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Original Article

Real-world comparison of the effects of injectable CGRPs on the headache impact test in an academic family medicine clinic: a pilot study

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Abstract

Background: Injectable anti-CGRP monoclonal antibodies (MABs) are increasingly used for migraine prevention. While trial data shows they reduce the average number of monthly migraine days, more real-world comparative evidence is needed to understand their impact on the Headache Impact Test (HIT-6).

Objective: Determine the efficacy of injectable anti-CGRP MABs on the HIT-6 scores in patients enrolled in the migraine clinic at multiple time intervals

Methods: This non-randomized, prospective case series involved a specific group of migraine patients who were started on injectable anti-CGRP MABs (erenumab-aaoe, fremanezumab-vfrm, and galcanezumab-gnlm), along with other recommended preventative therapies. The goal was to assess the average change in the HIT-6 score and the monthly number of migraine days compared to baseline.

Results: The primary outcome comparing the change in HIT-6 scores from baseline across the three groups showed no statistically significant differences in the mean scores at any time point (p-values of 0.8344, 0.1694, and 0.1301 for 3, 6, and 12 months, respectively). Similarly, the primary outcome comparing the change in average monthly migraine days from baseline among the three groups also revealed no significant differences in the mean at any time point (p-values of 0.5237, 0.1233, and 0.2115 for 3, 6, and 12 months, respectively).

Conclusion: Injectable anti-CGRP MABs improved HIT-6 scores and reduced the average number of monthly migraine days. However, no significant differences were observed between treatments at any time point. Despite these benefits, patients face cost-related challenges in continuing these therapies in real-world settings.

Keywords: migraine, chronic migraine, Headache Impact Test (HIT-6), anti-CGRP monoclonal antibodies, calcitonin gene-related peptide (CGRP)

Background

Migraines affect 15.4% of the population with higher prevalence in females, peaking between ages 18 and 44.[1,2] Individuals with migraines incur higher direct and indirect medical costs, including nine more lost workdays annually compared to individuals without migraines.[3,4] The International

Headache Society defines migraines without aura as headaches with specific features and associated symptoms. In contrast, migraines with aura have transient focal neurological symptoms that precede or accompany the headache.5,6 Migraines are classified as episodic (0 to 14 headache days per month) or chronic (greater than or equal to 15 headache days per month) for three or more months.[7]

The American Academy of Neurology (AAN) last updated the episodic migraine guidelines in 2012. Medications with established efficacy included antiepileptic drugs (divalproex sodium, sodium valproate, topiramate), beta-blockers (metoprolol, propranolol, timolol), and triptans (frovatriptan). Probably effective agents included antidepressants (venlafaxine, amitriptyline), beta-blockers (atenolol, nadolol), and triptans (naratriptan, zolmitriptan).[8] Of these, only divalproex sodium, valproate, topiramate, propranolol, and timolol are approved by the United States Food and Drug Administration (U.S. FDA) for migraine prevention. Other therapies not addressed by the AAN guidelines include onabotulinumtoxin A or nutraceuticals such as magnesium, coenzyme Q10, and/or riboflavin (vitamin B2). These preventative treatments may reduce headache frequency by 50%, although dose-related adverse effects often limit tolerability.[9]

Calcitonin gene-related peptide receptor antagonists (anti-CGRPs) are now available for migraine prevention. Three subcutaneous injectable anti-CGRP monoclonal antibodies (MABs) were approved by the U.S. FDA in 2018 for preventative treatment of migraines in adults: erenumab-aooe (Aimovig®), fremanezumab-vfrm (Ajovy®), and galcanezumab-gnlm (Emgality®).[10-12]

Elevated CGRP levels during migraines with or without aura promote vasodilation of blood vessels and cerebral inflammation. Therefore, blocking CGRP, reduces vasodilation and cerebral inflammation, thereby reducing migraine and headache frequency.[13] These agents significantly decreased mean monthly migraine days from baseline in both episodic migraines (average of around 4 fewer monthly migraine days vs. 2 with placebo) and chronic migraine (average of around 5 fewer monthly migraine days vs. 3 with placebo).[10-12] Injectable anti-CGRP MABs are effective as monotherapy, but they can also be used with other preventative and acute (abortive) therapies without the worrisome side effects of other treatments.[10-12]

While these agents in clinical trials appear to improve mean monthly migraine days, trials did not utilize newer validated tools for measuring migraine response, such as the Migraine Disability Assessment (MIDAS) or the Headache Impact Test (HIT-6). The HIT-6 is a six-item self-administered questionnaire that can help measure adverse headache impacts on social functioning, role functioning, vitality, cognitive functioning, psychological stress, and headache pain.[14] The scores for HIT-6 range from 36 to 78 with four headache impact severity categories: little or no impact less than or equal to 49, some impact 50-55, substantial impact 56-69, and severe impact 60-78. The HIT-6 questionnaire has also been shown to discriminate well between chronic, episodic, and non-migraine patients. An American Headache Society (AHS) Consensus Statement defines the

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meaningful improvement in HIT-6 as a reduction from a baseline of ≥ 5 points.[15] The HIT-6 assessment is convenient and easier to administer than the MIDAS, making it more practical for clinical use. To date, trials have assessed HIT-6 scores for 1 or 2 of the injectable anti-CGRP MABs but not a comparison of all 3 simultaneously.

Objective

This study aimed to compare the effects of injectable anti-CGRP MABs on the HIT-6 scores and mean monthly migraine days in patients enrolled in the migraine clinic at multiple time intervals.

Methods

Design

This study was approved by the Texas Tech University Health Sciences Center (TTUHSC) Amarillo Institutional Review Board #A20-4171. This study is a non-randomized, prospective case series that involved a defined group of migraine patients followed over time to examine associations between erenumab-aooe, fremanezumab-vfrm, and galcanezumab-gnlm and subsequent outcomes on mean change from baseline in the HIT-6 scores and monthly average number of migraine days. This research involved a time-series design without randomization to treatment groups due to potential insurance formulary issues. In this study design, each participant had measurements done before and after receiving an injectable anti-CGRP MAB at pre-specified intervals, including an initial visit, 3 months, 6 months, and 12 months.

Inclusion criteria

Male or female, any ethnicity, ages 18 to 70 years old, able to speak and read English, diagnosis of episodic or chronic migraine with or without aura, prescribed an injectable anti-CGRP MAB therapy. Patients must have been prescribed two separate or combination preventative therapies over 3 months without adequate response, which was determined based on subjective symptom reporting on migraine scales and objective migraine findings before injectable anti-CGRP MAB were initiated. Patients may have concurrent prescriptions of other acute (abortive) migraine therapies (i.e., triptans, ergotamine derivatives, non-steroidal anti-inflammatory drugs (NSAIDs), acetaminophen, or butalbital/acetaminophen/caffeine). Patients may also be prescribed magnesium, Coenzyme Q10, and/or riboflavin (vitamin B2) at any time before the initiation of injectable anti-CGRP MAB.

Exclusion criteria

<18 years old or > 70 years old, diagnosis of medication overuse headache or episodic cluster headaches, concurrent use of opiates, pregnancy, myocardial infarction, stroke, transient ischemic attacks, unstable angina, coronary artery bypass graft surgery or percutaneous coronary intervention within 6 months of screening, venous thromboembolism including deep vein thrombosis and/or pulmonary embolism within 6 months of screening, uncontrolled systolic blood pressure over 140 mm Hg or diastolic blood pressure over 90 mm Hg.

Recruitment

Subjects were recruited by word-of-mouth discussions during clinic visits at the Texas Tech Physicians (TTP) Headache Clinic located in an academic family medicine clinic at the TTUHSC School of Medicine in Amarillo, Texas. Individuals who had established caregiver relationships in Texas Tech Physicians (TTP) Headache Clinic were approached about involvement in the study and new patients. The screening script approved by the IRB was used for word-of-mouth discussions on patient recruitment.

Subjects screened but meeting the exclusion criteria (screening failure) will be replaced one-for-one with additional candidates with a goal of 60 subjects (20 per group).

Interventions

Migraines were managed according to the standard medical recommendations for individuals receiving injectable anti-CGRP MABs, and selection depended largely on insurance versus the availability of first-dose sampling. Erenumab-aaoe is available in 70 to 140 mg pre-filled syringes (PFS) and is injected subcutaneously (SubQ) every 1 month. Fremanezumab-vfrm is available in a 225 mg autoinjector or PFS and may be administered at 225 mg subQ every 1 month or 675 mg subQ every 3 months. Galcanezumab-gnlm is available in a 120 mg autoinjector or PFS and is typically administered as 240 mg subQ once and then 120 mg subQ every 1 month. Individuals who met the screening criteria and consented to be in the study had to complete the Headache Impact Test (HIT-6) questionnaire. Subjects were required to complete this questionnaire at baseline before or in temporal relationship to the first injectable anti-CGRP MAB therapy dose. This questionnaire was required to be filled out at baseline, 3 months, 6 months, and 12 months. Individuals were required to complete an initial face-to-face visit in the headache clinic and could also have subsequent face-to-face visits. If the subject's preference changed to telehealth, they could complete their follow-up appointment via telehealth. The HIT-6 questionnaire was completed either in person or by telehealth.

Table 1. Demographics and baseline characteristics

Characteristic	erenumab-aaoe 140 mg (n=6)	fremanezumab-vfrm 225 mg (n=11)	galcanezumab-gnlm 120 mg (n=11)
Age	32.1 ± 11.3 (18-54)	39.9 ± 12.2 (18-60)	40.0 ± 12.9 (18-60)
Sex, Female	6 (100%)	10 (90.9%)	11 (100%)
Race, white	6 (100%)	11 (100%)	11 (100%)
Chronic migraine diagnosis	5 (83.3%)	10 (90.9%)	9 (81.8%)
Baseline monthly migraine days	16.5 ± 7.0 (10-30)	18.3 ± 7.5 (5-30)	16.1 ± 7.0 (5-30)
Baseline HIT-6 score	68 ± 5.0 (65-78)	66 ± 6.1 (53-78)	66 ± 6.4 (53-78)
Combination preventative treatment with injectable anti-CGRP MAB	3 (50%)	6 (54.5%)	6 (54.5%)
Prior Medication use			
Antiepileptics	6/6 (100%)	9/11 (81%)	10/11 (90.9%)
Tricyclic antidepressants	3/6 (50%)	3/11 (27.2%)	3/11 (27.2%)
SSRI or SNRI	2/6 (33.3%)	4/11 (36.4%)	7/11 (63.6%)
Beta-blockers	1/6 (16.7%)	4/11 (36.4%)	2/11 (18.2%)
OnabotulinumtoxinA	1/6 (16.7%)	4/11 (36.4%)	1/11 (9%)
Current Acute Treatments			
Triptan	5/6 (83.3%)	6/11 (54.5%)	6/11 (54.5%)
Dihydroergotamine	0/6 (0%)	0/11 (0%)	0/11 (0%)
Oral gepant	1/6 (16.7%)	0/11 (0%)	1/11 (9%)
NSAID	5/6 (83.3%)	8/11 (72.7%)	6/11 (54.5%)
Acetaminophen	1/6 (16.7%)	4/11 (36.4%)	3/11 (27.2%)
Butalbital/acetaminophen	1/6 (16.7%)	1/11 (9%)	0/11 (0%)
Concurrent preventative therapies	3/6 (50%)	6/11 (54.5%)	6/11 (54.5%)

Statistical Analysis

No formal statistical power calculations were performed for this pilot study. Continuous variables are summarized with descriptive statistics, including number, mean, median, standard deviation (SD), minimum, and maximum, and categorical variables were summarized with counts and percentages as appropriate. For the primary outcomes, a one-way ANOVA was performed to compare the change in HIT-6 and change in average monthly migraine days from baseline from 3 months, 6 months, and 12 months between the three different groups (erenumab-aooe, fremanezumab-vfrm, and galcanezumab-gnlm). The statistical analyses were conducted using SAS 9.4.

Results

Recruitment occurred from February 2020 until March 2021 during which 28 patients met the inclusion criteria (6 erenumab-aooe, 11-fremanezumab-vfrm,and11galcan-ezumab-gnlm). The average age was 39 years, 96% were women, 92% had a diagnosis of chronic migraines, the baseline average monthly migraine days was 17, and the average HIT-6 score at baseline was 66 (severe impact). The most commonly used preventative migraine medications included topiramate, amitriptyline, venlafaxine, fluoxetine, propranolol, and onabotulinumtoxin A, while sumatriptan or sumatriptan/naproxen were the most frequent acute treatments. Acetaminophen and ibuprofen were also frequently reported. Additional patient demographics and baseline characteristics are reported in

Table 1. For graphical representations of the data, please refer to the box plots in Figures 1 and 2 which highlight central tendency, spread, and potential outliers in the data set. All 28 patients had baseline and 3-month

Table 2. Change in HIT-6 score from baseline

Time	Anti-CGRP MAB	Obs	N	Miss	Mean	Std Dev	Median	Min	Max	P-value
3 months	erenumab-aaoe	6	6	0	-6.2	4.4	-6.5	-13.0	0.0	0.8344
	fremanezumab-vfrm	11	11	0	-7.3	9.1	-4.0	-21.0	7.0	
	galcanezumab-gnlm	11	11	0	-5.0	10.1	-6.0	-22.0	18.0	
6 months	erenumab-aaoe	6	5	1	-14.2	10.7	-15.0	-25.0	-1.0	0.1694
	fremanezumab-vfrm	11	9	2	-12.1	9.9	-8.0	-32.0	-2.0	
	galcanezumab-gnlm	11	8	3	-3.1	12.9	-3.0	-23.0	22.0	
12 months	erenumab-aaoe	6	4	2	-25.3	8.2	-29.0	-30.0	-13.0	0.1301
	fremanezumab-vfrm	11	6	5	-19.0	11.9	-18.0	-38.0	-7.0	
	galcanezumab-gnlm	11	6	5	-12.7	5.2	-12.5	-21.0	-7.0	

HIT-6 scores and mean monthly migraine days reported. However, at 6 months, 6 patients were lost to follow-up, and by 12 months, 6 additional patients were lost to follow-up. Reasons included loss/change of insurance (6/12), preference for onabotulinumtoxinA and atogepant (3/12), pregnancy (1/12), and unspecified reasons (2/12). As shown in Table 2, the primary outcome change in HIT-6 from baseline demonstrated no statistically significant difference between the three treatment groups at 3, 6, or 12 months (p = 0.8344, 0.1694, and 0.1301, respectively). Similarly, Table 3 summarizes the secondary outcome of change in mean monthly migraine days which also showed no significant difference between the three treatment groups at 3, 6, or 12 months (p = 0.5237, 0.1233, and 0.2115, respectively).

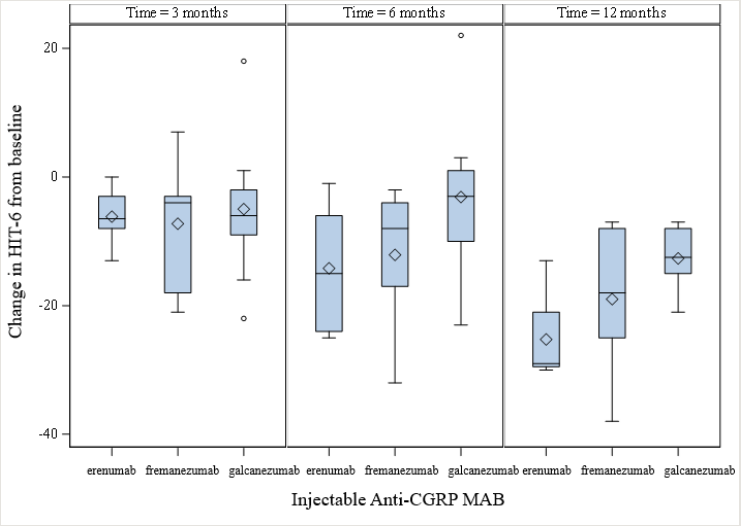

Figure 1. Box Plot change in HIT-6 Score from

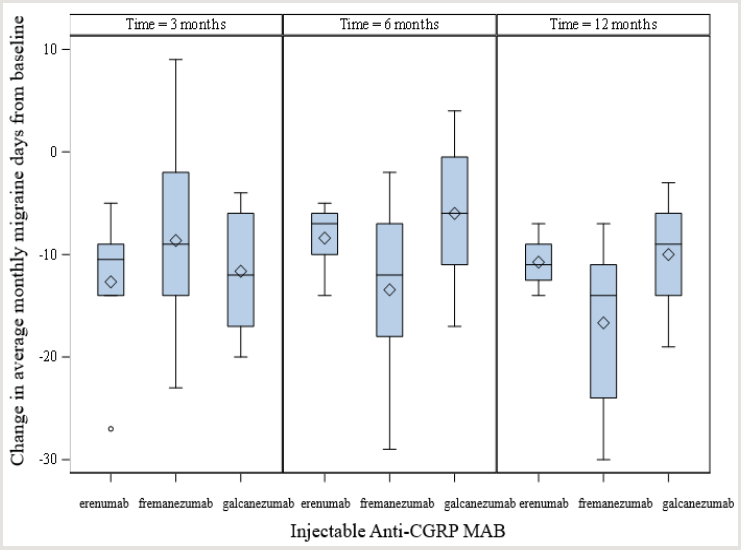

Figure 2. Box Plot change in average monthly migraine days from baseline

Discussion

In this study comparing injectable anti-CGRP MABs impact on HIT-6 and mean monthly migraine days, no differences were observed between the different treatment options. Although this study was not powered to assess clinical outcomes, patients were followed for up to 12 months, and it does appear that each anti-CGRP MAB does improve HIT-6 scores and mean monthly migraine days. In clinical trials, patients on injectable anti-CGRP MABs experienced around 5 fewer monthly migraine days on average compared to 3 with a placebo. In this study, at 3 months, 100% of erenumab-aaoe, 72.7% of fremanezumab-vfrm, and 90.9% of galcanezumab-gnlm experienced ≥ 5 fewer monthly migraine days on average at 3 months. The AHS consensus statement defines a meaningful improvement in HIT-6 as a reduction from baseline of ≥ 5 points within patients. In a systematic review and meta-analysis with erenumab, HIT-6 scores improved by -6.97 at 3 months.[16] A fremanezumab trial in 559 patients with chronic migraines found that at 6 months the HIT-6 scores improved by -8.1.[17] A galcanezumab trial in 87 patients with mostly chronic migraines found that at 3 months the HIT-6 scores improved by -4.4.[18] In this study, at 3 months, 66.6% of erenumab-aaoe, 45.5% of fremanezumab-vfrm, and 54.5% of galcanezumab-gnlm experienced ≥ 5 point improvement from baseline on their HIT-6 scores.

In 2024, the American Headache Society published a position statement that CGRP therapies are first-line options for the prevention of migraines and indicated, “initiation of these therapies should not require trial and failure of non-specific migraine preventative medication approaches.”[19] Though other experts from the American College of Physicians which recently published an update on migraine prevention reserved the use of CGRP medications for, “nonpregnant adults in outpatient settings who do not tolerate or inadequately respond to a trial or trials of a beta-adrenergic blocker (metoprolol or propranolol), the antiseizure medication valproate, the serotonin and norepinephrine reuptake inhibitor venlafaxine, or the tricyclic antidepressant amitriptyline.”[20]

In real-world practice, the treatment plan depends largely on patient preference, comorbidities, and the insurance plan, with many insurance plans requiring past medication failures with ≥60 to 90-day trial on other agents. In addition to injectable anti-CGRP MABS, there are widely available oral anti-CGRP medications. At the beginning of this study, rimegepant and ubrogepant were approved for acute migraine management. Now, rimegepant and atogepant are approved for chronic migraine prevention. Many patients may prefer oral gepants over injectable anti-CGRP MABs based on ease of oral administration. However, some patients may prefer the injectable anti-CGRP MAB if they have problems with nausea/vomiting or a preference for continuous CGRP inhibition. Each agent carries risks and benefits, and selection will still largely be driven by patient preference, comorbidities, and insurance plans.

This study had several strengths in comparing the 3 most common injectable anti-CGRP MABs in a real-world setting with a selection of agents based on patient characteristics and formulary restrictions. This patient population was representative of a typical migraine population, and this study design allowed each participant to serve as their own control to eliminate potential confounding characteristics. This study also reveals that many patients respond to and tolerate injectable anti-CGRP MABs but, unfortunately, are unable to continue therapy mainly due to insurance and formulary preference changes. This study also allowed other preventative therapies to be used with injectable anti-CGRP MABs, a distinct limitation of the currently available literature. This study also had several limitations: it was a single-center, small sample size, non-randomized, non-blinded, had a high drop-out rate, lacked a formal power analysis, and lacked a proper control group or randomization to individual treatment groups, posing a potential risk of selection bias.

Conclusions

This study reveals that while injectable anti-CGRP MABs (erenumab-aaoe, fremanezumab-vfrm, and galcanezumab-gnlm) showed improvements in HIT-6 scores and reduction in mean monthly migraine days, there were no significant differences between treatments. Real-world evidence supports their efficacy, and the response seen in this trial aligns with clinical trials showing that these agents do impact HIT-6 and monthly migraine days. Though the anti-CGRP agents are recommended as first-line therapy for migraines by some organizations, including AHS, our study suggests that insurance-related challenges limit long-term continuation. Future research should address ways to mitigate insurance-related coverage issues with injectable anti-CGRP MABS.

Table 3. Change in average monthly migraine days from baseline

Time	Injectable Anti-CGRP MAB	N Obs	N	N Miss	Mean	Std Dev	Median	Min	Max	P-value
3 months	erenumab-aaoe	6	6	0	-12.7	7.6	-10.5	-27.0	-5.0	0.5237
	fremanezumab-vfrm	11	11	0	-8.6	9.3	-9.0	-23.0	9.0	
	galcanezumab-gnlm	11	11	0	-11.6	5.9	-12.0	-20.0	-4.0	
6 months	erenumab-aaoe	6	5	1	-8.4	3.6	-7.0	-14.0	-5.0	0.1233
	fremanezumab-vfrm	11	9	2	-13.4	8.6	-12.0	-29.0	-2.0	
	galcanezumab-gnlm	11	8	3	-6.0	7.0	-6.0	-17.0	4.0	
12 months	erenumab-aaoe	6	4	2	-10.8	2.9	-11.0	-14.0	-7.0	0.2115
	fremanezumab-vfrm	11	6	5	-16.7	8.6	-14.0	-30.0	-7.0	
	galcanezumab-gnlm	11	6	5	-10.0	5.9	-9.0	-19.0	-3.0	

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Original Article

Geographic and Demographic Disparities in Bacterial Pneumonia Mortality: A Comparative Analysis of U.S.-Mexico Border and Non-Border Regions

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Abstract

Background: Bacterial pneumonia remains a significant public health concern in the U.S., particularly in regions with limited access to healthcare. Previous studies have highlighted disparities in infectious disease outcomes, but few have examined mortality trends specific to U.S.-Mexico border regions. The objective of this study is to compare bacterial pneumonia mortality rates between U.S.-Mexico border and non-border counties from 2000 to 2020 and assess demographic disparities.

Methods: This study utilized data from the CDC WONDER Multiple Cause of Death database. Bacterial pneumonia deaths were identified using ICD-10 codes J13–J15. Crude mortality rates and age-adjusted standardized mortality rates (ASMR) were calculated and stratified by gender, race, and ethnicity. Risk ratios were computed to compare mortality differences between groups.

Results: The ASMR for bacterial pneumonia in the U.S.-Mexico border counties was 2.2 per 100,000—double that of non-border counties (1.1). Males had higher mortality than females across all regions. Non-Hispanics and American Indian/Alaskan Native populations showed disproportionately higher mortality rates, particularly in border regions. The overall mortality risk in border regions was twice that of non-border areas (RR: 2.0).

Conclusion: Bacterial pneumonia mortality is significantly higher in the U.S.-Mexico border regions, with notable disparities across gender, race, and ethnicity. These findings suggest systemic healthcare access barriers and underinvestment in public health infrastructure in border communities. Targeted public health interventions addressing geographic and social determinants of health are critical to reducing pneumonia-related mortality in these vulnerable populations.

Keywords: bacterial pneumonia, mortality, health disparities

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Introduction

Bacterial pneumonia is characterized by inflammation of the lung parenchyma and alveolar spaces in response to a bacterial infection. Among the infectious causes of pneumonia, bacteria have a significant impact on the overall morbidity and mortality rates of pneumonia. Globally, community-acquired pneumonia (CAP) incidence is up to 450 million cases annually. In the U.S., the burden of CAP is substantial as there is an estimate of 2.2 to 8 million hospitalizations and 100,000 cases of CAP-related deaths annually, with 2.6-18.5% global mortality rates at the time of hospitalization and up to 31-44.5% within a year of hospitalization.[1]

Health disparities related to pneumonia have also been observed. One study found that pneumonia and influenza accounted for the largest number of infectious disease deaths throughout the 20th century, with the oldest age groups being heavily impacted.[2] CAP incidence rates among low-income and African-American populations were especially high in previous studies, demonstrating the importance of socioeconomic factors, such as poor housing conditions, poor air quality, increased rates of smoking, lack of medical insurance, and limited access to medical care, as well as the role of race as risk factors for CAP.[3,4]

Antimicrobial resistance is also a growing issue globally due to increased healthcare utilization, costs, morbidity and mortality. One study found increased antimicrobial resistance across 8 hospitals along the U.S.-Mexico border over the course of 6 years, with improper antimicrobial use, ineffective infection control precautions, travel, and cross-border migration as potentially contributing factors.[5] The significant burden of pneumonia on the U.S. healthcare system in addition to the unique challenges and disparities associated with the border region prompt further investigation. This study aims to examine differences in bacterial pneumonia mortality between U.S.-Mexico border regions and non-border regions, utilizing data from the CDC Wonder Multiple Cause of Death Database.

Methods:

We queried the CDC WONDER Multiple Cause of Death database for bacterial pneumonia deaths from 2000-2020 based on ICD-10 codes J13, J14, and J15. The crude rate and ASMR per 100,000 people

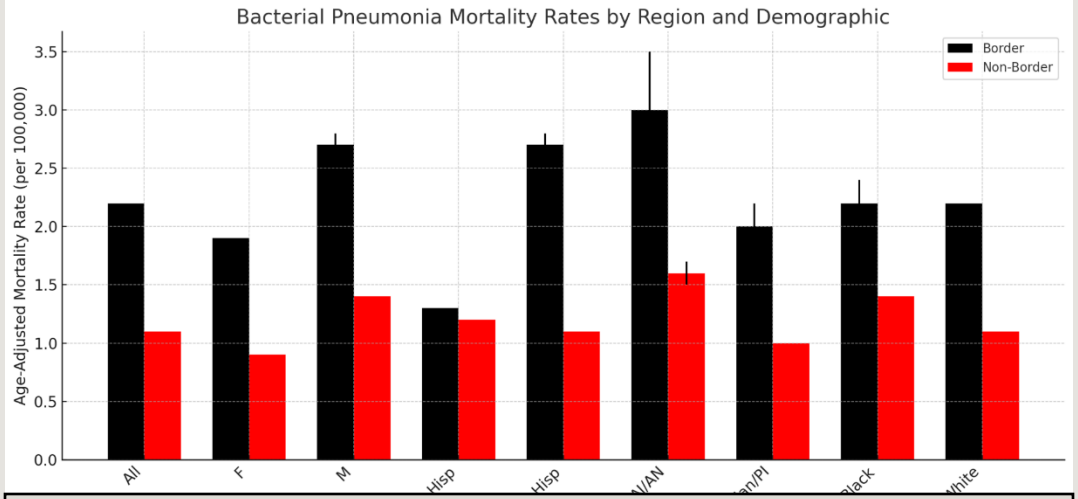

Figure 1. Bacterial Pneumonia Age-Adjusted Mortality Rates by Region and Demographic. Across nearly all groups, border regions experienced significantly higher mortality rates compared to non-border regions.

from bacterial pneumonia were compared between border and non-border regions. The crude mortality rate and ASMR, stratified by gender, ethnicity (Hispanic or Latino vs. non-Hispanic or Latino), and race, were also compared between border and non-border regions. 95% confidence intervals (CI) without overlap were considered significantly different.

Results:
Figure 1 shows the age-adjusted mortality rate for bacterial pneumonia in U.S.-Mexico border counties was 2.2 per 100,000, which was double the rate observed in U.S. non-border counties (1.1 per 100,000). This pattern of higher mortality in border regions was consistent across all demographic groups.

In Table 1, among genders, males exhibited higher mortality rates than females in both border and non-border regions. In border counties, males had a mortality rate of 2.7 (95% CI: 2.6–2.8), compared to 1.4 (95% CI: 1.4–1.4) in non-border males. Female rates were 1.9 (95% CI: 1.8–1.9) in border regions versus 0.9 (95% CI: 0.9–0.9) in non-border regions. Similarly, ethnic disparities revealed that non-Hispanic individuals had significantly higher mortality rates than Hispanics, particularly in border counties (2.7 vs. 1.3 per 100,000). Among racial groups, American Indians/Alaskan Natives showed the highest mortality rates, with 3.0 in border regions and 1.6 in non-border regions.

Risk ratios in Table 2 revealed that the overall mortality risk in border regions was double that of non-border regions (RR: 2.0). Subgroup-specific comparisons demonstrated that non-Hispanics in border counties had a 2.5-fold higher risk compared to Hispanics. Gender-based comparisons showed males had a higher risk than females across all regions, with border-region males at 1.9 times the risk of their female counterparts. Racial group comparisons within border regions indicated that American Indians/Alaskan Natives had the highest relative risks compared to Whites.

Conclusion
The findings of this study align with established literature documenting health disparities in U.S.-Mexico border regions due to significant healthcare access barriers. Residents in border counties often face challenges such as geographic isolation, inadequate healthcare infrastructure, and low rates of insurance, which contribute to delays in the diagnosis and treatment of bacterial pneumonia.[6] Historically, underinvestment in public health infrastructure in border areas has compounded these challenges, leading to higher morbidity and mortality rates.[7]

Consistent with Ruiz et al. (2016), Hispanic populations exhibited lower mortality rates despite socioeconomic disadvantages. This phenomenon, known as the Hispanic health paradox, may be attributed to strong familial and community support networks, cultural resilience, and protective health behaviors.[8] However, these protective factors require further investigation in the context of bacterial pneumonia. American Indians/Alaskan Natives demonstrated the highest mortality rates, underscoring systemic inequities in healthcare access and quality.[6] These disparities are consistent with historical patterns of underinvestment in healthcare services for these populations.[7] The higher mortality rates among males reflect patterns observed in other infectious diseases. Potential explanations include biological differences, occupational

Table 1. Age-adjusted mortality rates per 100,000 with 95% confidence intervals – Death due to bacterial pneumonia

	Demographic	Age-adjusted rate	Standard error	95% Confidence Interval
US-Mexico Border Region	All	2.2	0.0	2.1 - 2.3
	Female	1.9	0.0	1.8 - 1.9
	Male	2.7	0.1	2.6 - 2.8
	Hispanic	1.3	0.0	1.2 – 1.4
	Non-Hispanic	2.7	0.1	2.6 – 2.8
	American Indian or Alaskan Native	3.0	0.5	2.2 – 4.1
	Asian or Pacific Islander	2.0	0.2	1.7 – 2.3
	Black or African American	2.2	0.2	1.7 - 2.7
	White	2.2	0.0	2.1 – 2.3
US Non-Border Region	All	1.1	0.0	1.1 – 1.1
	Female	0.9	0.0	0.9 - 0.9
	Male	1.4	0.0	1.4 – 1.4
	Hispanic	1.2	0.0	1.2 – 1.3
	Non-Hispanic	1.1	0.0	1.1 – 1.1
	American Indian or Alaskan Native	1.6	0.1	1.5 – 1.7
	Asian or Pacific Islander	1.0	0.0	1.0 – 1.0
	Black or African American	1.4	0.0	1.4 - 1.4

exposures, variations in substance-use rates, and lower healthcare-seeking behaviors among males.

Addressing these disparities requires targeted public health interventions. The Global Health Security Agenda emphasizes

the importance of improving healthcare access and implementing comprehensive surveillance systems to reduce health disparities.[9] Interventions aimed at social determinants of health, such as expanding healthcare coverage and reducing poverty, have been shown to reduce mortality in high-risk populations.[6,9]

Lessons from global studies demonstrate that geographical accessibility to healthcare significantly impacts infectious disease outcomes.[10] These insights suggest that addressing healthcare access barriers in U.S.-Mexico border regions could mitigate the disparities observed in bacterial pneumonia mortality rates.

This study has several limitations, largely related to the use of the CDC WONDER Multiple Cause of Death database. The database contains only mortality data and does not capture incidence, access to care, or treatment outcomes, which restricts our ability to assess the complete burden of

Table 2. Age-adjusted risk ratios comparing key demographic categories by and within US-Mexico border classifications – death due to bacterial pneumonia

Group 1	Group 2	Age-Adjusted Risk Ratio
US-Mexico border region	***US non-border region***	
All	All	2.0
Female	Female	2.1
Male	Male	1.9
Hispanic	Hispanic	1.1
Non-Hispanic	Non-Hispanic	2.5
American Indian or Alaskan Native	American Indian or Alaskan Native	1.9
Asian or Pacific Islander	Asian or Pacific Islander	2.0
Black or African American	Black or African American	1.6
White	White	2.0
US-Mexico border region only		
Female	Male	0.7
Hispanic	Non-Hispanic	0.5
American Indian or Alaskan Native	White	1.4
Asian or Pacific Islander	White	0.9
Black or African American	White	1.0
US non-border region only		
Female	Male	0.6
Hispanic	Non-Hispanic	1.1
American Indian or Alaskan Native	White	1.5
Asian or Pacific Islander	White	0.9
Black or African American	White	1.3

disease. Furthermore, the accuracy of cause-of-death reporting depends on death certificate documentation, which may underreport or misclassify HCV or HCC and result in potential misestimation of mortality rates. Individual-level variables — such as socioeconomic status, insurance coverage, comorbid conditions, and access to screening or treatment — are also unavailable, despite their potential influence on mortality patterns and disparities. As a result, while our analysis identifies notable differences in mortality across geographic and demographic groups, the precise drivers of these disparities remain unclear.

Further research is necessary to explore the protective factors associated with the Hispanic health paradox and their applicability to other at-risk populations. Additionally, comparative studies of bacterial pneumonia mortality trends across other international border regions could provide valuable insights for global health policies and interventions.

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Case Report

Pectoralis Major Myocutaneous Flap Reconstruction of a Traumatic Gunshot Wound to the Oropharynx: A Case Report

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Abstract

Penetrating injuries to the neck can be complex and life-threatening. The main priority in these events is to stabilize the patient and address any immediate danger. For patients who survive, there is often a need for reconstruction. Complications such as fistulas may also arise, which can be resolved through reconstruction. The standard of care in most hospitals across the United States for neck reconstruction involves the use of a free flap and free tissue transfers, based on the defect and the patient's overall health status. In this case report, we present the successful closure and reconstruction of a laryngopharyngeal gunshot wound and an associated pharyngocutaneous fistula using a left pectoralis major myocutaneous flap (PMMF). This case highlights the PMMF as a safe and well-researched alternative to free flap reconstruction in select patients and demonstrates a potential niche for regional flap reconstruction in modern head and neck surgery.

Keywords: Reconstruction, Regional Flap, Trauma

Introduction

Since its introduction in 1979, the pectoralis major myocutaneous flap (PMF) has been utilized in head and neck surgery to improve outcomes, reduce complications, and facilitate single-stage reconstruction.[1] Despite the success of this regional flap, advances in microsurgery and free flap reconstruction have shifted the standard of care for head and neck reconstruction in developed countries toward free flap techniques.[2] While free flaps are currently considered the best choice, there remain situations where regional flaps may be appropriate alternatives. The PMF has a long history of use as a regional flap for head and neck reconstruction and has demonstrated high flap survival rates.[3] In developed countries, the PMF is primarily indicated for salvage reconstruction due to complications such as fistula formation or for primary reconstruction in patients with multiple comorbidities. It remains the first choice for head and neck reconstruction in developing countries and in regions lacking access to a microsurgery team.[4]

Penetrating neck trauma is characterized by damage to the neck that breaches the platysma muscle.[5] Such injuries can affect various neck structures, leading to vascular

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injury in 25% of cases, aerodigestive injury in 23% to 30%, and the need for laryngotracheal or pharyngeal repair in 32.8% of cases.[5-7] Initial management of penetrating neck trauma can be challenging, given the potential for rapid patient deterioration. Although the initial phases of management have received significant attention in the literature, there is limited coverage regarding the reconstruction of penetrating neck injuries. In this case report, we highlight the use of a PMF to close and reconstruct a gunshot wound to the neck and an associated pharyngocutaneous fistula.

Case Summary:

A 17-year-old male presented to the emergency department with a self-inflicted gunshot wound to the midline of the neck. The patient arrived via air ambulance and had his airway secured through a cricothyrotomy prior to arrival. The 6-cm entry wound was located just inferior to the chin, with no exit wound. A head CT revealed several hematomas and an interpeduncular cistern subarachnoid hemorrhage. Bullet fragments were visualized in the neck, including a fragment in the C2 transversarium wall. CT angiography showed mild irregularity of the left proximal internal carotid artery without flow limitation, as well as pooling of contrast in the soft tissue of the neck. Bilateral common carotid, cervical internal carotid, and vertebral arteries were all patent.

Upon operative exploration, significant laryngeal-tracheal damage and a 5-6 cm esophageal injury were identified, along with numerous vascular injuries to branches of the thyroid artery and the left external jugular vein (Figure 1). Due to extensive head trauma, there was increased intracranial pressure that needed resolution before surgery could proceed. On the sixth hospital day, a direct laryngoscopy and neck

Figure 1: CT reconstruction showing extensive laryngeal damage

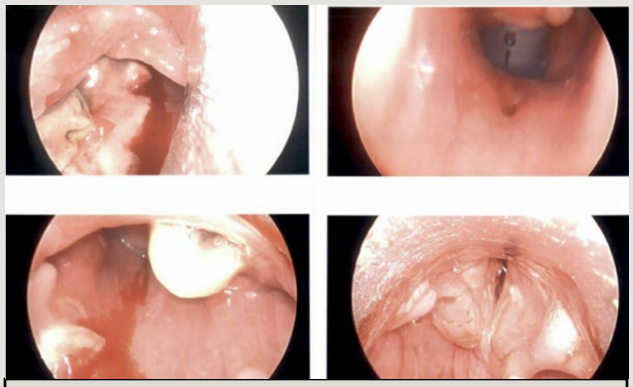

Figure 2: Laryngoscopy showing fistula, bullet fragments, and laryngeal damage

exploration were performed (Figure 2). A significant left pyriform sinus defect connected to the external open neck wound, along with partially destroyed thyroid cartilage, was noted. The external skin wound measured approximately 5 cm by 4 cm. At this time, foreign bodies were removed, and hypopharyngeal/laryngeal tissue was debrided until healthy mucosal edges were reached. On hospital day 20, a pharyngocutaneous fistula was assessed, measuring 3 cm from the left pyriform sinus to the external neck wound. Vocal cord function was evaluated through flexible scope examination. The right vocal cord was mobile; however, the left cord was paralyzed, as expected. After discussions with the family, larynx preservation was offered based on the findings from the flexible scope examination.

On hospital day 23, a pharyngoplasty and left pectoralis major myocutaneous flap (PMMF) were performed to address the wound and fistulas. Over the next 6 days, the fistula resolved, and the flap healed appropriately. On hospital day 29, the patient was discharged to a rehabilitation facility.

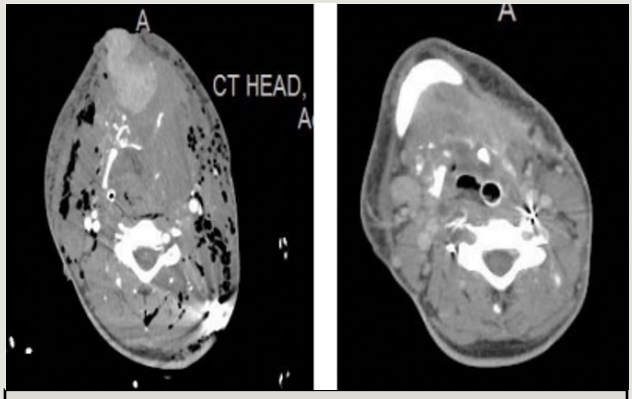

Figure 3: CT scan at admission (left) and discharge (right)

Discussion:

The role of regional flap reconstruction is still being defined in an era where free flap reconstruction has become the standard where possible. In certain cases, there is a preference for free flap reconstruction, especially when a thin, pliable flap is needed for proper shaping or when the pedicle must pass through an anatomical stricture. Free flaps are also favored when substantial reconstruction is needed in areas too distant from any regional flap or in major bone reconstruction scenarios.[8] The only distinct indication for regional flaps is in patients lacking donor vessels. For patients with severe comorbidities, poor prognosis, or those who are medically fragile, a regional flap may be preferable due to its comparable outcomes, easier execution, shorter operative time, and often lower economic burden compared to free flap reconstruction.[8,9] Stevens et al. discuss the treatment of blast wounds, including considerations for reconstruction. They emphasize the importance of a deliberate approach and mention the potential use of vascularized local flaps and free flaps.[10]

Conclusion:

This case report highlights a patient population for which regional flaps may be considered over free flap reconstruction and explores other circumstances that may prompt a surgeon to consider a regional flap for neck reconstruction. Education on the indications, advantages, and disadvantages of each reconstruction method will enable surgeons to make the most appropriate choice for their patients until more definitive research is conducted.

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Case Report

Rectal Fistula Causing NSTI of the Right Gluteal Region and Thigh after Colonoscopy

Rebecca Joseph, BS[1]; Milcah Poothakary, BA[1]; Hannah Daniel, MD[1]; Justin Vaughan[2], MD; Ariel P. Santos, MD, MPH, FRCSC, FACS, FCCM[2]

Abstract

Necrotizing soft-tissue infections (NSTI) are severe and rapidly progressing bacterial infections that carry high mortality. We are presenting a unique case of NSTI following colonoscopy associated with rectal carcinoma in a man on his mid-60s who noticed swelling and pain in his right lower extremity four days following a colonoscopy. The patient was diagnosed with NSTI and underwent surgical debridement. Three days after surgical intervention, the colonoscopy report returned confirming rectal cancer, which may have contributed to NSTI development. This case highlights a rare but serious complication following colonoscopy, emphasizing the need for clinicians to consider NSTI in patients with malignancy and immunocompromised conditions who present with signs of sepsis and soft-tissue infection after endoscopic procedures.

Keywords: Rectal Fistula, NSTI, Colonoscopy, Gluteal Region, Thigh, Case Report

Introduction

Necrotizing soft-tissue infections (NSTI) are severe and potentially life-threatening bacterial infections. Bacteria can spread through the tissue, releasing destructive toxins that lead to the development of deep ulcers, abscesses, and tissue necrosis.[1] The infection can spread rapidly, leading to sepsis and high mortality rates averaging 25%.[2] NSTI may occur due to a variety of procedures such as intramuscular injection, gastrostomy tube insertion, percutaneous coronary revascularization, endoscopy and hemorrhoidectomy.[3] In this paper, we describe a rare case of NSTI developing after a colonoscopy associated with rectal cancer.

Case Description

A male in his mid-60s with a medical history of type 2 diabetes mellitus (DM) presented to the emergency department with complaints of swelling and tenderness in his right lower extremity four days after undergoing colonoscopy and rectal mass biopsy. He had no prior history of trauma or surgery. The colonoscopy report revealed a large circumferential mass spanning from 4 cm to 10 cm from the anal verge. A biopsy of the rectal mass was performed (Figure 1). Upon physical examination, his right lower extremity was warm, erythematous, and firm to touch; the affected area extended from the right mid-gluteal region to just above the posterior right knee. The patient was hypotensive with a blood pressure of 89/59. Laboratory data obtained in the emergency department indicated severe infection and

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Figure 1: Appendix opening (left) and rectal mass (middle and right) in a 66-year-old male following routine colonoscopy.

was notable for a white blood cell count of 28,000/mm3 (reference range, 4,000–10,000/mm3). The rest of the laboratory results were as follows: blood urea nitrogen level, 8 mg/dL (8–20 mg/dL); hemoglobin 9.8 g/dL (13.7-17.5 g/dL); sodium 136 mmol/L (136-145 mmol/L); creatinine, 0.49 mg/dL (0.7–1.2 mg/dL); lactic acid, 7.8 mmol/L (0.5–2.0 mmol/L); glucose, 112 mg/dL (74-106 mg/dL); hemoglobin A1C 6.4 % (3.8-5.6 %); and total bilirubin, 0.7 mg/dL (0.3–1.2 mg/dL). The patient's Laboratory Risk Indicator for Necrotizing Fasciitis (LRINEC) score was calculated to be 6, indicating a moderate risk for necrotizing fasciitis. He was started on a course of intravenous (IV) clindamycin and piperacillin-tazobactam as empiric treatment for NSTI while cultures were collected and submitted for gram-stain and culture. Three days after admission, blood cultures were positive for Pseudomonas sp., and the patient was continued on IV piperacillin-tazobactam per sensitivity report.

Upon admission, computed tomography (CT) of the right lower extremity with contrast showed a 32 cm multiloculated collection of fluid and gas from the gluteal musculature along the lateral musculature of the right thigh consistent with an abscess (Figure 2). Additional subcutaneous gas was noted in the anterior and medial aspect of the distal thigh, concerning for necrotizing fasciitis. CT of the abdomen and pelvis showed irregular wall thickening of the distal sigmoid colon with possible fistula.

Due to the high level of suspicion for NSTI, urgent surgical intervention was required. The patient was immediately taken to the operating room for incision and drainage of the right thigh abscess, and excisional debridement of the right gluteal and thigh. The total area of skin and subcutaneous tissue found to be involved by NSTI measured 40 cm x 12 cm x 12 cm which was adequately debrided (Figure 3). Once infection controlled with daily wound dressing change, a vacuum-assisted closure (VAC) device was applied over the open wound.

Three days after the surgical debridement of NSTI, the patient's colonoscopy returned with report of moderately differentiated rectal adenocarcinoma. Additionally, Gastrograffin enema showed a marked area of annular constriction measuring 6 cm along the rectosigmoid region proximally with the edema (Figure 4). A fistula was found along the right lateral wall of the proximal rectosigmoid extending along the right acetabulum into the right hip joint, suggestive of colorectal carcinoma. Carcinoembryonic antigen (CEA) levels were measured at 8 ng/mL (0.0-3.0 ng/mL). The next day, the patient underwent a diverting colostomy. The patient showed improvement and gradual wound healing over the next six days in the surgical intensive care unit (SICU). He was then transferred to a long-term acute care (LTAC) hospital for direct physician supervision, local wound care, and to finish a course of IV

Figure 2: CT of the right lower extremity shows subcutaneous air in the gluteal musculature extending into the distal thigh.

antibiotics. After 34 days of care at the LTAC, the patient was transferred to inpatient rehabilitation and directed to follow-up in four weeks for the final staging of rectal cancer. After a multidisciplinary discussion, it was discussed that the patient will benefit from neoadjuvant therapy, which consists of an extended course of chemotherapy and radiation treatment.

Discussion

NSTI is often difficult to distinguish from cellulitis upon physical exam and the index of clinical suspicion must be high to quickly and accurately diagnose NSTI. Signs and symptoms may include fever, tachycardia, hypotension, shock, swelling, erythema, pain disproportionate to appearance, skin discoloration, crepitus, and subcutaneous gas.[4] The Laboratory Risk Indicator for Necrotizing Fasciitis (LRINEC) score was developed to help differentiate NSTI from other soft tissue infections. This score is based on a CRP > 150 mg/L, WBC > 15,000/mm3, Hemoglobin > 13.5 g/dL, Na < 135 mEq/L, creatinine > 1.6 umol/L, and glucose > 180 mg/dL.[5] Recent studies have shown that the LRINEC score is a poor predictive factor of NSTI.[6] If the diagnosis of NSTI is uncertain but the suspicion is high,

Figure 3: Post-Debridement surgical site on the right thigh for NSTI treatment.

the gold standard is surgical exploration which is both diagnostic and therapeutic.

NSTI can be categorized based on the microbiology of the infection and divided into four categories: polymicrobial (type I); monomicrobial caused by Staphylococcus aureus (type II); monomicrobial caused by clostridium species, gram-negative bacteria, or Vibrio species (type III); and fungal infection (type IV).[1] In our case, the presence of gas in soft tissues on radiographic imaging indicates the NSTI is more likely to be type I or III.

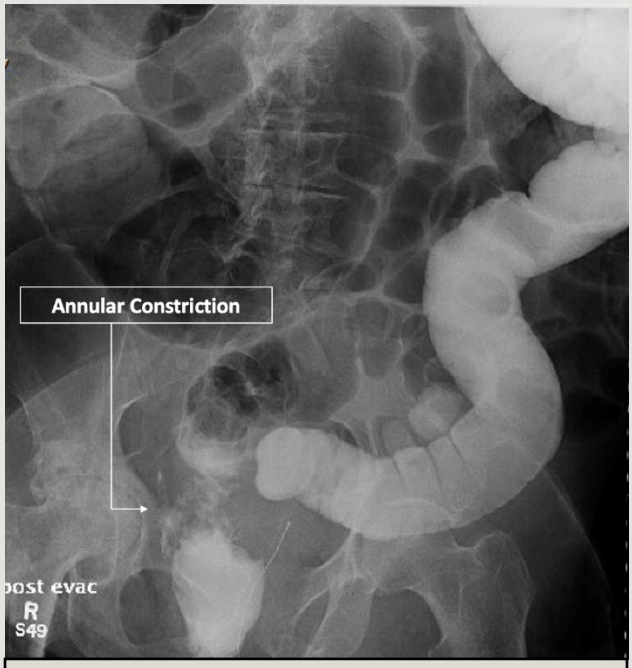

Figure 4: Gastrografin enema revealing annular constriction and fistulae in the rectosigmoid region with colorectal carcinoma implications.

Risk factors for NSTI include a depressed immune system or decreased tissue perfusion caused by DM, malnutrition, IV drug use, obesity, chronic alcohol abuse, leukemia, steroid use, renal failure, peripheral artery disease, or cirrhosis.[5] Those with NSTI and underlying DM were reported to have higher mortality and polymicrobial infection rates.[2] Our patient may have had an exacerbated clinical course because of comorbidity of DM and weakened immune system from underlying malignancy.

The development of NSTI associated with colonoscopy or rectal cancer is not commonly reported in the literature. Fistulae may be a complication of conditions such as colorectal cancer and can provide a pathway for bacteria to enter the body and cause a necrotizing infection. A retrospective cohort study on subjects presenting with NSTIs found that the GI fistulae facilitated continuous chemical irritation, compromised skin integrity, and exacerbated the spread of infection.[7]

The patient might have an underlying fistula that could have caused the NSTI, which the colonoscopy might exacerbate (Figure 5). Endoscopists must be aware of this possible complication to warn the patient to seek medical attention if unusual signs and symptoms occur after the procedure.

Conclusion

NSTI may develop after a colonoscopy, especially in elderly patients with DM and/or underlying malignancy. Early diagnosis, appropriate treatment, and source control of sepsis are the mainstays in managing NSTI. Clinicians should consider NSTI as a potential diagnosis in patients presenting with unexplained sepsis, pain, and tenderness following a colonoscopy. Additionally, it is important to be aware of possible underlying colonic or rectal malignancies that may weaken the immune

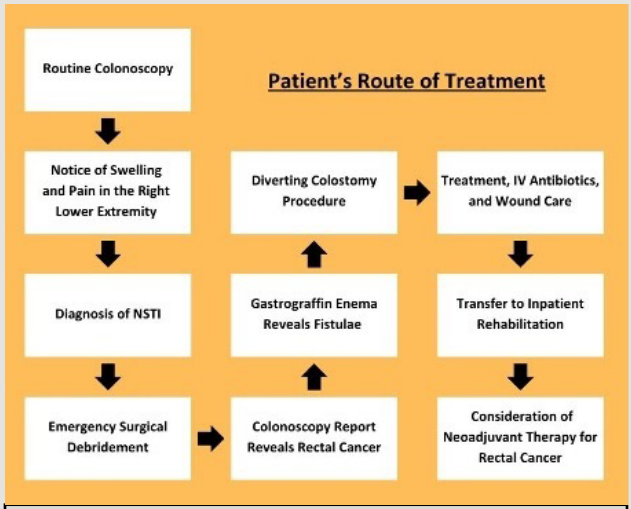

Figure 5: The chronological sequence of events in the patient's medical journey, from the initial colonoscopy to the diagnosis and treatment of NSTI and the discovery and management of rectal cancer.

system, leading to fistula formation and further exacerbating NSTI.

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Case Report

Bladder Perforation from Foley Catheter Insertion in a Middle-Aged Man in the Emergency Department

Nathan Kragh, MSN, APRN, FNP-C[2], Jeannette Sandoval, MSN, APRN, FNP-C[2], Geuel Simiyu, MS[1] , Mujahed Laswi, MD[1,2]

Abstract

Iatrogenic bladder perforation secondary to a Foley catheter insertion is extremely rare, and the incidence is difficult to define. Bladder rupture in general is a serious, rare complication that can lead to high morbidity and mortality if not recognized and managed promptly. In an attempt to summarize information for this case report, risk factors for bladder injury in a newly placed Foley catheter were investigated and found to be variable. In this discussion, we present a 48-year-old male who was diagnosed with a bladder perforation after a Foley catheter insertion in the emergency department for management of urinary retention. After insertion, there was a prompt return of 1000 mL of bloody urine. Computed tomography was performed, showing the tip of the catheter penetrating through the dome of the bladder. X-ray cystogram confirmed the diagnosis. The patient subsequently underwent repair of the perforation. The postoperative course was uncomplicated, and the patient recovered well. Bladder perforations can be associated with high morbidity and mortality. Prompt recognition and treatment are imperative for improved patient outcomes. This case report is presented with the goal of describing the incidence, etiology, and management of an acute iatrogenic bladder injury with peritonitis.

Keywords: Bladder Perforation, Iatrogenic, Diagnosis, Management

Introduction

Bladder rupture or perforation is a rare condition with serious complications. The bladder is anatomically protected by the pelvis; therefore, many bladder injuries are a consequence of severe bladder wall weakness or considerable blunt force trauma to the abdomen [1]. Perforations are categorized as either extra-peritoneal (EP) or intraperitoneal (IP) [1]. EP rupture releases urine into the prevesical (Space of Retzius) and perivesical spaces, whereas IP rupture releases urine into the intraperitoneal cavity [1]. The release of contaminated fluid to these abdominal cavities leads to the development of serious infections such as peritonitis and sepsis, and it is associated with up to 22-50% mortality if not detected and repaired [1,2]. EP ruptures

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Table 1. Significant Laboratory Values for Patient in the emergency department

	Patient Values	Reference Ranges	Urine Analysis			
WBC (x10e3/mcL)	8.6	4.0-10.6	**Color**	Red	**Ketones**	1+
Hemoglobin (gm/dL)	14.9	14.5-17.7	**Clarity**	Turbid	**Urobilin**	2.0
Hematocrit (%)	43	42-53	**Specific Gravity**	1.015	**Bilirubin**	3+
Creatinine (mg/dL)	2.0	0.6-1.3	**pH**	8.5	**Blood**	3+
Sodium (mmol/L)	127	136-145	**Leuk Est**	3+	**Ur WBC**	>50
Lactic Acid (mmol/L)	2.1	0.4-2.0	**Nitrate**	Negative	**Ur RBC**	>20
Ethanol (mg/dL)	215	<=3	**Protein**	3+	**Ur Bacteria**	None seen
Alcohol (%)	0.19	Critical High >0.34	**Glucose**	Trace	**Ur Squam. Epith.**	None seen

make up a majority of incidents, especially as a consequence of high-impact injury to the abdomen. IP ruptures are rare but are usually seen in non-traumatic and chronic conditions such as malignancy, chronic cystitis, and chronic substance abuse that cause irritation and weakening of the bladder wall [5]. Iatrogenic bladder perforations are even more rare, with an incidence that is not well defined. Symptoms of perforation are very nonspecific and can often go unnoticed. Urinary catheters are placed in about 12-25% of hospitalized patients [2]. Therefore, placing bladder perforation high on the differential is essential, especially with a high mortality rate. Here we present a case of iatrogenic intraperitoneal bladder perforation in a middle-aged man following a Foley catheter insertion.

Case Report

Our patient is a 48-year-old male who presented to a local emergency department complaining of a one-day history of mid-epigastric pain. He reported not feeling well for two weeks prior and mentioned a fall the day prior. The patient denied any injury or loss of consciousness from the fall. The patient reported urinary retention, not having urinated since the day prior. Pertinent medical history includes no chronic medical issues, no medications, and no previous surgeries. He is self-employed as a landscaper. Patient admits to drinking alcohol daily, including eight beers the day prior, he denies tobacco or illicit drugs. The patient's initial ethanol level was 215 mg/dL. Initial physical exam by the emergency department physician reported mild epigastric tenderness, soft, nondistended abdomen, no masses or pulsations, normal bowel sounds, and negative rebound tenderness. Due to urinary retention, emergency department staff placed a Foley

catheter. He had a prompt return of bloody urine with an initial output of 1000 mL. The patient had some initial relief but continued to have abdominal pain and bloody output from the Foley. Computed tomography (CT) of his abdomen and pelvis was obtained for further evaluation. Findings included a moderate amount of free intra-abdominal fluid, a single bubble of free air in the mid-abdomen anteriorly, and mild bladder wall thickening, particularly along the dome and the bladder. The bladder contained a Foley catheter and a small amount of air, and the Foley catheter tip appeared to have penetrated the bladder dome. Surgery was consulted due to these findings. An X-ray cystogram was conducted to confirm the diagnosis of bladder perforation, showing contrast extravasation into the abdominal cavity.

The patient was taken to the operating room and underwent a diagnostic laparoscopy, converted to an exploratory laparotomy, washout of urine, and repair of a 5 cm laceration at the dome of the bladder. A JP drain was left in the repaired area, and a Foley catheter was left indwelling in the bladder. The patient's postoperative hospital course was uncomplicated, and he was subsequently discharged on postoperative day 3 with the JP drain and Foley catheter. The patient was evaluated in the clinic for follow-up two weeks later and underwent a cystogram, showing the bladder was intact. The Foley and the JP drain were removed, and no further issues were reported.

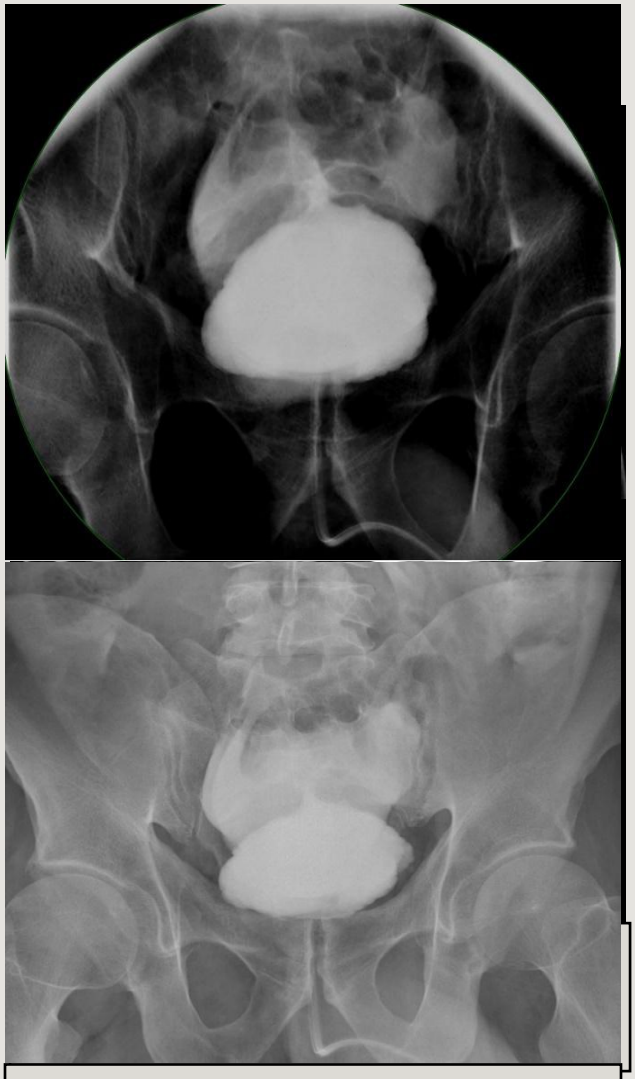

Figure 2. XR cystogram prior to surgery: contrast extravasation into abdominal cavity

Discussion

Etiology

Bladder rupture can be caused by traumatic or spontaneous etiologies [5]. Traumatic bladder rupture is due to blunt abdominal trauma, often at the weaker points of the bladder, such as the dome, seen from a rise in intravesicular pressure [1]. Bladder rupture is classified as either EP or IP and can be associated with a high morbidity and mortality rate [1,2,5]. EP bladder ruptures are more common than IP bladder ruptures, occurring from forceful impact to the anterior bladder. Non-traumatic causes of bladder injury include malignancy, chronic cystitis or pyelonephritis, repeated catheterizations, outflow obstruction/stones, substance abuse, and iatrogenic hypospadias [4].

Incidence

The majority of bladder injuries are trauma-

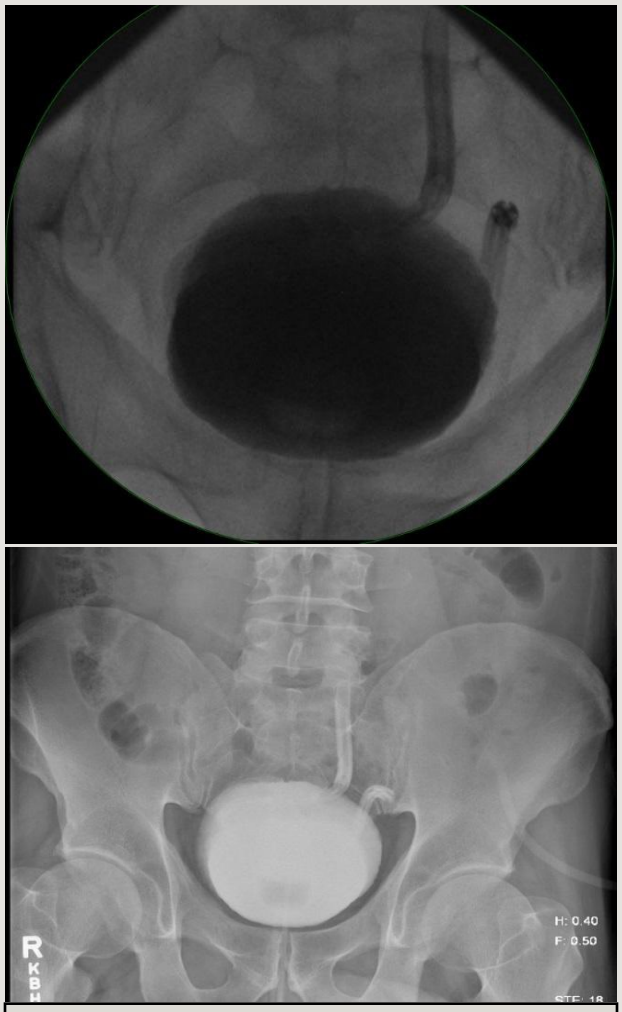

Figure 3. XR cystogram at follow up: Patient bladder wall

related and have a high morbidity and mortality rate, ranging around 22-50 % [1,2]. Typical signs and symptoms are variable and include suprapubic pain, hematuria, difficulty and painful urination, low urine output, increased bun/creatinine (due to peritoneal absorption), and free fluid on imaging [1,2]. According to the American Urology Association (AUA), gross hematuria is the most common indicator of bladder injury [3].

Spontaneous bladder perforation from a Foley catheter is rare and can be either EP or IP, usually associated with chronicbladder disease. The incidence and etiology of a single Foley catheter placement resulting in bladder injury are not well defined in the literature. One case report suggested several possible etiologies, including negative pressure sucking to the bladder wall mucosa causing irritation and necrosis, or drain obstruction causing frank perforation, or chronic microbial colonization leading to wall weakness [5]. Roughly 12 to 25 % of hospitalized patients receive a Foley catheter at some point during their admission [2].

Management

A cystogram is recommended by both the American Urological Association (AUA) and European Association of Urology (EAU) for suspected bladder injuries [6]. Plan film and CT cystography have similar specificity and sensitivity [3]. The AUA states intraperitoneal bladder ruptures “must” be repaired surgically (open or laparoscopic) and as promptly as able to avoid increased risk of peritonitis, sepsis, or other complications [3]. Complex repairs require a follow-up cystoscopy [3].

Conclusion

A commonality found in researching this topic was a delay in diagnosis, which directly correlated with poor outcomes. Bladder perforation has a high mortality and is clearly related to the rarity and delayed diagnosis. Recognition of a change in this patient’s presentation following Foley catheter placement led to prompt imaging and surgical management. It could be argued that he presented to the ER with a perforated bladder or near perforation due to overdistention or injury from falling the evening prior.

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Case Report

Septic and Dislocated Elbow as the Initial Manifestation of a Cervicothoracic Syrinx: Case Report

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Abstract

Case: A previously healthy 56-year-old male presented with a painless, swollen elbow and septic shock following a minor puncture wound. Imaging and subsequent arthrocentesis revealed a dislocated elbow with concurrent septic arthritis, yet the patient demonstrated minimal pain and near full range of motion. This discordant clinical picture prompted further investigation, revealing an extensive, previously undiagnosed cervicothoracic syrinx.

Conclusion: Septic arthritis with simultaneous acute-appearing joint dislocation represents an unusual initial presentation of neuropathic arthropathy secondary to syringomyelia. Clinicians should maintain high suspicion for underlying neurological pathology when encountering patients with severe joint abnormalities but disproportionately minimal pain or functional limitation.

Keywords: Syrinx, Elbow Dislocation, Septic Arthritis

Introduction

Syringomyelia is condition characterized by a fluid filled cavity, syrinx, found within the parenchyma of the spinal cord.[1] While many cases are discovered incidentally, symptomatic patients typically present with pain, hyperesthesias, myelopathic symptoms, or occipital headaches.[2]

Charcot arthropathy is a chronic, neuropathic arthropathy characterized by progressive joint destruction. Cervical syrinx has an established relationship with Charcot arthropathy of the upper extremity, with the shoulder being the most commonly affected joint, followed by the elbow.[3] Despite this well described correlation, there are relatively few cases of cervical syrinx and Charcot arthropathy of the elbow.[4,5,6] A recent systematic review identified only 50 such cases in the literature, 33 of which were isolated elbow arthropathy as in our patient.[7] More unusual still, only two previous case reports have described septic arthritis of the elbow in patients with

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Figure 1. (A) Clinical photograph of the affected elbow showing significant soft tissue swelling and a posterolateral wound. (B) AP radiograph of the affected elbow showing aggressive periosteal reaction along the medial aspect of the humerus concerning for possible osteomyelitis. (C) Lateral radiograph of the affected elbow showing posterior dislocation with a large effusion.

neuropathic arthropathy secondary to cervical syrinx.[8,9] Notably, all previously reported cases presented with advanced Charcot changes in the affected joint.

Here we outline the presentation and subsequent follow up of a patient with previously undiagnosed cervicothoracic syrinx who presented with concurrent septic arthritis and a radiographically acute appearing elbow dislocation.

Case Description

A 56-year-old man with no past medical history presented to the emergency department with progressive swelling to the right elbow which had begun the previous month following a punctate wound to the posterolateral elbow. His physical exam was notable for significant elbow swelling though a painless arc of motion from 5 to 135 degrees. He was febrile to 39.4 degrees Celsius with an elevated heart rate of up to 130, and elevated ESR and CRP. He met sepsis criteria at the time of presentation. Further neurological examination revealed diminished proprioception in his feet and inability to heel toe walk along with decreased pain and temperature perception to his bilateral upper extremities.

Radiographs in the emergency department demonstrated a dislocated ulnohumeral joint without evidence of joint destruction (Fig. 1). The workup was continued with CT (Fig. 2) and MRI (Fig. 3) of the elbow which demonstrated a posterior elbow dislocation with a large elbow effusion concerning for septic arthritis and aggressive periosteal reaction along the medial aspect of the distal humerus suggestive of osteomyelitis. The patient subsequently underwent urgent surgical irrigation and debridement of the right elbow. He was initially started on broad-spectrum antibiotics, cefepime and vancomycin, which were later narrowed to cefazolin based on culture sensitivities of methicillin sensitive staph aureus.

The patient's unusual presentation of painless joint dislocation with infection prompted further neurological investigation. MRI cervical spine demonstrated an expansile T2/STIR signal hyperintense signal nearly completely replacing the cord parenchyma extending from the level of the dens through T3 level which was consistent with syrinx formation (Fig. 4). Postcontrast MRI was obtained and did not demonstrate an underlying neoplasm. Neurosurgical consultation was obtained, though the

Figure 2. Coronal (A), Sagittal (B), and Axial (C) CT of the humerus and elbow demonstrating a posterior elbow dislocation with periosteal reaction and cortical erosion of the posteromedial aspect of the distal humerus.

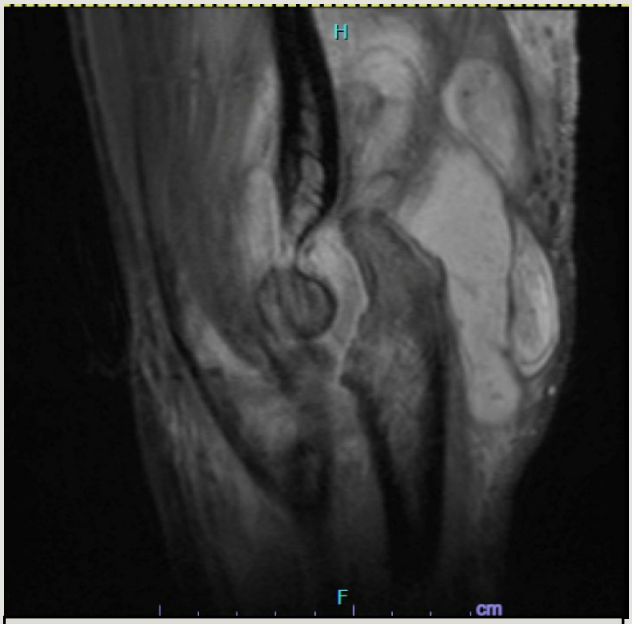

Figure 3. Sagittal proton density fat suppressed magnetic resonance imaging scan of the elbow demonstrating destructive changes of the coronoid with extensive

Figure 4. Sagittal T2-weighted (A) and T1-weighted (B) magnetic resonance imaging scan of the cervical spine showing a syrinx extending from the level of the dens through T3. (C) Axial T2-weighted magnetic resonance imaging scan of the cervical spine showing a syrinx near completely replacing cord parenchyma.elbow effusion which is continuous with subcutaneous and muscle edema.

patient ultimately declined surgical intervention, stating he had minimal perceived disability and was concerned about potential surgical risks. Over the next six days, the patient continued to have spiking fevers with elevated inflammatory markers which necessitated a third irrigation and debridement. Following this third surgery he was discharged with a peripherally inserted central catheter and six weeks of antibiotics per infectious disease.

At his initial postoperative visit, radiographs demonstrated rapid onset of neuropathic changes with progressive osteolysis of the elbow, near-complete absence of the coronoid process and portions of the olecranon, and heterotopic ossification peripherally. At 10-week follow-up, the patient's elbow remained clinically unstable though still pain-free, with near-full range of motion. Radiographs showed progressive findings of neuropathic arthropathy with persistent posterolateral dislocation (Fig. 5). The patient was counseled regarding elbow arthrodesis at 90 degrees to address the instability, but he declined, believing the position would severely limit his occupational activities. At one-year follow-up, the patient reported no pain in his elbow but noted progressive loss of dexterity in his hands, and loss of range of motion, now with a roughly 30-degree arc of motion. Despite these symptoms, he remained uninterested in surgical management of either the syrinx or the elbow, as he desires to preserve any motion possible to the elbow to maintain his employment. He continues to follow with the neurosurgical and orthopedic clinics for monitoring of the progression of his symptoms.

Discussion

Neuropathic arthropathy, also known as Charcot arthropathy, is a chronic condition in which there is progressive fragmentation of bones which ultimately results in destruction of the affected joint. The pathophysiology has been proposed to involve a combination of neurovascular and neurotraumatic mechanisms. The neurotraumatic theory states that a loss of protective sensation occurs in the joint which allows repeated trauma to go unnoticed which over time causes degradation of the joint.[10] Alternatively, the neurovascular theory states that increased blood flow to the neuropathic joints results in increased osteolysis and demineralization.[11] Charcot arthropathy can present secondary to a multitude of underlying pathologies, most commonly diabetes in the lower extremity

and syringomyelia in the upper extremity.[12] Presenting symptoms vary based on the severity of the disease and can include swelling, deformity, erythema, and warmth in the affected area.

Syringomyelia is a progressive, chronic condition caused by abnormal cerebrospinal fluid flow and is characterized by a fluid-filled cavity present in the spinal cord. It is most commonly associated with a Chiari I malformation, but can also be seen years after spinal trauma, meningitis, intramedullary or extramedullary tumors, or can be due to an idiopathic cause.[13] The most common presenting symptoms are paresthesias, hyperesthesia, and non-radicular segmental pain. Other common symptoms are gait ataxia and hand muscle weakness with loss of fine motor function. Classically, a centrally located syrinx can selectively compress the dorsal columns of the spinal cord, leading to isolated loss of pain and temperature sensation.[2,14]

Treatment of a syrinx varies based on the underlying pathology. Patients with a Chiari I malformation often are deemed to benefit from craniocervical decompression, which consists of a removal of the posterior arch of C1 and a suboccipital craniectomy with removal of arachnoid adherences.[15] If these treatments fail, or if the syrinx has an idiopathic cause, a shunt is often used to decompress the syrinx. This, however, is generally not preferred due to high complication rates and the shunt's lack of addressing the underlying pathology[16]. First-line treatment for the extremity manifestations should address the underlying syrinx when possible. Orthopedic management options for Charcot elbow are limited, with arthroplasty being contraindicated. Arthrodesis is regarded as the most reliable option for providing stability, though at the expense of motion.[17] Our patient's case illustrates the complex decision-making involved, as the patient prioritized motion preservation for employment purposes.

This case is distinctive for several reasons. First, unlike previously reported cases of septic, neuropathic elbows,[4-7] our patient presented with what radiographically appeared to be an acute dislocation without the typical findings of advanced Charcot. This suggests that the infection and the resulting inflammatory cascade may have disrupted the joint capsule and ligamentous structures, precipitating a fairly acute dislocation in an elbow already compromised by early neuropathic changes. Second, the patient had no prior diagnosis of

Figure 5. 10-week follow-up AP (A), external oblique (B), and lateral (C) elbow radiographs demonstrating erosive arthropathy with bone loss and extensive heterotopic ossification at the elbow joint.

or symptoms from his extensive cervicothoracic syrinx, despite its impressive size on MR imaging. This reinforces the often-insidious nature of syringomyelia, where patients may adapt to gradually developing neurological deficits without recognition.

Conclusion

This case highlights a previously undescribed presentation of neuropathic elbow arthropathy secondary to a previously undiagnosed cervicothoracic syrinx, manifesting initially as septic arthritis with concurrent joint dislocation. While the patient initially presented with relative sparing of the joint architecture, his follow-up has gone on to demonstrate the expected neuropathic changes with extensive destruction of the joint. Clinicians should maintain a high index of suspicion for underlying neurological pathology when encountering patients with significant joint pathology but disproportionately minimal pain or functional limitation. A thorough neurological examination is essential in such cases and may reveal previously unrecognized underlying pathology.

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Original Research

Impact of Rural Clinical Experience on Medical Student Attitudes Toward Rural Practice

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Abstract

Background: Rural communities face persistent health disparities and physician shortages, making rural exposure in medical education increasingly important.

Objective: This study investigates the impact of short rural clinical rotations on medical students' interest in rural practice with housing assistance provided by the home institution.

Methods: Over a one-year time frame from May 10, 2024, to May 10, 2025, this study surveyed a total of 21 participating medical students within one week of starting and after completing a rural clinical rotation. A total of 17 medical students at Texas Tech University Health Sciences Center at the Permian Basin Campus completed both pre- and post-surveys during a one- to four-week rural rotations.

Results: Students expressed an increased likelihood of participating in a career in rural or underserved medicine (p=0.0005 via Wilcoxon signed-rank test), an increase familiarity with challenges and requirements of practicing in rural or underserved settings (p=0.0002 via Wilcoxon signed-rank test) and rated an increased confidence with their ability to meet the needs of these populations (p=0.03 via Wilcoxon signed-rank test). Post-survey analysis of 18 responses revealed that 16/18 expressed a positive influence in their interest to serve rural communities while 2/18 expressed no influence. Qualitative responses emphasized themes of community connection, broad physician scope of practice, and recognition of social determinants of health.

Conclusion: This study highlights the effectiveness of brief rural clinical rotations in shaping student perspectives, underscoring the potential role of targeted educational experiences in preparing and ushering the next generation of physicians for rural practice.

Keywords: Rural, Graduate Medical Education, Exposure

Background

Rural health represents a cornerstone of the healthcare landscape, yet it is a sector under

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mounting strain. Approximately 14% to 19% of the U.S. population reside in rural areas [1,2]. Rural populations are older and tend to have higher burdens of chronic disease and mortality than urban populations [1,3]. For example, national COPD prevalence is 12.0% in rural vs 5.9% in urban communities[4]. Cancer incidence was higher in nonmetropolitan at a rate of 460 per 100,000 individuals when compared to metropolitan counties with a rate of 447 per 100,000 [1]. This trend persists for mortality in cancer patients with a rate of 182 per 100,000 in non-metropolitan areas compared to 166 per 100,000 in metropolitan areas [1]. These healthcare gaps coincide with socioeconomic disparities: rural counties often have higher rates of poverty and uninsured individuals. Rural residents also often need to travel further for care, an average of 17 miles to the nearest hospital, with many rural counties have few or no providers [5,6]. These factors together produce higher overall mortality and worse outcomes for rural America. Rural communities face a critical shortage of clinicians. Only 10% of U.S. physicians practice in rural areas despite nearly 20% of the population living there [1,6]. Urban counties have roughly 1.6 times more primary care doctors per capita than rural counties [6]. Moreover, one-third of current physicians will reach retirement age in the next decade, with half being over 55 years of age [6]. Since 2005, 180 rural hospitals have closed nationwide, with two-thirds of those closures occurring in Southern states including Texas [5]. In Texas alone dozens of rural hospitals have shut in recent years, leaving many counties with no inpatient facilities [5]. Loss of local services forces has required hospitals to expand service areas and has widened gaps in emergency response times. Shortages in staffing is not limited to physicians, as rural nursing, physical therapists, and mental health specialists also have either urban practice tendencies or diminishing rural practices [7-9].

The implications of these shortages are clearer when comparing the services available to these communities. For example, screening rates for breast, colorectal, and other cancers are lower in rural areas than urban [1,10]. Mental health care is especially scarce in rural counties, with increased travel time being associated with poorer mental health and more comorbidities [3]. Telehealth expansion holds promise, but broadband access is lacking for a sizable portion of rural residents. Reimbursement and insurance factors further compound disparities [11]. Many rural residents are uninsured or underinsured with Texas amongst the highest rates in the country. Medicare and Medicaid payments often do not cover the higher costs of rural care. These system-level issues restrict care even when physical services exist. When evaluating ownership patterns of hospitals between rural and urban environments from 1988 to 2005, 41.3% of rural hospitals were government-run compared to only 28.49% of urban hospitals [12]. In addition to geographic factors, systemic barriers limit rural healthcare: cultural and linguistic barriers are important considerations that affect many rural communities in the South.

Substantial evidence indicates that exposing students to rural medicine during training boosts rural recruitment. In an integrative review, students with rural clinical placements were significantly more likely to choose rural practice after graduation [13]. Targeted medical school and residency programs that admit students from rural backgrounds and require rural rotations substantially increase the rural workforce [6,13]. However, currently only about 1% of graduate medical education programs are located in rural settings, and few medical students have sustained rural training

experiences [6]. Expanding rural-track residencies, locating training in community health centers and critical-access hospitals, strengthening loan repayment and incentive programs have been critical to addressing the under-supply of rural clinicians [6].

Objective

Our study evaluates how structured rural rotations with provided housing offers potential to address these gaps by assessing their impact on medical students' perceptions and interest in rural practice.

Methods

This study utilized a pre- and post-survey design conducted at Texas Tech University Health Sciences Center Odessa (TTUHSC). A list of all third year and fourth-year medical students that planned to participate in a pre-existing rural clinical rotation was obtained between May 10, 2024, to May 10, 2025. The inclusion criteria were enrollment in the School of Medicine, participation in either a one-week rural rotation for MS3s or a two- to four-week rural rotation for MS4s. TTUHSC provides the students housing during these rural rotations. This study evaluated this existing process with a pre-survey was distributed a week prior to the rural rotation for medical students and a post-survey was distributed within a week of completion of the assigned rotation. Students were given the opportunity of reimbursement for housing or were given placement by housing via TTUHSC.

Rural rotation sites were dependent on length of exposure and type of exposure. Rotation sites included Alpine, Texas; Marathon, Texas; Fort Stockton, Texas; and Presidio, Texas. The cities fall into Brewster, Pecos, and Presidio County are designated as rural by 2023 Rural-Urban Continuum Codes (RUCC) as codes 7, 7, 9, respectively [14].

Three Likert-scale survey questions remained the same between the pre- and post-survey: how likely are you to consider practicing medicine in a rural or underserved area, how familiar are you with the challenges and rewards of practicing in rural or underserved areas, and how confident are you in your ability to meet the healthcare needs of rural or underserved populations. The pre-survey included demographic questions including whether they have lived or consider themselves from a rural location, and interest in residency specialty. Students were also asked about prior rural healthcare exposure with an open-ended response. The post-survey gauged the quality of the rotation with questions including how valuable do you believe the rural clinical rotation was in providing insight into the healthcare needs of rural or underserved populations, how likely are you to recommend a similar rural clinical rotation experience to your peers, and to what extent do you feel the rural clinical rotation influenced your interest in rural or underserved practice. An open-ended meaningful experience prompt and comments prompt was used to discuss novel experiences and address issues that faced medical students during the rotation.

Statistics

Statistical software and reproducibility. Analyses were conducted in Python 3.10.4 on a 64-bit Windows 10 (10.0.26100) workstation (Intel® Core™ i7-12700KF, 32 GB RAM). Data handling used pandas 2.2.3 and NumPy 1.26.4; inferential tests (Wilcoxon signed-rank, paired t-test, Shapiro–Wilk) used SciPy 1.14.0; figures were produced with Matplotlib 3.10.1. All procedures in this pipeline are deterministic given the data and package versions; nevertheless, a fixed random seed (42) and recorded library versions were used to facilitate exact replication on other systems.

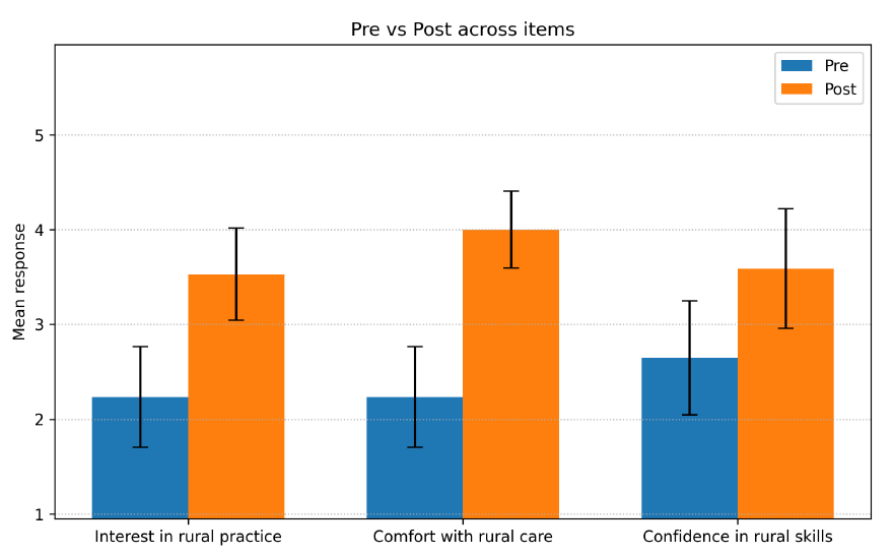

Figure 1. Mean response before and after rural healthcare exposure
The three rural questions were evaluated: interest in rural practice, comfort with rural care, and confidence in rural skills. Displayed are the average pre- and post-survey survey responses with a 95% confidence interval displayed.

Due to the use of single ordinal items, Wilcoxon signed-rank test as the primary inferential test to assess systematic pre and post shifts; the Wilcoxon p-value and the rank-biserial correlation (r, -1 to +1) were used as an effect size. Paired t-tests on numeric difference scores (post-pre) were run as robustness checks and Cohen's dz is reported for those analyses. To account for the three related tests, Holm (family-wise) and Benjamini–Hochberg (FDR) adjusted p-values. Descriptive statistics (mean, SD, median, IQR) are provided for each time point, and mean change with 95% CIs is shown to convey precision. All tests were two-sided, significance was defined as $p < 0.05$ unless otherwise noted for adjusted tests, and analyses were performed in R. Qualitative open-ended responses were analyzed thematically to identify recurrent domains for program improvement.

Ethics

This project was conducted as a Quality Improvement (QI) initiative and was reviewed and approved by the TTUHSC Quality Improvement Review Board (QIRB #24009). This project did not meet criteria for human subject's research requiring IRB oversight, as it was designed to improve internal processes. The QI project was carried out under the supervision of the QIRB, who ensured compliance with ethical standards and institutional policies. All involved team members received appropriate oversight, and the intervention aligned with professional responsibility and improvement objectives. Participation in the QI activities preserved anonymity: the data used were de-identified, no individual responses were traceable, and all analyses were conducted in aggregate. Participation did not affect academic standing or credit, and students were informed that involvement was voluntary and confidential.

Results

A total of 38 surveys were received; 20 medical students completed a pre-survey while 18 completed a post-survey for the

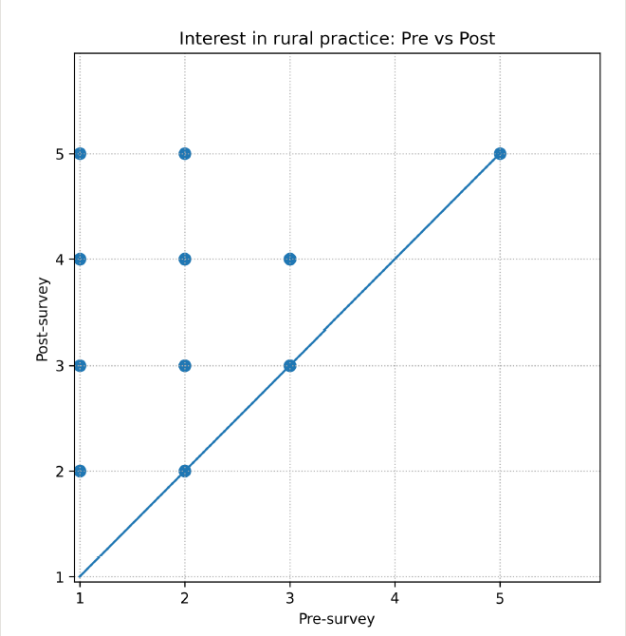

Figure 2. Effects of rural exposure on students' interest in rural practice
The graph above shows the pre-survey response on the x-axis and the post-survey response for same students on the y-axis. Points plotted to the left of the line indicate improved experiences with exposure, points plotted on the line indicate no change in interest, and points plotted to the right of the line indicate decreased interest in rural practice.

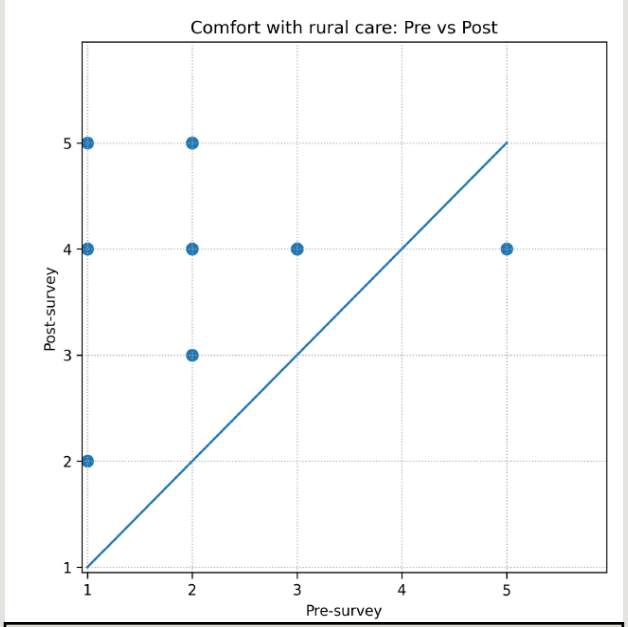

Figure 3. Effects of rural exposure on students' comfort within rural care
The graph above shows the pre-survey response on the x-axis and the post-survey response for same students on the y-axis. Points plotted to the left of the line indicate improved comfort with exposure, points plotted on the line indicate no change in comfort, and points plotted to the right of the line indicate decreased comfort in rural practice.

rural clinical rotations. Of those, 17 medical students provided both a pre- and post-survey resulting in 34 paired responses for analysis. Participation in these rural experiences led to significant improvements across all measured domains.

Of the 20 medical students that completed the pre-survey, 4 indicated having lived in a rural region before and 6 students indicated having prior rural healthcare exposure all of whom gained prior exposure due to opportunities through our medical school.

Three Likert-scale questions were analyzed between the matched 17 surveys via Wilcoxon signed-rank test. Students reported an increased likelihood of considering a career in a rural or underserved areas following the rotation ($p = 0.0005$). Figure 1 shows the average mean score for the first question as 2.24 which improved to 3.53 after the experience. Students also reported substantially greater familiarity with the challenges and requirements of practicing in rural or underserved settings, with post-survey scores showing a statistically significant increase from pre-survey scores with a mean of 2.24 to a post-survey mean of 4.00 ($p = 0.0002$). Confidence in their ability to meet the healthcare needs of these populations also increased with an average pre-survey rating of 2.65 to a post-survey rating of 3.59 ($p = 0.0327$).

Post-rotation responses to two additional items further corroborated the paired-analysis results. When asked, "How valuable do you believe the rural clinical rotation was in providing insight into the healthcare needs of rural or underserved populations" and "How likely are you to recommend a similar

rural clinical rotation experience to your peers?", all students (18/18) reported they found the rotation valuable in some capacity and would recommend the rotation to peers. When asked directly about the rotation's effect on career interest, "To what extent do you feel the rural clinical rotation influenced your interest in rural or underserved practice?", 16 of 18 students (89%) reported a positive influence (8 slight positive, 8 strong positive) while 2 (11%) reported no influence. Representative qualitative comments explained why the experience resonated: students described witnessing the personal, close-knit nature of rural patient–physician relationships; observing attendings develop broad clinical competence to manage care without nearby specialists; and gaining firsthand insight into social determinants that shape clinical decision making in resource-limited settings. Some statements from qualitative text-free experiences included: "Learned a lot of different ways of practice, learned about socioeconomic factors in the region," "Just interacting with the people from rural communities was an impactful experience. They are so grateful that you are there to help address their medical need," and "it was enjoyable to have patients pop in without appointments and really see the value of small-town medicine." Due to limited sample size, text analysis was not performed, but the experiences section was positive focusing on procedures performed, exposure to different clinical experiences, learning rural health difficulties, and better understanding of nuanced relationship between rural providers and their patients. Free text other comments for clinical rotations were completed by 7/18 students – 5/18 students described the exposure in further depth including "…amazing experience and I would strongly encourage…," "experience was quite unique…," and "I would highly recommend this experience." One student commented on their desire to practice in underserved areas and the last student commented on a desire to have more rural experience exposure "with OB and general surgery exposure as well."

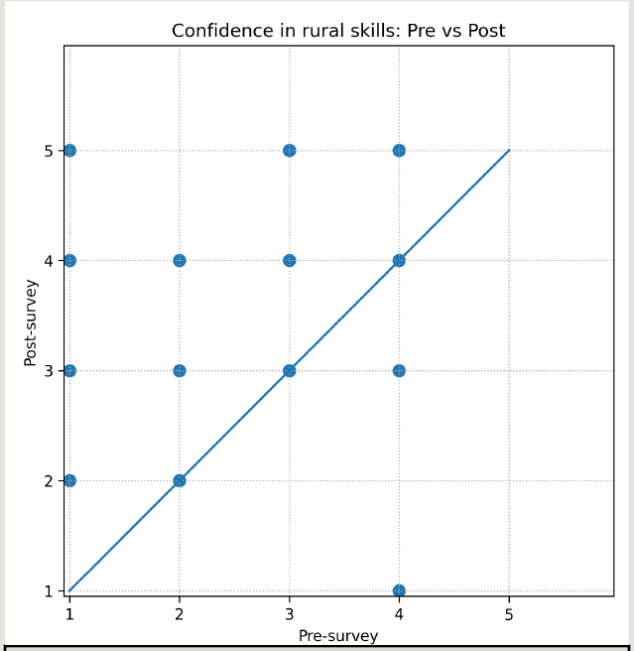

Figure 4. Effects of rural exposure on students 'comfort within rural care
The graph above shows the pre-survey response on the x-axis and the post-survey response for same students on the y-axis. Points plotted to the left of the line indicate improved confidence with exposure, points plotted on the line indicate no change in confidence, and points plotted to the right of the line indicate decreased confidence in rural practice.

Discussion

Rural Americans continue to experience substantially worse health outcomes than urban counterparts, with higher mortality from cardiovascular disease, cancer, respiratory illness and other conditions [11]. Despite occupying ~69% of Texas's landmass, rural Texans suffer disproportionately - for example, deaths from cancer, heart disease, and chronic lung disease are significantly higher in rural Texas than statewide averages [11].

Compounding these challenges is the fact that at least 17 rural hospitals closed in Texas from 2010-2019, a rate higher than any other state [15]. Medical education represents a key lever for change: prior studies and our findings indicate that even brief, structured rural rotations can enhance students' understanding of rural practice, strengthen their confidence in addressing community health needs, and increase openness to rural career paths [6,13]. This mirrors prior work showing that positive rural placements boost interest in rural careers [16].

Our results align with international studies demonstrating the impact of rural exposure. For example, Ray et al. found that students' interest in rural medicine rose after repeated rural clinical placements, especially when experiences were positive and community-focused [17]. Similarly, Washington State found that medical graduates who participated in a Rural Underserved Opportunities Program were nearly twice as likely to eventually practice in rural areas [16]. In our cohort, participants reported that the rural rotation was worthwhile and would recommend it to peers, underscoring high engagement. Students consistently noted improved familiarity with the unique challenges of rural medicine, greater confidence in their ability to provide care in underserved settings, and a heightened likelihood of considering a rural career. These findings support the notion that embedding rural clinical experiences shape perceptions. Notably, students in our study often entered with varied specialty interests; yet after their rural rotation they reported greater interest in rural practice, echoing other evidence that community immersion can promote health equity through proper distribution of physicians [16].

Despite these positive effects, important barriers remain. Rural health ventures generally receive less funding than urban counterparts. Recent legislative sessions have only begun to reverse this: from 2019-24 $64 million has been awarded to organizations to established new accredited rural based residencies, but longstanding underinvestment means many rural sites still struggle [18]. High educational debt is a major deterrent for students considering low-paying primary care or rural work, with 31-58% of residents having debt that exceeds $200,000. Recent federal rules capping graduate borrowing at roughly this level have raised alarms: by eliminating Grad PLUS loans and limiting total loans (e.g. $200K cap), policymakers risk excluding financially vulnerable students from medicine altogether [19]. Pathman et al. noted that while high debt can drive physicians into service-obligation programs (33% of obligated grads worked rurally vs 7% without obligations), it can also deter low-income applicants from entering medicine or choosing primary care [20]. These financial pressures compound the challenge of rural exposure: many students can only access rural training through independent away rotations, which often occur late in medical school [19]. Institutional coverage of housing may resolve some of the trepidation for these students that are considering rural careers but have little prior experience.

Rural Texans also experience more socioeconomic disadvantage: poverty and uninsured rates are higher in rural Texas with 76 rural counties exceeding 20% uninsured rate, creating both greater need and greater strain on rural providers [11] . Addressing this requires statewide collaboration, for example, Texas Tech University Health Sciences Center (serving the West Texas region) explicitly focuses on rural needs. Other Texas institutions have followed suit with UNT Health Fort Worth's ROME Rural Scholars track requiring extended rural clerkships. Medical schools could share rural training sites and jointly

develop rural curriculum to amplify impact; for instance, Texas Hospital Association has advocated incentives and support for rural training programs. Early exposure is also crucial: embedding rural medicine experiences in preclinical years may normalize rural practice and attract students before specialty choices harden [16]. Our findings suggest that even a few weeks of rural work can shift attitudes, so scaling up these opportunities across all Texas schools would likely strengthen the pipeline.

Further research is needed to confirm that attitude changes translate into career decisions. Longitudinal tracking of medical graduates (e.g. 5-10 years post-training) could quantify what fraction of those with rural rotation experience ultimately practice in rural settings. This trend is well-established in graduate medical education with a substantial increase in family medicine residents practicing in rural healthcare following residency exposure [21]. It would also be important to evaluate outcomes such as recruitment/retention rates in communities that host students. Policymakers and educators should examine mitigation strategies for financial barriers: for example, loan forgiveness for rural service, enhanced scholarships, and guaranteed faculty positions at rural hospitals. There is evidence that targeted financial incentives do increase retention of providers in underserved areas, so piloting such incentive programs in Texas would be valuable [20]. Curriculum innovations that involve multidisciplinary rural health teams (nurses, PAs, therapists) need further evaluation, especially within educational practice settings as many specialties do not have residencies for these types of exposure.

Limitations

Our study cannot prove causation; students who opt into rural programs may already be predisposed toward rural care. Our sample was also drawn from a single institution's program, so generalizability and replicability need to be further evaluated. Survey data may also be influenced by recall bias or misinterpretation of questions. Qualitative feedback suggests high satisfaction, but self-reported interest does not guarantee future practice. Furthermore, the smaller sample size of this study requires further investigation to verify the impact on a larger scale and cross-institutional validity. Moreover, broader social factors (e.g. family preferences, spousal career, income expectations) also influence career choice.

Conclusion

Rural healthcare is an important aspect that has been falling to the background in U.S. healthcare. Growing disparities are further heightened by larger amounts of specialization and a drive to practice in urban settings. Our findings indicate that increased exposure to rural health during clinical rotations for medical students has shown a greater interest in rural practice. This form of exposure could be the key to fostering additional physicians in our areas of medically underserved communities. These initiatives require a combination of healthcare policy and interdisciplinary pushes to develop sustainable and meaningful changes for our rural communities.

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Letter to the Editor

Dear Editor,

I thank Amy Sappington, MSN, APRN, ACNP-BC, and Dr. Izi Obokhare, MD, FACS, FICS, for their original article in the West Texas Journal of Medicine on the breakthroughs and barriers to stoma education. [1] The outcomes of the study presented key information regarding the successful post-operative phase for patients who are home- or facility-bound after abdominal surgery requiring an ostomy. The study touches on multiple categories that factor into the ostomate's success in the postoperative phase and throughout their lifespan. This research emphasizes areas of care that show weaknesses and room for improvement that we, as healthcare professionals, can provide for our patients.

The study discusses the variability of ostomy supplies, the ability to obtain them, and the importance of interdisciplinary team involvement. It stresses the necessity of comprehensive discharge planning, especially for those with limited access to healthcare due to location or financial concerns. Finally, the article offers future considerations regarding counseling and assistance in the form of peer support groups. These are all wonderful considerations, yet I urge us to look further to expand our horizons of care for our ostomate patient population.

The Ostomy and Continent Diversion Patient Bill of Rights[2] is a tool for patient self-advocacy, urging patients to speak up and be heard. It states that ostomates should have resources for specific patient-centered situations, including supplies, patient health insurance circumstances, and access to healthcare professionals knowledgeable about each individual patient's needs in all settings. It also underscores the need for ongoing emotional support, which is a huge aspect of living this life.

In healthcare, we do an excellent job of discussing patient care and the need to address patient-specific challenges but have an exceedingly difficult time following effective implementation. Instead, I plead that we, as a profession whose job is to provide the ultimate service to those around us, truly take the time and energy required to begin to put these implementations into action. Perhaps in further development, we could form a standardized way of care for all patients receiving ostomies. I can, in fact, speak of the importance of such care because I am a nurse and an ostomate myself. I have had to find my own way countless times without the support or information supplied to me during my hospital stay and beyond. As such, my personal goal within the next year or two is to initiate an ostomy support group in my local community, in conjunction with the local trauma center where I work. At the support group, I plan on incorporating social support for patients, but also resources such as ostomy supplies and physician input and education, including an ability for networking amongst fellow ostomates to share information, suggestions, and the emotional support of knowing they aren't alone.

I feel very passionately about being able to provide this immensely needed help to those who are just like me and who struggle needlessly to carry on a "normal" life. It would seem to me that if I can make it

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happen, then so many other healthcare professionals can also make it happen by simply starting to think about what they would appreciate being offered if they were in a similar position themselves.

Sincerely,
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