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From Hearing to Headache: A Case of Otitis Media to Skull Base Cranial Osteomyelitis

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ABSTRACT

Otitis media is a common infection of the middle ear. While historically well-managed, complications may result from untreated infection. Pathogens can spread to nearby tissues and lead to bone destruction, abscess formation, and necrosis. We present a case of otitis media which progressed to cranial skull base osteomyelitis (SBO) in a 47-year-old man with smoking history, emphysema, methamphetamine abuse, and homelessness who had a month of progressive left ear pain, hearing loss, and headache. He stated that he could not afford Amoxicillin that had been previously prescribed and his exam was notable for otitis media changes as well as exquisite left mastoid-occipital-temporal tenderness. Noncontrasted facial CT showed left-sided mastoiditis with extension into the middle ear and surrounding ossicles. Left occipital bone was destroyed and associated with left mastoid air cells but there was no intracranial extension or abscess. Empiric IV antibiotics were administered. Bilateral otomicroscopy and left myringotomy were performed, pressure equalizer tube placed, and he was scheduled for mastoidectomy two days later with plan for further empiric intra auricular antibiotic eardrops. Intraprocedural cultures grew methicillin-resistant Staphylococcus aureus (MRSA) and he was a carrier per nasal swab. Despite the associated risks and non-candidacy for antibiotics apart from a supervised setting, the patient was adamant to leave post-procedure, refused further IV antibiotics, and was discharged on long-course oral antibiotics for 21 days with follow-ups discussed. However, he is lost to follow up. Understanding the infectious progression of otitis media to cranial SBO is vital in identification, treatment, and management of this rare complication.

INTRODUCTION

Otitis media affects the middle ear, typically in the pediatric population and is the second most common emergency room (ER) pediatric diagnosis, however it can occur at any age, especially when certain risk factors are present [1]. Most common causes are viral such as respiratory syncytial virus (RSV), coronavirus, influenza, adenovirus, metapneumovirus, and picornavirus. Secondary bacterial organisms that can lead to infections necessitating antibiotic therapy include Streptococcus pneumoniae, non-typable Haemophilus influenza, and Moraxella catarrhalis [1]. Nontreatment can lead to unfortunate invasive and nearby complications such as tympanic membrane perforation, mastoiditis, labyrinthitis, petrositis, meningitis, brain abscess, permanent hearing loss, and cavernous sinus thrombosis [1].

Osteomyelitis (OM) itself is relatively uncommon and is listed among the National Organization for Rare Disorders (NORD) [2]. The NORD remarks on the increased rate of OM in United States adults compared to children, due to the higher prevalence of diseases such as diabetes or procedural seeding as in the case of joint replacement, or predisposing open wounds [2,3]. The known destructive organisms typically involve Staphylococcus aureus, Staphylococcus epidermidis, Salmonella, Proteus, nontuberculosis Mycobacterium, Treponema pallidum, and Klebsiella Candida among bacteria. Cryptococcus, Aspergillus, Blastomycosis, and Mucormycosis are among the invasive fungi [3]. Treatment involves a prolonged course of directed antimicrobials, hyperbaric oxygen, or operative management [3]. A mortality rate has not been established but is based on adherence and clinical response to treatment. In untreated cases, the mortality is thought to be high.

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We present a case of a man with risk factors and socioeconomic barriers. He had hearing loss initially, and headache after untreatment, which was found to be the result of progressive otitis media which had locally and further invaded into the cranial bones, effectively becoming a skull base osteomyelitis (SBO).

CASE

A 47-year-old man with a past medical history of smoker with emphysema, polysubstance abuse, underweight status and chronic anemia presented to the emergency room (ER) in July 2023. He complained of left-sided otalgia and hearing loss. In the past month he had similar symptoms and was diagnosed with bilateral cerumen impaction which was manually disimpacted. He was provided prescriptions for carbamide peroxide 6.5% eardrops and oral amoxicillin. At that time, he endorsed improved hearing and was discharged without additional concerns. However, in the meantime, he endorsed an inability to acquire the prescriptions and had not taken them. On re-presentation, he endorsed new hearing loss and tinnitus. Vitals in the ER were a blood pressure of 147/81 mm/Hg, temperature 98º Fahrenheit, pulse 93 beats per minute, respirations 20 per minute, oxygen saturation 98% on room air, and a body mass index of 17.18 kg/m2. His labs are shown in **Table 1**.

Table 1. Lab Results at Presentation.

Lab test	Lab result	Reference range (units)
Red blood cells	3.94	4.20 - 5.90 M/uL
White blood cells	10.6	4.0 - 11.0 K/uL
Hemoglobin	12.4*	13.5 - 17.5 g/dL
Hematocrit	36.3*	40.5 - 52.5%
Neutrophils	76.7	Rel %
Glucose	111	70 - 99 mg/dL
Creatinine	0.6	0.9 - 1.3 mg/dL
Sedimentation rate	50*	0 - 15 mm/h
Amphetamine screen	Urine positive*	Negative <1000 ng/mL

**Indicates significant value*

The external ear exam was unremarkable bilaterally, and there was no appreciable fluctuance. Internal ear exam showed cerumen impaction again, and the left tympanic membrane was opaque with epithelial debris, concerning for inflammation such as otitis media. There was tenderness over the left mastoid, occipital, and temporal regions. There was no post-auricular abscess, facial nerve weakness, or meningismus. Computed tomography (CT) of the facial bones without contrast showed extensive left-sided mastoiditis with extension of inflammatory changes into the middle ear, along with destruction of the left occipital bone overlying the left mastoid air cells **(Figure 1).** CT head with and without contrast showed no intracranial extension or abscess formation. Empiric antibiotics were initiated with intravenous (IV) vancomycin 1 gm every 12 h, cefepime 2 gm every 12 h, and acetaminophen-hydrocodone 325-5 mg every 6 h as needed for pain. The diagnosis at this stage was left sided middle ear effusion, mastoiditis and suspected cranial osteomyelitis (OM).

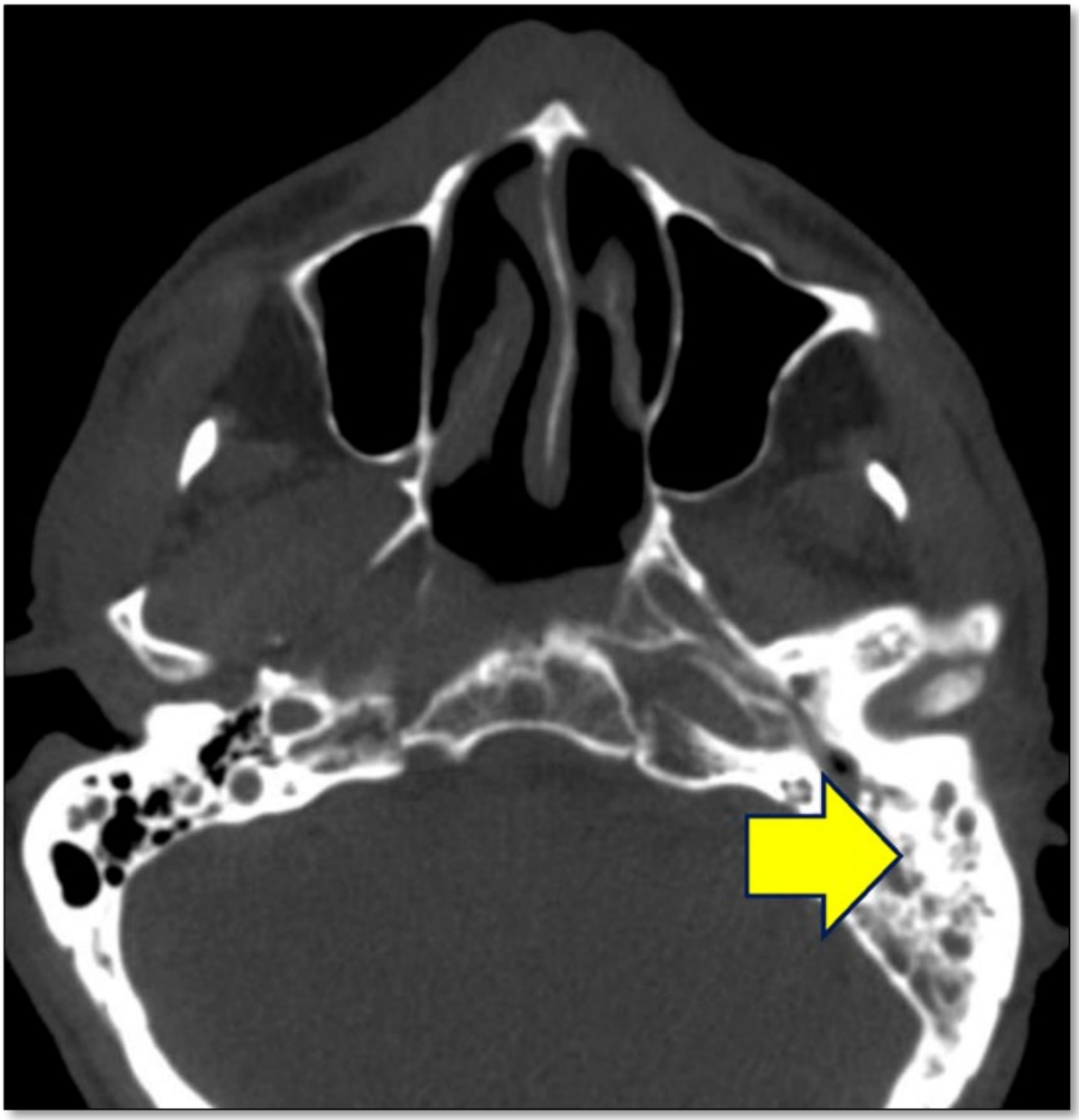

Figure 1. CT head and face without contrast shows extensive left-sided mastoiditis with inflammatory extension into the middle ear and surrounding ossicles. There is also destruction of the left occipital bone overlying the left mastoid air cells.

Otolaryngology/ears-nose-throat specialist (ENT) was consulted and performed bilateral otomicroscopy and left myringotomy with tympanostomy tube placement. Ciprofloxacin 0.3%-dexamethasone 0.1% eardrops were prescribed as four drops twice daily over 7 days to the left ear. Unfortunately, the patient's primary symptoms did not improve so that a left-sided cortical mastoidectomy was pursued on hospital day 2. Intraprocedurally, purulence and dehiscence of the temporal bone overlying the posterior fossa and sigmoid sinus was noted. Two intraoperative samples of tissue and fluid were sent for culture and grew methicillin-resistant Staphylococcus aureus (MRSA). He was also confirmed to be a MRSA nares carrier. Fortunately, magnetic resonance imaging (MRI) showed no evidence of Dural venous sinus thrombosis **(Figure 2)**, and source control was considered achieved. There was at least lesser risk of seeding to the posterior dura fossa and sigmoid sinus. Under the guidance of infectious disease (ID), 6 weeks of IV antibiotics and reassessment would be required given skull base osteomyelitis, determined by temporal bone involvement.

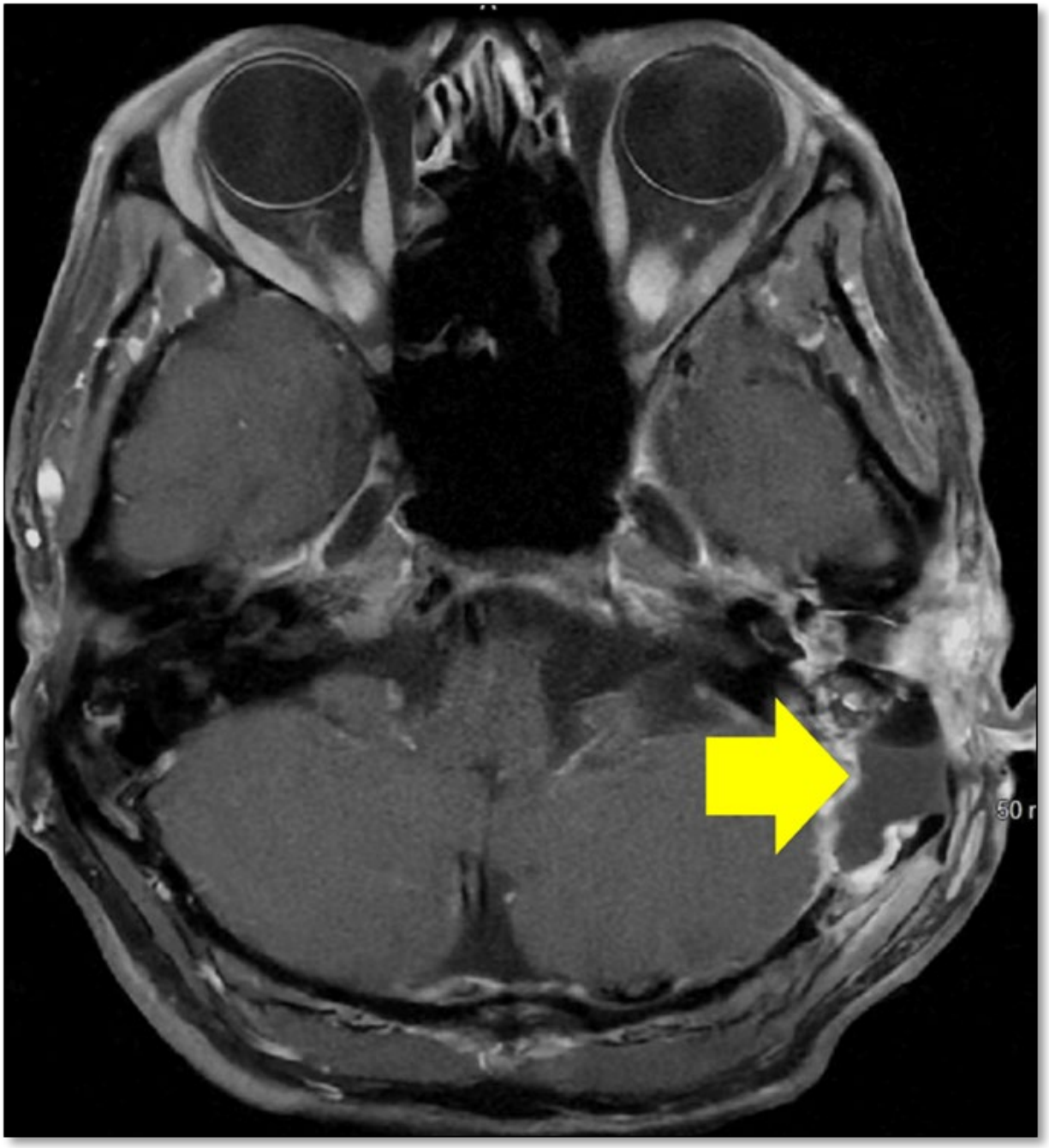

Figure 2. Post op MRI with and without contrast shows postsurgical changes compatible with left-sided mastoidectomy and reactive enhancement surrounding the surgical bed. Soft tissue inflammation into the left postauricular soft tissues.

The patient reported that his pain had improved immediately after the mastoidectomy and wished to go home, against medical advice (AMA). He refused to remain in the hospital for further IV antibiotic treatment and refused discharge plans to a nursing facility in which they would be able to administer IV antibiotics via peripherally inserted central catheter (PICC). He was counseled on the associated morbidity risk with leaving AMA and was deemed to have medical decision-making capacity. All IVs were removed and he was provided oral prescriptions for double-strength sulfamethoxazole/trimethoprim 800/160 mg twice daily and Levofloxacin 500 mg daily for 20 days. There is no chart record of the patient after this time. His course of illness is listed below **(Figure 3).**

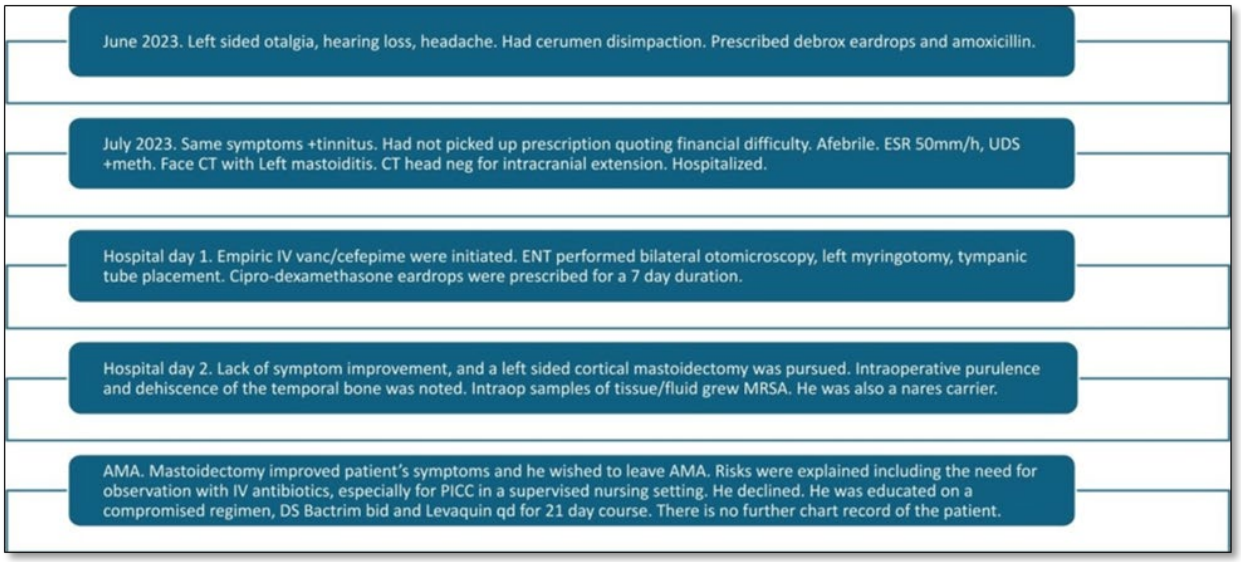

Figure 3. Patient's course of illness.
AMA: Against Medical Advice; CT: Computed Tomography; ESR: Erythrocyte Sedimentation Rate; DS: Double Strength; ENT: Ear-Nose-Throat; MRSA: Methicillin Resistance Staph Aureus; PICC: Peripherally Inserted Central Catheter; UDS: Urine Drug Screen

DISCUSSION

Secondary complications from untreated otitis media may involve tympanic membrane perforation, labyrinthitis, petrositis, meningitis, and brain abscess [1]. There is typically a point of entry from otogenic, sinogenic, odontogenic, or rhinogenic source leading to site and regional infection [3]. Low [4], for example, describe a progression of otitis media with tympanic membrane involvement followed by perforation and subsequent invasion into the external auditory canal report and cranial OM [4].

Early diagnosis and prompt treatment are crucial to minimize complications and improve outcomes in otitis media. Delayed or inadequate treatment can lead to disease progression such as SBO, emphasizing the need for heightened clinical suspicion and proactive management. The patient's refusal of further IV antibiotics and AMA discharge emphasizes the importance of patient education and addressing socioeconomic barriers to ensure continuity of care and prevent relapse or complications.

As otitis media is a predominantly pediatric disease, much of management is extracted from the pediatric literature [2]. Where SBO is concerned, treatment typically involves a multifaceted approach including management of underlying predisposing factors such as glucose control, surgical intervention for source control, and targeted antibiotic therapy for a sufficient duration, often with the help of an ID specialist [3,5]. In this case, empiric IV antibiotics were initiated, and mastoidectomy was performed due to extensive involvement of the mastoid and surrounding bone. Antibiotics were able to be tailored to the patient's intraoperative cultures, which were positive for MRSA. Additionally, an evidence-based approach for duration of therapy was able to be established with the help of ID and ENT specialists.

For suppurative otitis media in the United States, oral antibiotics such as high-dose amoxicillin or a second-generation cephalosporin are the first line of treatment. However, if tympanic membrane perforation is involved, ototopical antibiotics are preferred over systemic antibiotics due to their superior concentration delivery without systemic side effects [1]. If a patient appears to have disease refractory to first line therapy, then a beta lactam inhibitor should be added, such as high-dose amoxicillin-clavulanate [1]. In chronic cases where patients experience four or more episodes of otitis media in one year, then they are considered candidates for myringotomy with tube placement. If they continue to experience a recurrence of otitis media, they can then be treated with ototopical antibiotic drops [1]. Treatment of SBO involves broad-spectrum antibiotic therapy for a duration of 3 to 6 months for bacterial or fungal positive cultures, and the first 4 to 6 weeks should be IV administration. For bacterial SBO, an aminoglycoside plus b-lactamase, a third-generation cephalosporin, or an oral fluroquinolone are used. For fungal SBO, high dose amphotericin is preferred [3,6]. Early identification of the causative pathogen is also key in treating pathology. If conservative therapy fails to provide source control, as determined by follow up imaging, then surgical debridement is indicated [3,6,7].

Emerging evidence suggests that hyperbaric oxygen treatment for osteomyelitis improves the penetration of certain antibiotics into the bone and stimulates osteogenesis [8]. This treatment also restores the leukocyte-mediated killing of gram-positive organisms and certain gram-negative microbes of the infected bone [8-10].

Healthcare providers must maintain a high index of suspicion for complications of untreated otitis media, such as SBO, especially in high-risk individuals. A comprehensive evaluation and management should always entail. Socioeconomic barriers, including medication affordability and unstable housing, significantly impact disease progression. Patient education and engagement are imperative to promote treatment adherence and facilitate timely follow-up. Ultimately, the patient's refusal of further IV antibiotics and AMA discharge made evidence-based treatment more challenging, so that providers had to develop a tailored approach with less optimal oral antibiotics within that first 4 to 6-week period after operative source control. It is not clear if these methods were successful in the patient's case, as he was lost to further follow up.

CONCLUSION

This case report emphasizes the progression of untreated otitis media to cranial osteomyelitis and SBO. Mainstay of therapy is early recognition, source identification, directed antimicrobial treatment, and source control. Ongoing research explores antimicrobial effectiveness, surgical techniques, and adjunct hyperbaric oxygen therapy to increase osteogenesis and outcomes.

There are several challenges in managing patients with complex medical and social backgrounds. The patient's socioeconomic barriers, including limited access to healthcare resources, affordability, and drug use, contributed to suboptimal management of his initially simple condition. Further refusal of care was another point where providers were challenged to tailor their approach to accommodate limitations the patient placed on his treatment plan. In sum, advanced cranial osteomyelitis remains challenging to treat, particularly in patients with multiple comorbidities and social barriers to care.

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