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Wagner's Score as a Tool for Assessing Diabetic Foot Ulcers and Predicting Surgical Intervention in a County Hospital in Guatemala

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Abstract

Diabetes is a significant cause of mortality and morbidity throughout the world, particularly in low- and middle-income countries (LMICs). Uncontrolled diabetes can lead to a myriad of conditions, including diabetic neuropathy. A common consequence of neuropathy, coupled with poor vascular circulation is diabetic foot infection (DFI). The Wagner Score (WS) is a validated tool used to assess severity of diabetic foot ulcers. Its use has been studied in high income countries and suburban teaching hospitals in affluent regions. In LMICs, where advanced diagnostic modalities are often scarce, WS could serve as a low-cost and rapid tool to prognosticate and predict clinical outcome for patients presenting with DFI. In this study, we perform a retrospective chart review of 77 patients admitted to a county hospital in El Petén, Guatemala. Patients were predominantly men (79.2%) between 61 – 70 years old. Ulcers were the most common presentation, and WS IV (out of V) the most frequent classification. Age, surgical intervention, and edema were positively correlated with increasing WS, while hematocrit and debridement/lavage were negatively correlated. Our results suggest that WS is an effective, low-cost, and rapid tool for predicting likelihood of surgical intervention in a previously untested setting. This information is critical for improving care of patients with diabetes in LMICs throughout the world.

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Introduction

Diabetes is a significant health issue worldwide, potentially causing complications across a variety of organ systems [1]. Diabetic neuropathy is a consequence of uncontrolled diabetes mellitus that typically affects the lower extremities first [2]. Numbness and loss of sensation can lead to unrecognized and consequently unmanaged foot infections. Subsequently, ulcers, abscess, necrosis, gangrene, and edema may develop. Diabetic foot infections (DFIs) are typically the consequence of poor blood flow and delayed wound healing [3]. In high-income countries (HICs), advanced modalities are used to assess peripheral vascular disease, but in low- and middle- income countries (LMICs) vascular assessment is limited by equipment and cost [4, 5]. Mortality from the often-preventable complications of diabetes can be as consequential as malignancies in this population, resulting in a decreased work force and substantial economic disadvantages [6].

The Wagner Score (WS) is used to classify diabetic foot ulcers, ranging from 0 (no open lesions) to 5 (gangrene or necrosis of the entire foot) [7]. WS has been previously shown to be associated with advanced age, glycated hemoglobin (HbA1c), and duration of diabetes [8]. These results suggest that WS might be used to stratify risk for surgical intervention. Today, WS has only been studied in the context of suburban teaching hospitals. Further, the treatment and management of diabetic foot ulcers varied by WS, with ulcer debridement more often performed for WS <2 and below-knee amputation more common in WS 3 – 5 [8]. In the present study, we seek to validate and investigate the utility of WS for assessing diabetic foot ulcer and how it correlates with surgical intervention in a county hospital in El Petén, Guatemala: Hospital Nacional de San Benito (HNSB). We hypothesize that increasing WS will be associated with greater likelihood of surgical intervention, which would make WS a useful planning tool in the context of an LMIC hospital. The present study was undertaken to determine the utility of the WS in operative vs. conservative management of patients presenting with a DFI at HNSB.

Methods

Study Design

HNSB does not have electronic medical records. For this study, we performed a retrospective paper chart review of non-consecutive admissions at HNSB from 2014 - 2023 in all patients presenting with a DFI. Approval from Dr. Cesar Ortiz Vargas, HNSB hospital director, was obtained prior to data collection.

Data Collection

Data was collected by clinical history-taking, physical examination, and laboratory tests. Medical professionals recorded patient information by hand. Surgical options for patients included digital, trans-metatarsal, below- or above-the-knee amputation, as well as debridement and lavage.

Data was collected from paper charts and organized into an electronic format for further statistical analysis.

Patients were grouped according to WS. WS1 is assigned for superficial ulcers; WS2 for deep ulcers without abscess or osteomyelitis; WS 3 for deep abscess, osteomyelitis, or joint sepsis; WS4 for partial-foot gangrene; and WS5 for whole-foot gangrene. [Table 1].

Wagner's Classification of Diabetic Foot Ulcers

Wagner's Score	Description
0	Skin intact but bony deformities lead to "foot at risk"
1	Superficial Ulcer
2	Deeper, full thickness extension
3	Deep abscess formation or osteomyelitis
4	Partial gangrene of forefoot
5	Extensive gangrene

Table 1. Wagner Score 1 – 5 and corresponding qualitative descriptions.

Inclusion & Exclusion Criteria

The study was comprised of all ages and genders. Patients must have presented to HNSB with one of the following as a foot complication of their diabetes: infection, ulcer, abscess, necrosis, gangrene, or edema (n=109). Those with no data for Wagner Score were excluded (n=32). The final study population size was 77 individuals.

Data Analysis

Handwritten data was translated to Microsoft excel and analyzed by UT Southwestern's Clinical and Translational Science Award Program. Spearman's rank correlation was used to assess the correlation between WS and numerical variables, such as age, length of study, and other demographic data. A nonparametric Wilcoxon rank-sum test was used to assess WS with binary categorical variables, such as whether the patient presented with infection or underwent surgery. Specific values, when presented, are given as means ± SD.

Results

Seventy-seven patients presenting with diabetic foot infections were assigned and recorded with a WS. The average age was 57.33±11.68 years old, with the youngest subject being 30 and the oldest 89. There were 61 men (79.2%) and 16 women (20.8%). [Figure 1].

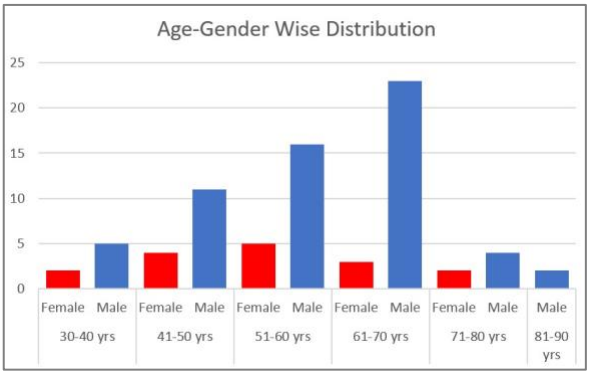

Figure 1. Age-Gender Wise distribution of patients. Y-axis given as a % of total study population. Red bars represent females and blue bars represent males.

Sixty-five patients (84%) presented as an "emergency". Emergency status was defined as initial presentation to the ER rather than referral from medicine or another department. Ulcer was the most common presentation of diabetic foot infection (46%), followed by necrosis (31%), abscess (15%), and gangrene (8%). [Figure 2].

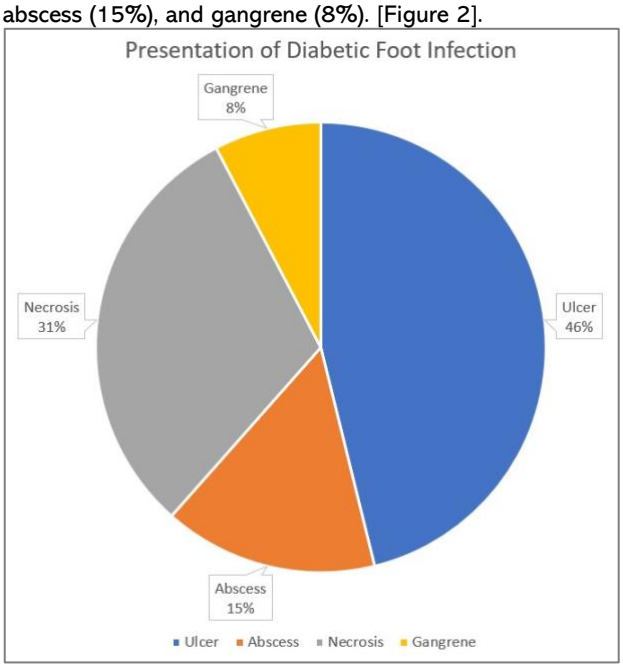

Figure 2. Presentation of Diabetic Foot Infection. 46% present as ulcer (blue), 31% as necrosis (gray), 15% as abscess (orange), and 8% as gangrene (yellow)

Distribution of WS among patients was 2.6% WS1 (n=2), 10.39% WS2 (n=8), 28.57% WS3 (n=22), 46.75% WS4 (n=36), and 11.69% WS5 (n=9) [Figure 3].

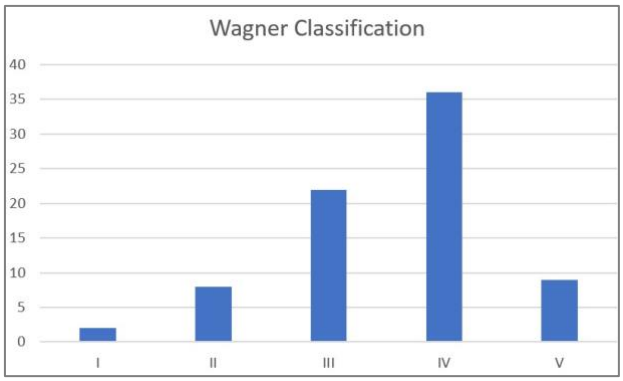

Figure 3. Distribution of Wagner Score. X-axis is WS 1-5, Y-axis is percentage of total study population.

Spearman's rank correlation of WS demonstrated a positive correlation with age (p=0.03) and a negative correlation between WS and hematocrit (Hct) (p=0.05) [Table 2, Figure 4a-b].

		Spearman's Rank Correlation		
Variable	Mean ± StdDev	Correlation	P-Value	95% Confidence Limit
WS	3.55 ± 0.93	0.25	0.0263	(0.03, 0.45)
Age (Yrs)	57.44 ± 11.68			
WS	3.55 ± 0.93	-0.23	0.0469	(-0.45, -0.003)
Hct (%)	33.56 ± 6.81			

Table 2. Spearman's Rank Correlation of WS for continuous variables; only significant results displayed. See Supplemental Table 1 for all results. consolidated into one note.

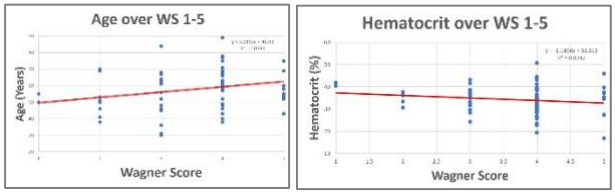

Figure 4a, 4b. Scatterplots showing correlation between Wagner's Score, age, and HCT.
Left, 4a: Age over Wagner Score (y = 3.2193x + 46.43)
Right 4b: Hct over Wagner Score (y = -1.106x + 38.313)

Wilcoxon rank-sum test showed an association between increasing WS, surgical intervention (p<0.01), and presence of edema (p=0.03). Individual surgical interventions are listed below, but on their own, did not demonstrate significant differences between WS. Patients with lower WS were more likely to be treated with debridement and lavage (p<0.01) [Table 3].

Table 3. Wilcoxon rank-sum test for WS and discrete variables. Variables marked by an * demonstrate significant p-value and include debridement/lavage, surgical intervention, and presence of edema. While there are 23 surgical interventions listed for those in WS II, there are only 22 patients. It is likely that one of the patients received two different surgical treatments, and his data was consolidated into one note.

Treatment	Wagner's Grade					p-value
	I (n=2)	II (n=8)	III (n=22)	IV (n=36)	V (n=9)	
No Surgical Treatment	2	-	-	-	-	n/a
Debridement & Lavage*	-	2	4	-	-	0.0062
Digital Amputation	-	4	17	24	7	0.3164
TMA Amputation	-	-	1	1	1	0.3891
Below the Knee Amputation	-	-	-	-	-	n/a
Above the Knee Amputation	-	1	5	8	1	0.9396
Surgical Intervention (Total)*	-	5	23	33	9	<0.0001
Edema*	2	8	22	34	7	0.0261

Discussion

Diabetes is a significant and growing health concern, both in HICs and LMICs. The World Health Organization reported that of the 422 million individuals with diabetes worldwide, the majority are living in LMICs [9]. While HICs often have advanced diagnostic modalities (e.g. contrast-enhanced magnetic resonance angiography, digital subtraction angiography) to assess for disease manifestations such as peripheral vascular disease, LMICs suffer from a paucity of such resources [5]. This is compounded with lack of specialty surgical care. For instance, at HNSB all DFIs and amputations are managed by general surgeons [14]. Thus, low-budget and easily available tools are critical for assessing risk of poor outcomes in patients with diabetes.

Diabetic foot infection is a frequent lower extremity complication of diabetes. It can occur from unperceived trauma or ill-fitting shoes, coupled with vascular compromise. Though infections are typically poly-microbial, common culprits include Staphylococcus, Streptococci, Pseudomonas, and other anaerobic species [10]. At least 15% of patients with diabetes progress to DFIs and 80% of non-traumatic lower limb amputations are preceded by this condition [11]. Previous studies by Vera-Cruz et al. have evaluated existing systems for characterizing DFIs, including the Wound, Ischemia, and Foot Infection (WIFi), University of Texas (UT), and Wagner Score [7]. They find that all three have good predictive ability of major amputation, with WIFi being the most predictive (Area under receiver operating curve 0.899), Wagner being the second-most (AUC 0.852), and UT least (AUC 0.785).

The Hospital Nacional de San Benito (HNSB) in El Petén, Guatemala encounters patients with a wide variety of both chronic and acute illnesses. A frequent presentation is DFI, and the healthcare providers currently utilize Wagner Score as a classification tool. Wagner Score was developed in 1981 by observing patients from Rancho Los Amigos Hospital in Los Angelas, California [12]. An extensive system for recognizing, preventing, and treating DFIs based on WS has been utilized across the world and evaluated in various clinical environments.

Shah et al. recently published an extensive report on WS as a tool for treating DFIs based on observations at a suburban teaching hospital [13]. The WS has been validated in other settings, but to our knowledge, this is the first report in Central America. HNSB is the major referral county hospital of the entire department (state) of El Petén and limited resources are the rule [15 - 17]. Validity of WS in this setting is therefore pivotal.

The majority of our patients with recorded WS were men (61 – 70-year-old), consistent with findings from Shah et al. The higher prevalence of DFIs in men may be due to more severe neuropathy, decreased joint mobility, and greater foot pressures as compared to female patients with diabetes [18]. Further, elderly patients tend to have more comorbidities and have had a longer period to develop peripheral vascular disease. The most common presentation of DFI in our study was ulcer, followed by necrosis, abscess, and gangrene. The high prevalence of ulcers mimicked findings from Shah et al., but their study found a greater proportion of gangrene as well as cellulitis. As ulcers commonly occur following pressure and poor wound healing, it is unsurprising that this is a frequent manifestation of uncontrolled diabetes.

WS IV was the most frequently recorded class in our patient population, followed by III, V, II, and I. This is in stark contrast to findings from a suburban teaching hospital, where the most frequent grades were II (42%), III (34%), IV (12%), I (8%), and V (4%) [8]. This is likely due to greater healthcare access in affluent regions, in contrast with the rural setting of El Peten. Many of the patients at HNSB must travel by bus or foot across long distances to receive care. This likely contributes to delayed treatment and greater progression of disease. In a study of rural residents with heart failure, Lee et al. found that when compared to urban residents, a larger proportion of rural patients were likely to wait longer than 72 hours after onset of symptoms to seek medical care [19]. Healthcare providers and medical teams organizing global health trips to LMICs should strongly consider providing diabetesspecific care and check-ups to rural populations.

In our analysis of continuous variables relative to WS, we found that increasing age and decreasing hematocrit were significantly correlated to WS. The increasing age is likely due to both greater likelihood and severity of infections in the geriatric population [20]. This is also supported by our finding that most patients fell into the 61–70-year-old age bracket. The finding that hematocrit tended to decrease with higher WS may be due to the strong association of anemia with diabetic foot ulcers and infections [21]. Often, anemia is a consequence of chronic kidney disease in diabetic patients. However, in the context of frequent or persistent foot infection, it may be caused by chronic inflammation. Sequestration of iron can occur when patients experience a chronic inflammatory state, and this contributes to the development of anemia.

Critically, we found that surgical intervention of any type was more likely with a greater WS. This suggests that the WS can be utilized as a low- or no-cost surrogate tool for gauging a patient's clinical course.

Strengths of our study included the novelty of a rural hospital population from an LMIC, which has not previously been assessed, substantial total study population (n=77), wide array of clinical variables, and a strong partnership with the care team at HNSB. The finding that WS is associated with likelihood of needing surgical intervention will be useful for other rural LMIC hospitals when evaluating patients presenting with DFIs. Though we only found significance for a limited number of clinical variables, we were able to assess many other important factors such as blood pressure, medication adherence, and prior amputation status. Finally, we have a clear and consistent line of communication between our team in the U.S.A. and the HNSB in Guatemala, allowing for direct communication of findings and suggestions for improvement. Limitations of our study include the low patient number in certain categories (only 2 patients with WS I), missing patient data from many charts, hand-written, and thus possibly inaccurate, recording of patient information, and variability in clinician assessment of DFIs. Additionally, some variables in the chart appeared to be inaccurately reported. This is likely due to the fast-paced and resource-limited nature of hospitals in LMICs. This serves as a critical reminder of challenges faced in global health research, particularly in LMICs.

Next steps include the standardization of Wagner Score classification at HNSB, which can be accomplished by structured lessons and demonstrations for local clinicians. Additionally, other classification scores such as WIFi should be explored as they may be of greater predictive value. A standardized note-taking template will help with future data collection and reduce both missing and inaccurate data points. Finally, efforts should be made at both the local and national level to support public health initiatives targeting people with diabetes in rural areas of LMICs.

Conclusions

Diabetic foot infections are a serious issue at the Hospital Nacional de San Benito, a rural county hospital in a low- and middle- income country. Wagner's score is a convenient and qualitative stratification tool used to assess the severity of a diabetic foot ulcer. Our results validate the correlation between WS, age, and risk for surgery, as previously found in the context of suburban teaching hospitals. In contrast, no association was observed with HbA1c or duration of diabetes. This may be due to limited testing equipment and reliability at HNSB, as well as lack of standardized records for disease process.

Nonetheless, the finding that WS is positively associated with surgical intervention can serve as a fast, cost-effective, and efficient method for planning care in a resource-limited hospital. In the future, WS should be grouped by broader categories such as "low" (WS 1-3) and "high" (WS 4, 5), and inter-provider reliability of reporting should be assessed. The finding that Wagner Score has utility in both high-income and low- and middle-income countries is significant in that it validates the classification system and offers a unique tool when treating diabetic foot infections.

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