1	1.3-7.3	1.9	0.6-5.7	0.47
	Mixed[±]	4.4	2.1-8.9	6.3	3.4-11.3	0.45

Baseline wound characteristics %, 95% CI	Complex anatomy[§]	31.3	24.5-38.9	31.9	25.1-39.6	0.90
	Exposed bone, tendon, or joint or osteomyelitis	8.9	5.3-14.5	8.1	4.7-13.6	0.84
WOUND CARE UTILIZATION						
Wound treatment visits or stays, mean per person (SE)	***VHA***					
	Outpatient: General practice	1.3	(0.1)	1.5	(0.1)	0.44
	Outpatient: Wound specialist	4.2	(0.3)	6.9	(0.7)	<0.001
	Outpatient: Non-wound specialist	0.07	(0.04)	0.006	(0.006)	0.08
	Hospital stays	0.6	(0.08)	0.6	(0.8)	0.69
	Skilled nursing stays	0.2	(0.04)	0.1	(0.03)	0.10

Variable	**Category**	**Rural Veterans** (n=160)		**Urban Veterans** (n=160)		**p-value for difference**
WOUND CARE UTILIZATION (CONT.)						
Wound treatment visits or stays, mean per person (SE)	***Medicare*** **(among 22 rural and 19 urban dual users only)**					
	Outpatient: General practice	2.3	(1.2)	3.6	(2.6)	0.76
	Outpatient: Wound specialist	1.1	(0.5)	0.9	(0.3)	0.62
	Outpatient: Non-wound specialist	0	--	0	--	N/A
	Hospital stays	0.4	(0.1)	0.7	(0.3)	0.57

	Skilled nursing stays	0.2	(0.1)	0.3	(0.1)	0.78
	Total – VHA and Medicare					
	Outpatient: General practice	1.6	(0.2)	1.9	(0.4)	0.53
	Outpatient: Wound specialist	4.3	(0.3)	7.1	(0.7)	<0.001
	Outpatient: Non-wound specialist	0.07	(0.04)	0.006	(0.006)	0.08
	Total outpatient visits	6.8	(0.4)	9.9	(0.8)	<0.001
	Hospital stays	0.7	(0.09)	0.7	(0.09)	0.59
	Skilled nursing stays	0.2	(0.05)	0.1	(0.03)	0.17
	Total inpatient stays	0.9	(0.1)	0.8	(0.1)	0.94

CI: confidence interval

VHA: Veterans Health Administration

§Complex anatomy includes Charcot foot, hammer toe, or previous amputation at wound site

±Mixed etiology includes any wounds that could not clearly be defined by one of the categories listed but instead had features of two different underlying conditions, such as arterial disease and diabetes

Figure 1 Cumulative Incidence of Chronic Lower Limb (LL) Wound Healing Among Rural and Urban Veterans in VISN 20 From October 1, 2006, to September 30, 2007, Based on Competing Risks Proportional Hazards Model. Adjusted for age (including age squared and age cubed), marital status, living in a single family home, having a VHA primary care provider at baseline, dual (Medicare and VHA) wound care use, service connected disability level, number of comorbid conditions, LL wound and amputation history, wound etiology, and exposed bone, tendon, or joint at baseline.

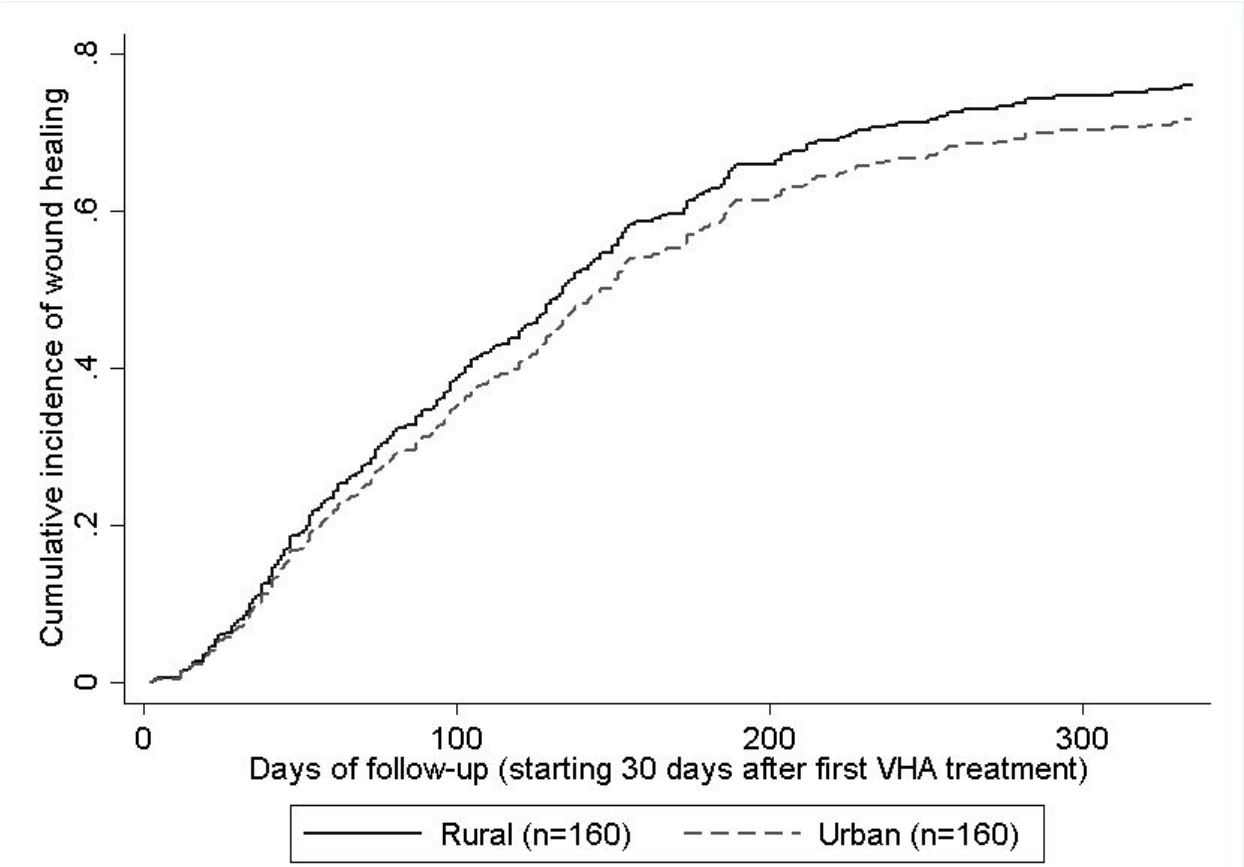
Cumulative incidence of wound healing
0
.2
.4
.6
.8
0
100
200
300
Days of follow-up (starting 30 days after first VHA treatment)
Rural (n=160)
Urban (n=160)

Table 3. Adjusted[±] competing risks proportional hazards regression results for wound healing among veterans with chronic lower limb wounds.

Residence category	**Primary Outcome**		**Competing Risks**			
	Wound healed (n=234 events)		Wound amputated (n=27 events)		Veteran died with wound (n=20 events)	
	Hazard Ratio (95% CI)	p-value	Hazard Ratio (95% CI)	p-value	Hazard Ratio (95% CI)	p-value
Urban	Reference		Reference		Reference	
Rural	1.11 (0.84-1.47)	0.45	2.65 (1.02-6.87)	0.045	0.35 (0.12-0.97)	0.043

Reference: Reference category in regression model (HR=1.0)

CI: confidence interval

VHA: Veterans Health Administration

[±]Adjusted for: age (including age squared and age cubed); marital status; living at home; having a VHA primary care provider at baseline; dual VHA-Medicare wound care use; service-connected disability ≥50%; number of comorbid conditions; lower limb wound and amputation history; wound etiology; complex anatomy at wound site; and exposed bone, joint, or tendon or osteomyelitis at baseline