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Case Report

Profound Recurrent Arterial Thrombosis and Limb Amputation Following Street-Acquired Cutaneous Infection: A Case Report and Discussion of Barriers to Prophylactic Anticoagulation

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Abstract

Bridging the gap between outpatient and clinical settings for unsheltered patients is the primary goal of Miami Street Medicine, a volunteer-run initiative to improve health access among resource-limited populations. In this report, we discuss the case of Mr. Z, an unsheltered patient in his forties, with no known history of hypercoagulability, who presented to the Emergency Department (ED) with acute foot pain and pallor. Over the course of an extended hospitalization, his clinical course was complicated by vascular graft bypass using a cryopreserved vein, multiple bypass revisions, osteomyelitis and ultimately limb amputation. This disease trajectory, attributable to the lack of access to both prophylactic and therapeutic outpatient anticoagulation, underscores the critical need for a more Socioeconomic Determinants Of Health (SDOH)-conscious approach at all phases of the care continuum. To break the cycle of admission and readmission, discharge planning informed by the barriers to which a patient is vulnerable facilitates medication adherence in the pre-hospital setting, while improving outcomes in the post-hospital setting. Inherent to the Street Medicine model is an opportunity for advocacy through integrated intervention at the grassroots level, with the potential to prevent major complications secondary to manageable conditions such as those experienced by Mr. Z.

Keywords: Emergency Department; Street Medicine; Prophylactic Anticoagulation

Introduction

Persons Experiencing Homelessness (PEH) in the United States have a significantly higher mortality rate than their housed counterparts, often due to common and treatable medical conditions [1]. Poor outcomes in this population reflect the lack of formal primary care and/or follow-up pathways after discharge from acute care settings. Studies have shown PEH to have increased susceptibility to multiple types of soft tissue injury, street-acquired infections, limb ischemia and limb loss [2-5]. Similarly, this population has been associated with higher rates of substance use disorders and psychiatric illness, often co-morbid and untreated and are predisposed to unique challenges in accessing ongoing prophylactic and/or follow-up care [6]. The culmination of these intrinsic and extrinsic elements contributes to a significantly increased burden of, treatable disease that disproportionately affects PEH, while exacerbating the higher propensity for avoidable life and limb-threatening complications of these injuries.

'Street Medicine' groups consist of medical teams who strive to fulfill the needs of these populations by serving as clinical touchpoints through which direct care is provided to PEH on-site and free of charge. The concept of Street Medicine was pioneered in the early 1990s by American physician Dr. Jim Withers, who proposed healthcare reforms aligned with the needs of PEH after recognizing their dependence on emergency services for essential care and often only after deteriorating to crisis levels [2]. In the decades that followed, his field work inspired the mobilization of dedicated Street Medicine physicians, medical

students and ancillary staff to conduct volunteer outreach clinics that aim to reconcile the barriers to care imposed on those disenfranchised from traditional models for healthcare administration.

Appraising the effectiveness of Street Medicine initiatives can be challenging, as limited funding, high attrition rates and the lack of institutional support confound aggregate data. Nonetheless, the many success stories and near misses identified as a result of consistent Street Medicine outreach validate its potential when implemented strategically [3]. However, while the majority of morbidities experienced by PEH can be managed conservatively by Street Medicine teams, certain cases present beyond any prospect of rehabilitation.

This case examines the clinical evolution of an unsheltered male in his forties with no identified hypercoagulable conditions or previous medical diagnoses, whose quality of life was diminished due to surgical limb amputation necessitated by complications from poorly controlled Peripheral Arterial Disease (PAD), despite eventual Street Medicine engagement. His disease trajectory illustrates an intensive surgical course, which included a series of preceding Acute Limb Ischemia (ALI) events, bypasses and associated revisions and ultimately limb amputation due in part to the inaccessibility of prophylactic therapy. Our purposes herein are two-fold: to present an extreme example of a patient who endured detrimental outcomes that could have potentially been diverted through time-sensitive Street Medicine intervention and to leverage this anecdotal evidence to guide discourse about patient care optimization to better serve our neighbors living on the street.

Case Report

A 48 year-old male ("Mr. Z") with an unknown past medical history initially presented to an institutional tertiary care public hospital Emergency Department (ED) with a chief complaint of right lower extremity pain. The patient denied any personal or family history of hypercoagulability disorders. Social history was significant for unsheltered homelessness and a two-year history of tobacco and cocaine use. On physical examination, bilateral pedal pulses were non-palpable and notably absent on Doppler ultrasonography. Accordingly, Mr. Z was inducted on an anticoagulation regimen, to which he demonstrated a subtherapeutic physiological response. Screening for hypercoagulability was negative. He was discharged 7 days later with a referral to outpatient vascular surgery for further consultation regarding his treatment plan.

Months later, Mr. Z presented again to the ED with left lower extremity pain. This time, there was associated pallor and hypothermia of the limb, as well as a non-healing laceration to the first digit of the left foot. He self-reported his noncompliance with prescribed medical management and had been unable to attend his outpatient follow-up appointment due to his transient housing status and lack of means to attend. He was promptly admitted for Acute Limb Ischemia (ALI) of his left foot and a peripheral arterial embolism in his left leg. He emergently underwent catheter-guided thrombolysis of the left popliteal artery, however revascularization was unsuccessful. The patient underwent diagnostic angiography which indicated extensive vascular disease, precluding the use of any autogenous veins for vein grafting. Mr. Z was counseled as to his treatment options, which included sympathectomy for pain control and anticoagulation. [What did he choose?] Discharge to an acute rehabilitation facility was recommended, but despite attempts the patient was denied insurance coverage for admission. He was ultimately discharged to self without shelter provisions.

Six months thereafter, Mr. Z presented with acute-on-chronic left first toe pain with discoloration of the toe and absent pedal pulses. The prior non-healing wound was at this time concerning for wet gangrene. Moreover, he endorsed burning and pain bilaterally in his hands. Following evaluation, he was admitted for ultrasound-guided revascularization via stenting and was initiated on intravenous antibiotics. During admission his bypass was found to be occluded shortly after and he ultimately underwent amputation of hallux with metatarsal of the left foot. [Discharge details, what was the plan?].

Four months later, Mr. Z returned to the ED with purulent drainage from the left great toe hallux amputation site, attributed to consequences of homelessness and extensive PAD. At this time, he was complaining of dyspnea. CT angiogram implicated over ten pulmonary embolisms (Fig. 1). Due to his vascular status, the patient underwent an Above the Knee Amputation (AKA) secondary to the failure of multiple bypasses, poor patency of autologous veins, history of noncompliance to anticoagulation and concern for osteomyelitis. As Mr. Z progressed towards recovery, social workers applied for his admission to an acute rehabilitation facility, which was denied once again. On postoperative day 8, the patient proceeded to be discharged without stable housing. Following his most recent hospitalization, the patient has been followed by our Street Medicine team regarding

the chronic non-healing of his amputation site. His prognosis remains unfavorable as his health status continues to be impacted by his environmental circumstances and limited means of mobility, with a broken wheelchair.

Given his multiple bypass occlusions, he underwent a left leg bypass using a cryopreserved vein allograft. (When was this?) He was discharged to self and counseled to continue to take apixaban and aspirin for anticoagulation. The patient admitted non-compliance due to his current social situation during his next admission. At this time, the patient was evaluated for Inferior Vena Cava (IVC) filter placement, however was denied as there were no contraindications to oral anticoagulation therapy.

Management

From a quality improvement perspective, it is important to note that it was only during Mr. Z's third hospital presentation that he was screened for hypercoagulability dysfunction. Although the results were negative, his hematological evaluation indicated a sub-therapeutic response to inpatient anticoagulation. Algorithmic clinical decision-making would typically prompt an investigation into the pathophysiology of the patient's biological response as a potential risk factor for recurrent thrombosis; instead, his poor outcomes were renounced as nonadherence to pharmacologic treatment. Likewise, during Mr. Z's subsequent hospital admission, he was evaluated for IVC filter placement, however, was denied due to the lack of medical contraindications to oral anticoagulation alternatives. The thrombotic events that ensued were once again ascribed to patient noncompliance. The gross oversimplification of the multifactorial contributory mechanisms to this patient's health status perpetuates the stigma of deviance among PEH, while increasingly impeding the optimization of medical management.

Upon encountering Mr. Z nine months following his last known hospital admission, his amputation site was remarkable for an ulcer likely from a combination of pressure and impaired arterial flow that would benefit from more extensive care than that which may be delivered through Street Medicine (Fig. 2,3). His mobility issues persisted, as he continued to struggle with a semi-functional wheelchair that was compromised in its weight-bearing capacity. Ongoing communication remained a challenge, as Mr. Z denied cellular or alternative methods of contact, thereby increasing his propensity of attrition. The patient noted that he is not in possession of any identification, which further hinders access to vital services. When interviewed regarding his health, Mr. Z maintains that he has yet to establish a primary care provider, as he is still experiencing homelessness. Presently, the Street Medicine team continues to support the patient in the provision of basic wound care and general health surveillance through weekly street outreach.

Global Health Problem List

1. Cyclicity of preventable hospital admissions among PEH
2. Social determinants of health
3. Personal safety and the potential for rehabilitation
4. Stigma
5. Street Medicine challenges

Global Health Problem Analysis

1. Cyclicity of Preventable Hospital Admissions Among PEH

PEH often find themselves condemned to a cyclical pattern of chronic morbidity neglect, disease progression, acute care solicitation and nonadherence to treatment plans post-discharge. Although divergence is largely due to systemic circumstances as opposed to individual deviance, in the absence of ongoing health maintenance, the emergency treatment paradigm inevitably becomes futile; as responsiveness decreases, indefinite interventions, such as amputation, become the sole recourse (Fig. 4). The downstream consequences of this practice are detrimental on both a micro level, to patient health and macro level, to the healthcare system, manifested through increased expenses and excessive infrastructural resource strain [7,8]. Because patient access to emergency care is legally protected by way of the Federal Emergency Medical Treatment and Labor Act (EMTALA) regardless of insurance or financial status, no analogous legislation extends to primary care; therefore, the ED not only becomes the primary clinical touchpoint for PEH, but often the only clinical touchpoint. Research demonstrates this phenomenon to be more pronounced among those with decreased health literacy.

After initial discharge following Mr. Z's primary presentation of ALI, his housing insecurity status made Street Medicine assistance challenging, while limited financial resources and low health literacy contributed to his inability to obtain prescribed

medications. Moreover, post-acute care necessitated follow-up via vascular surgery outpatient clinics; due to Mr. Z's inaccessibility to reliable means of communication, such as mobile devices/active cellular service, scheduling and appointment reminders became unfeasible. Keenly aware of these nuances, Street Medicine aims to overcome these barriers by facilitating scheduling and logistical support, including arranging transportation on a case-by-case basis. The aforementioned scenario is not atypical among PEH and further validates the need for data-driven mapping and subsequent outreach, formal protocols to address administrative bottlenecks and dedicated funding for rideshare services and/or public transit stipends.

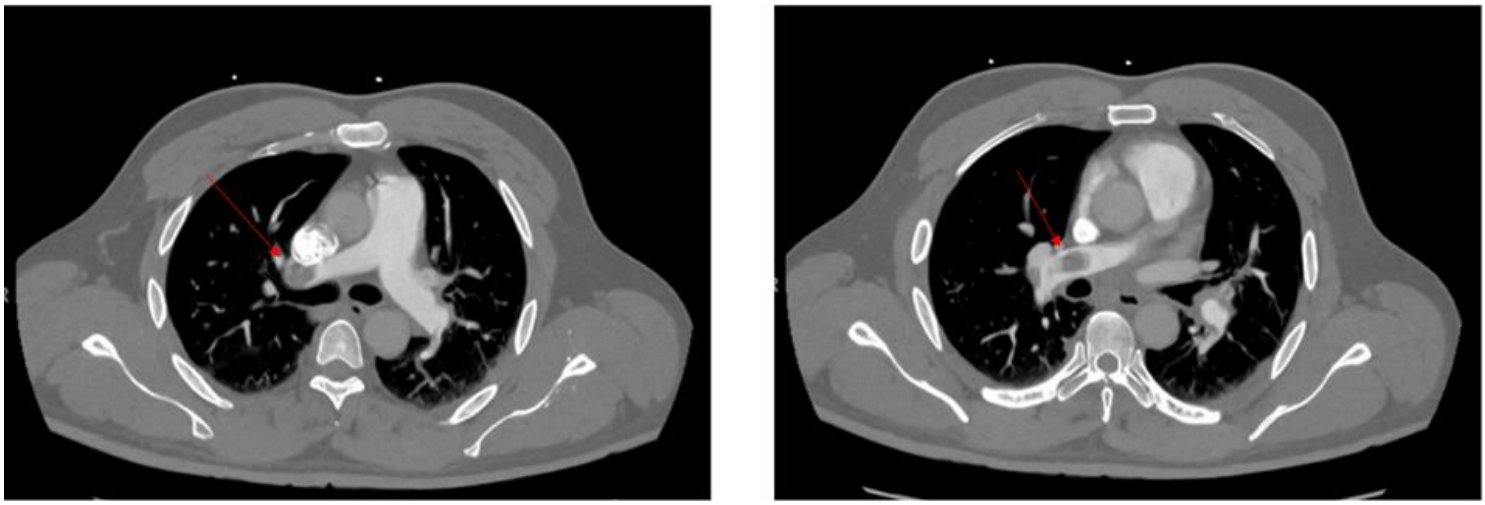

Figure 1: CTA findings of 10+ pulmonary embolisms (two of which are demarcated by red arrows).

Figure 2: Non-healing pressure ulcer worsened by impaired blood flow and overlying slough suspicious for infection at the amputation site.

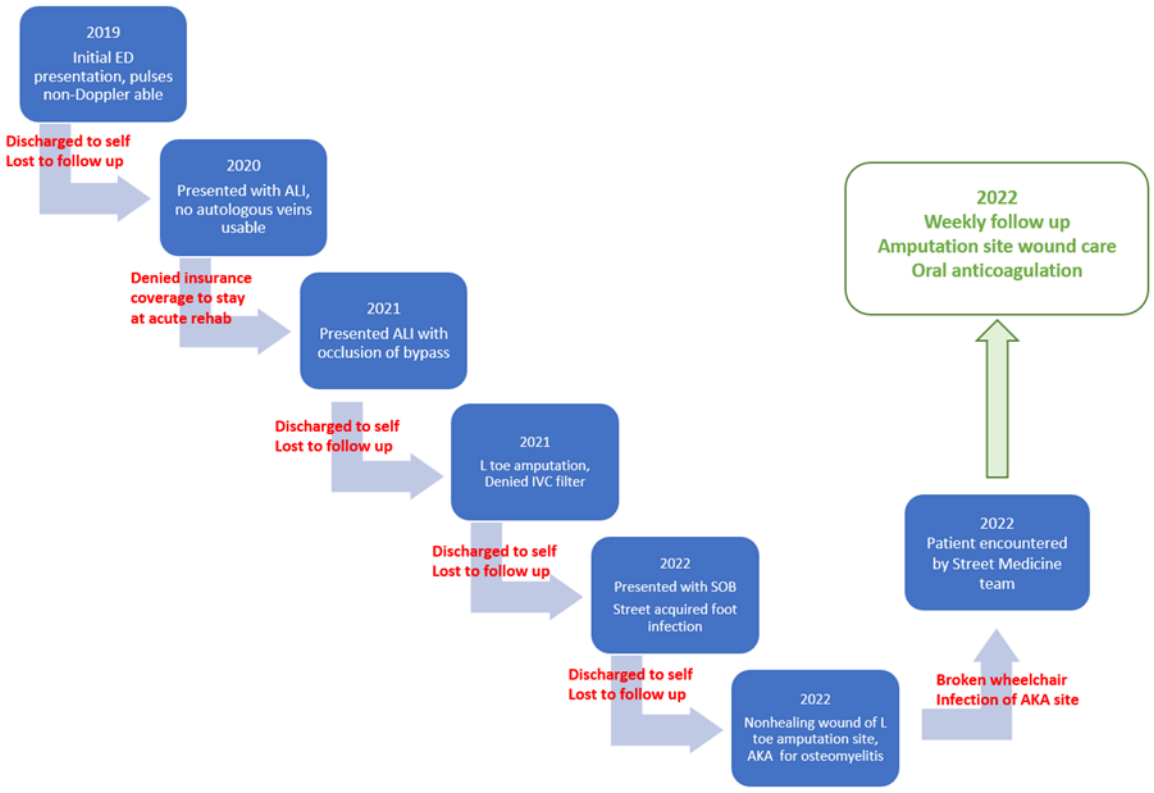

Figure 3: Interval history. ED = Emergency Department; ALI = Acute Limb Ischemia; SOB = Shortness of Breath; AKA = Above the Knee Amputation.

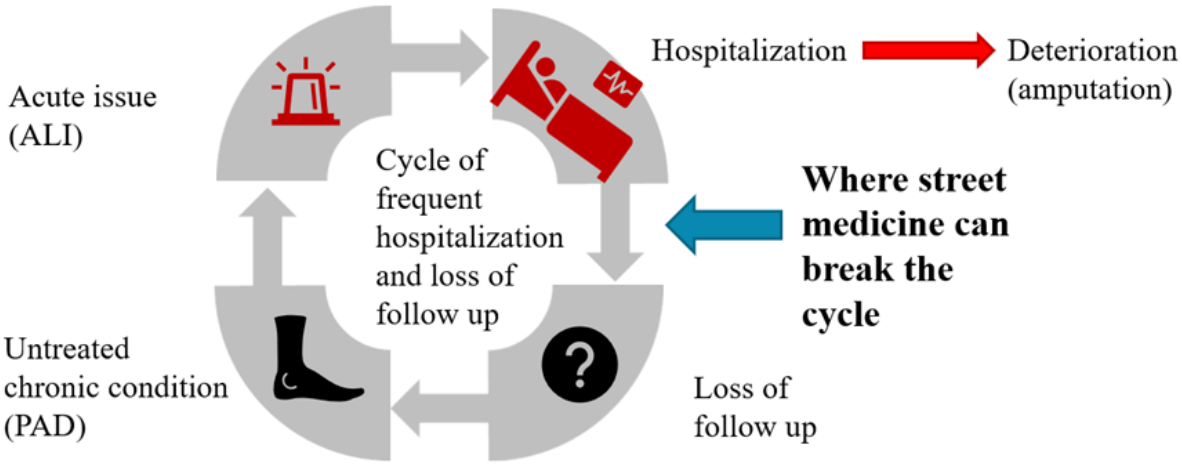

Figure 4: The cyclicity of acute care hospitalizations (i.e. ALI) secondary to chronic, untreated morbidities (i.e. PAD). The law of diminishing returns implies its inevitable futility, while underscoring the need for intervention at critical timepoints.

2. Social Determinants of Health

According to the World Health Organization (WHO), SDOH refers to income level, social support, childhood development, education, employment, housing status and gender, all of which, both individually and combined, significantly influence patient health outcomes [11]. While evidence has well-established that those within lower socioeconomic strata have been associated with more unfavorable health consequences compared to those of higher socioeconomic status, research as to its justifications remains relatively ambiguous. Although this warrants further inquiry, predominant theories implicate higher exposure to risk factors and the direct physiologic impact of chronic stress due to poverty as causal factors [12,13].

The prevalence of PAD is less than five percent in those under 50 years of age, while chronic limb-threatening ischemia occurs in only ten percent of these cases, emphasizing the exceptionality of this incidence in a quadragenarian with no known pertinent history [9]. Mr. Z had multiple risk factors related to SDOH, such as low income, minority status, low social support and housing status and insensitivity to these aspects likely contributed to unfavorable outcomes. Because patients stratified as low socioeconomic or minority status have been shown to undergo amputation at a higher rate, physicians have a responsibility to try to adapt treatment regimens according to patient means and anticipate potential complications [10]. This is especially important in the discharge planning phase, where patient empowerment is predictive of longer-term compliance. Overutilization of emergency services, extended hospital admissions and critical care presentations would improve as a direct result of re-engagement in an individual's own care. In moving towards this goal, it has been reported that many physicians feel helpless and frustrated when facing complex social challenges and encounter barriers when trying to address these issues [14]. Therefore, ongoing interdisciplinary collaboration among physicians, nurses, social workers, community health workers, patient advocates, psychologists and other stakeholders in the PEH care team, such as Street Medicine workers, is essential.

3. Personal Safety and Potential for Rehabilitation

PEH are confronted with multiple challenges post-amputation, including, but not limited to, impaired mobility, inadequate wound hygiene, supplementary expenses, increased vulnerability to victimization and occupational disadvantages. Reliance on mobility assistance devices, such as wheelchairs, aside from profoundly impacting quality of life, limits physical activity, imposes additional accessibility barriers to follow-up care and exacerbates prescription procurement difficulties. Moreover, PEH without access to regular hygiene are increasingly susceptible to poor wound healing and thus, are more susceptible to infection at the amputation site, as well as complications such as cellulitis, sepsis, gangrene and necrosis. Additionally, the financial burden of wound care supplies on those who are resource-limited cannot be understated. Furthermore, approximately a quarter of surveyed patients experiencing homelessness reported being physically assaulted while unsheltered, with disabled individuals more vulnerable to targeting [15]. Finally, the physical disadvantages resulting from amputation impose prohibitive functional restrictions that make finding meaningful employment more arduous.

Mr. Z's impaired mobility and financial status prevented him from attending follow-up appointments and obtaining pharmacological anticoagulation therapy. His wound care regimen was limited due to his lack of access to proper hygiene and thus places him at a higher risk for complications resulting from infection. Lastly, his sentiments regarding personal safety and future employment prospects insinuate the psychosocial repercussions of amputation and its counterproductivity to positive health outcomes. Interventions focused on the prevention of disease progression decrease the risk of amputation and present a more actionable solution to deter post-amputation sequelae. Community resource mobilization and health programming are assets that may be leveraged to promote a culture of wellbeing and establish enduring social support networks. Leadership at the local level offsets the requisite investment by external parties, enhances self-sufficiency and stewardship and has the potential to thrive alongside the Street Medicine model.

While free clinics and community health centers often provide some necessities free of charge, it is generally insufficient for the purposes of routine maintenance and/or a reliable source of materials. Social workers play a pivotal role for patients experiencing the barriers to care described. The early involvement of social workers in these cases may allow ample time to seek resources for people to help with safe discharge planning. Helping facilitate patient access to resources they may not otherwise be aware of or able to access without an advocate, such as a social worker.

4. Stigma

The stigma associated with PEH continues to pervade the institutions of medicine, despite progressive attempts at trauma-informed care and inclusivity training at the professional level. Loaded verbiage, such as "frequent fliers," confer prejudicial undertones that lead to both implicit and explicit bias, fundamentally detracting from the delivery of dignified, high-quality care. Not only does this deter treatment-seeking behaviors, but alienation from one's own healthcare has been shown to lessen medication adherence compared to a shared decision-making model. If non-compliance secondary to circumstance was indeed a concern, it should be considered a medical indication for long-acting prophylaxis and inform discharge planning. In the electronic health record, any reference to noncompliance should be properly contextualized and not exploited as justification for peremptory decisions, as this conduct may be due to a lack of ability rather than an act of defiance.

In the case of Mr. Z, a displaced patient without cellular access or transportation who suffers from chronic limb pain/claudication, his absenteeism at follow-up appointments and failure to acquire his prescriptions cannot simply be dismissed as noncompliance. This characterization perpetuates a stigma among PEH that increases the disconnect between PEH and those entrusted with their care, resulting in further marginalization. Re-engaging at-risk populations requires advocacy through empathy, understanding and action. Empathy involves a conscious effort to use humanizing language, whereas understanding requires interviewing a patient in-depth about health circumstances. Finally, adopting a proactive approach to chronic care based on pragmatic treatment planning positions vulnerable patients like Mr. Z for success.

5. Street Medicine Challenges

A primary objective of Street Medicine is to serve as a long-term primary care touchpoint for PEH. Outcome metrics defined by the literature typically include endpoints such as decreased ED utilization, expense reduction and a decline in readmission rates for PEH who are engaged by Street Medicine organizations. While objective tracking remains a challenge due to funding limitations and notorious attrition rates, the informal consensus as to the efficacy of Street Medicine is optimistic. Studies have shown this model to be effective in increasing insurance enrollment, decreasing ED utilization and reducing aggregate healthcare costs [17]. A poll of mobile Street Medicine clinics in Southern California estimated savings of $3,000-$9,000 per patient annually [18]. Similarly, between 2015 and 2017, Pennsylvania-based Lehigh Valley Health Network saved an estimated $3.7 million in ED expenses after mobilizing a local street medicine team [19].

[Paragraph about Street Medicine model variability and difficulty in studying the effectiveness of street medicine models due to variability]. The Street Medicine model is not yet well defined– there is wide variability among Street Medicine groups in their team member composition, funding sources, scope and model of operations [20]. While the loose framework allows for leadership to tailor the structure of their group to the laws and policies of their respective governments and the needs of the unique populations served, the lack of uniformity makes it difficult to study the effect of the intervention on a large enough scale to draw conclusions about the generalizability of a given approach. Furthermore, the standard of care among Street Medicine groups vary due to the novelty of the health care model and large variation in scope. Different models offer different degrees of continuity, a fact which incites discussion as to how to generalize Street Medicine models to universally apply a framework allowing the medical team to fulfill their responsibility to complete a treatment plan with a patient at risk for critical outcome [21].While many Street Medicine groups conduct research to evaluate their own effectiveness using a wide range of markers which lack the scope to derive generalizable conclusions, scoping reviews of these studies conducted to understand Street Medicine models against one another may allow for the comparison of different models. Therefore, future directions might include systematic review and meta-analysis of similarly-modeled Street Medicine groups. As depicted by the case of Mr. Z, Street Medicine has the potential to improve quality of life for PEH, while reducing health infrastructure burden. With adequate funding and the recruitment of an interdisciplinary team of dedicated physicians, clinicians, social workers and other stakeholders, this community-based model can be scaled to serve at-risk PEH across populations. Further inquiry into longer-term outcomes with larger sample sizes of PEH are warranted to derive statistically significant and actionable insights.

Learning Points

▪ PEH are at a disproportionately higher risk for complications secondary to chronic conditions responsive to outpatient medical management

▪ Noncompliance with post-acute care regimens among unsheltered patients is often due to extrinsic, as opposed to intrinsic, factors

▪ SDOH-associated barriers to care must be reconciled with discharge planning to ensure sustainability, whereas relative contraindications to impractical management choices should be avoided

▪ Street Medicine organizations are strategically-positioned to support high-risk PEH through consistent outreach and pathways to care to prevent extreme adverse disease sequelae

Conflict of Interest

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Author Contributions

All authors contributed equally on this final manuscript.

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