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Homelessness, Personal Hygiene, and MRSA Nasal Colonization among Persons Who Inject Drugs

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Abstract Methicillin-resistant *Staphylococcus aureus* (MRSA) infection is a leading cause of hospitalization and medical visits among individuals experiencing homelessness and also among persons who inject drugs (PWID), populations with significant overlap in urban centers in the USA. While injection drug use is a risk factor for MRSA skin infections, MRSA is also known to transmit easily in crowded, public locations in which individuals have reduced personal hygiene. Individuals in urban centers who experience homelessness or drug addiction may spend significant amounts of time in environments where MRSA can be easily transmitted, and may also experience reduced access to facilities to maintain personal hygiene. We assessed the relationship between homelessness, personal hygiene, and MRSA nasal colonization, a proxy for MRSA infection risk, in a study of PWID in Boston, MA ($n = 78$). Sleeping in a homeless shelter for at least one night in the last 3 months was significantly associated with MRSA nasal colonization (OR 3.0; $p = 0.02$; 95% CI 1.2, 7.6). Sleeping at more than one place during the last week (considered a metric of elevated housing instability) was also associated with a threefold increase in odds of MRSA nasal colonization (OR 3.1; $p = 0.01$; 95% CI 1.3, 7.6). MRSA nasal colonization was strongly associated with use of public showers (OR 13.7; $p = 0.02$; 95% CI 1.4, 132.8), although few people in this study (4 of 78) reported using these public facilities. Sharing bedding with other people was also associated with increased risk of MRSA colonization (OR 2.2; $p = 0.05$; 95% CI 1.0–4.7). No associations between hand hygiene, frequency of bathing or clothes laundering, or street sleeping were observed. Use of public facilities supporting persons experiencing homelessness and housing instability, including shelters and public showers, is associated with an increased risk of MRSA nasal colonization in this study. Personal hygiene behaviors appear less associated with MRSA nasal colonization. Environmental assessments of MRSA contamination in homeless shelters and public sanitation facilities are warranted so as to inform appropriate intervention activities.

Keywords Methicillin-resistant *Staphylococcus aureus* · Drug users · Skin diseases—bacterial · Hygiene · Homeless persons

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Background

Skin infections are a leading cause of hospitalization, medical care–seeking and healthcare costs among persons who inject drugs (PWID) in the USA [1, 2]. Methicillin-resistant *Staphylococcus aureus* (MRSA) is the most common etiological agent of these difficult-to-treat, and often recurrent, infections [3, 4]. MRSA infection can cause a range of clinical manifestations, from folliculitis to bacteremia and sepsis [5]. Research and interventions to reduce incidence of bacterial skin infections are critical to improving health and reducing medical costs associated with injection drug use. However, specific injection practices associated with MRSA infection remain unclear, and research findings on this topic are inconsistent in the literature [6–8]. Efforts to understand the broader context of MRSA ecology among PWID are needed to improve intervention.

In urban areas in the USA, there is broad overlap between substance misuse, homelessness, and housing instability [9–11]. Homelessness is associated with increased risk of MRSA nasal colonization independent of drug use as well as increased prevalence of skin infection [12–14]. Skin infections are a dominant cause of medical visits among homeless persons [15, 16]. Evaluating MRSA risk factors in the context of the co-exposures of injection drug use and homelessness is a critical component of prevention.

MRSA can be transmitted in crowded places, especially in locations where individuals have reduced access to personal hygiene [17, 18]. Additionally, reduced personal hygiene has also been associated with increased risk of tMRSA ransmission, even in the context of non-crowded environments [19]. Hand hygiene in particular is a well-established risk factor for MRSA transmission within hospital environments [20–23]. PWID, especially those who experience homelessness or housing instability, may spend time in locations with elevated risk of MRSA contamination, including day centers, homeless shelters, hospitals, or prisons. These locations may pose MRSA exposure risk independent from injection practices. Likewise, urban PWID may face curtailed access to personal hygiene activities, such as showering, dental and hand hygiene, and laundry, as a result of housing instability or addiction, and substance use itself is associated with reduced attention to self-care [24].

Staphylococcus aureus is a commensal of the respiratory microbiome, colonizing upwards of 30% of the general population [25]. MRSA nasal colonization is much less common, affecting less than 2% of the US general public [26]. MRSA nasal colonization is associated with increased risk of skin infection [27]. Nasal screening for MRSA is a common tool to identify persons at elevated infection risk and is commonly performed in Emergency Departments, as well as in epidemiologic studies as a marker of elevated infection risk [28].

In this study, we assessed the relationship between personal hygiene behaviors, experiences of homelessness and housing instability, and MRSA nasal colonization in a study of urban PWID enrolled in a longitudinal intervention study in Boston, MA. We hypothesized that the use of public facilities for sleep and hygiene, as well as reduced personal hygiene behaviors, would increase risk of MRSA nasal colonization in this population. Our goal was to better inform infection reduction efforts.

Methods

Study Design The Skin and Needle Intervention (SKIN) study is a longitudinal, randomized trial to evaluate a motivational interviewing-based educational intervention to reduce incident injection-related bacterial skin infection among PWID in Boston, MA. In the parent study, which is currently ongoing, participants are identified and recruited within 4 days of inpatient admission at Boston Medical Center, an urban, safety net hospital. Participants are randomized to an educational intervention program focused on needle and skin cleaning skills or to standard hospital care condition, which includes only HIV testing and counseling. Participants are then followed at 1 week, and 1, 3, 6, 9, and 12 months to assess prevalence of high-risk injection practices and bacterial infection. Eligibility criteria included the following: recent injection drug use (at least 3 days out of the week prior to hospital admission), spoken English language proficiency, the ability to return to BMC for follow-up, at least two additional contacts with valid phone numbers, and no known upcoming prison sentence or planned move from the region.

We recruited all SKIN participants who received either a baseline or follow-up assessment from October 2016 to April 2018 to join a nested study on risk factors for MRSA nasal colonization. Interested participants provided a nasal swab specimen and a brief interview about hygiene behaviors and homelessness at their regular SKIN study assessments. Interviews and specimen collection were conducted by trained SKIN research assessors.

Questions about personal hygiene included the following: frequency of hand washing or sanitizer use during the day; frequency of bathing or showering during a typical week, method of bathing or showering (sink, bath, shower, washing up at the sink), bathing/showering location (home, home of friend or family member, shelter, jail, halfway house, residential treatment facility, detox facility, public bathroom facility (public showers), or hospital); frequency and method for laundering clothing (sink without soap in a public restroom or shelter, sink with soap in a public restroom or shelter, laundromat, shelter washing machine or service, at my home); whether the individual shared clothing, towels, or bedding with other people; location of sleep in the last 90 days (own home, family member or friend's home, shelter, street, hospital, prison, detox facility, and residential treatment); and the number of different places slept in the last week (same place all week; 2–3 different places; > 3 different places). We defined housing instability using dichotomized responses to the latter question, with more than one location of sleep in the last week indicative of elevated housing instability.

Laboratory Analysis The nasal swab specimens were maintained in refrigerated conditions for fewer than 2 h after collection and transported by hand to the Boston University Medical Center (BUMC) Clinical Microbiology and Molecular Diagnostics Laboratory. At the lab, nasal specimens were refrigerated and cultured on the day of collection using manufacturer-specified protocol for Remel Spectra chromagar plates (Remel, Lenexa, KS, USA).

Statistical Analysis Hygiene and housing variables were evaluated descriptively. Prevalence of MRSA nasal colonization was assessed at any time during the study period and participants were designated as MRSA colonized if they had at least one positive nasal swab specimen at any time during the study period. We used univariate logistic regression with clustering of standard errors to evaluate risk factors for MRSA nasal colonization across repeated sampling, employing a 0.05 threshold to identify statistical significance. All analyses were conducted in Stata 15 (StataCorp, TX, USA) [29].

Results

Study Population Demographic data are presented in Table 1. Of 108 individuals eligible to join the nested study, 78 (72.2%) agreed to do so. Mean age of participants was 39 years. Approximately half identified as non-white, and 64% of participants were male. Nearly 90% reported opioid use in the last month, with a mean of approximately 25 days of injecting in the last month. A majority of participants (62.8%; $n = 49$) identified as homeless during the prior 3 months. Prevalence of MRSA nasal colonization in this study was 28.2% ($n = 22$).

MRSA Nasal Colonization Risk Factors Sleeping in a homeless shelter for at least one night in the last 90 days was associated with a 200% increased risk of MRSA nasal colonization (OR 3.0, $p = 0.02$; 95% CI 1.2, 7.62) (Table 1). Sleeping at more than one place during the week was also strongly positively associated with MRSA nasal colonization (OR 3.1; $p = 0.01$; CI 1.3, 7.6). We did not observe significant associations between MRSA nasal colonization and other variables associated with homelessness or housing instability,

Table 1 Study population demographics and risk factors for MRSA nasal colonization among PWID in Boston ($n = 78$; mean age 38.7 years (SD: 11 years))

Characteristic	***N* (%)**
Demographics	
Sex (Male)	50 (64.1%)
Race (White)	41 (52.6%)
Latino/a (Yes)	14 (18.0%)
Primary drug (Opiates)	69 (88.5%)
MRSA nasal colonization[1]	**22 (28.2%)**
MRSA nasal colonization risk factors	**OR (95% CI), *p* = value[4]**
Sleeping in a homeless shelter in the last 3 months	3.0 (1.2, 7.6), $p = 0.02$
Sleeping at > 1 place during the last week[2]	3.1 (1.3, 7.6), $p = 0.01$
Use of public shower facilities in the last week[3]	13.7 (1.4, 132.8), $p = 0.02$
Sharing bedding with other people	2.2 (1.0–4.7), $p = 0.05$

[1] Defined as at least one positive MRSA nasal culture during the study period

[2] Evaluated as a measure of housing instability

[3] Public restrooms are exclusive of restrooms in homeless shelters, day centers, or hospitals

[4] Statistical results assessed using univariate logistic regression with clustered standard errors for repeat sampling. No associations were observed between MRSA nasal colonization and the following factors: hand hygiene, clothes laundering method or frequency, showering/bathing method or frequency, or sleeping on the street

including sleeping outdoors, in detox facilities, doubled up, or prison.

Use of public showering facilities in the last month was associated more than 13 times the odds of MRSA nasal colonization (OR 13.7; $p = 0.02$; 95% CI 1.4, 132.8). However, only four individuals (all homeless) reported using public showers, so estimates are unstable. Sharing bedding with other people was also associated with increased risk of colonization (OR 2.2; $p = 0.05$; 95% CI 1.0–4.7). We did not observe significant associations between other personal hygiene behaviors, including frequency of hand washing, frequency or method for clothes laundering, frequency or method of showering/bathing, and MRSA nasal colonization.

Discussion

Our findings indicate that the use of homeless shelters is associated with increased risk of MRSA nasal colonization among PWID. Additionally, the use of public showers, while reported infrequently in our population, is also strongly associated with MRSA colonization and warrants further research attention. These findings are suggestive of bacterial contamination of these public facilities intended to support sleep and hygiene among persons experiencing housing instability. It is also likely that increased person-to-person contact or crowding in shelters facilitates the transmission and persistence of pathogens, including MRSA. The association between staying at homeless shelters and MRSA colonization has been demonstrated in other studies [14, 30–33]. However, microbiological studies of MRSA contamination within shelters or within public restroom facilities are limited to date and are warranted given these findings [34–37].

A growing literature highlights the importance of publically accessible restroom facilities to health and wellbeing of persons experiencing homelessness [38–42]. Public showers in Boston may include publically available facilities at YMCAs, the Salvation Army, and public beaches, among others. Especially in cities with large unsheltered homeless populations, such as Los Angeles, efforts to increase accessibility of public hygiene facilities have garnered significant public attention, in large part due to open defecation and outbreaks of hygiene-related infectious diseases among homeless persons [43–46]. Our findings regarding public showers, although limited by sample size, suggest that regular maintenance and decontamination of public restrooms are needed to fully attain the health and hygiene-promoting goals of these facilities.

The majority of participants in our study who reported homelessness stayed in shelters in the last 90 days, compared to sleeping unsheltered on the street. This distribution likely differs in regions with a more temperate or Mediterranean climate than Boston, where the majority of individuals experiencing homelessness are sheltered, compared to sleeping on the street. We would assume that cities with a greater proportion of sheltered vs. unsheltered homeless persons might have higher prevalence of MRSA nasal colonization and hence skin infection among PWID; this is an intriguing area for future work.

Elevated housing instability, even among homeless persons, was associated with increased odds of MRSA nasal colonization in this study. This result concurs with that from a prior study in Boston of homeless persons [12]. The biological mechanism associating housing instability with MRSA nasal colonization (vs. MRSA exposure through person-to-person contact or environmental contamination at a homeless shelter, for example) remains unclear. Larger studies are needed to evaluate the biological or social underpinnings of this finding. However, we observe here that homelessness itself may not be the only MRSA risk factor associated with housing instability worthy of attention.

Personal hygiene behaviors, including hand hygiene, showering frequency, and clothes laundering frequency, were not associated with MRSA nasal colonization in this study. These findings differ from a prior study in Boston which focused specifically among homeless persons, as well as on a study of hygiene and MRSA colonization among incarcerated persons [12, 19]. It is possible that our findings are due to selection bias and/or study participant bias. SKIN study participants may be more attuned to hygiene than others, possibly because of the content of the research itself or because individuals with concern for personal health are more likely to join a research study. It is also possible that SKIN participants spent more time in hospital settings than other PWID, since recent hospitalization is an eligibility criterion for joining the study, and have greater access to hygiene facilities because of hospital stays. However, our results indicate that exposure to MRSA contaminated environments may play a more significant role in MRSA exposure than personal hygiene behaviors. These hypotheses are worthy of investigation in a larger study.

Limitations of this study include small sample size, which precluded our ability to conduct adjusted analyses. Because of the small sample, we were unable to consider confounding or effect modification in meaningful ways, or fully consider correlation between exposure variables. While our study is strengthened by longitudinal sampling, which is uncommon and valuable in MRSA colonization studies, the total number of participants remained too small to analyze the likely complex, and interrelated, relationships of our exposure variables. As a result, our findings highlight suggestive, but not definitive, associations. A limitation of our outcome assessment was sampling for MRSA colonization from a single body site, instead of from multiple sites. We opted to evaluate nasal colonization because nares sampling is non-invasive and more acceptable in our population. It is possible that participants who opted to join the study (72% of those approached) differed from those who did not in regard to hygiene or MRSA carriage, but we have no evidence to suggest that this is the case. We additionally note that self-reported behaviors may be unreliable, notably around personal hygiene topics, as is demonstrated in other studies [47–49]. A study design that asked participants to record behaviors throughout the day, rather than through recall, may improve accuracy of these reports, as may direct observation; however, the limitations of the accuracy of self-reports remain an important caveat to our findings. Despite these limitations, our study contributes to the understanding of the role of personal hygiene, homelessness, and housing instability in MRSA nasal colonization, a research area in which limited prior information exists.

Conclusions

Use of public facilities to support persons experiencing homelessness, including homeless shelters and public showers, is associated with increased odds of MRSA nasal colonization for PWID. These findings may be due to environmental contamination with MRSA at these facilities, close person-to-person contact, or both. Personal hygiene behaviors appear less important in predicting MRSA colonization. Our findings indicate that environmental contamination of public facilities may pose MRSA exposure risks for PWID, a vulnerable, high-risk, and hard to study population.

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Compliance with Ethical Standards

Ethics Approval All participants provided informed consent. All protocols involved in this study were approved by the Boston University Medical Center IRB (study ID: H-32577).

References

1. David MZ, Daum RS. Community-associated methicillin-resistant Staphylococcus aureus: epidemiology and clinical consequences of an emerging epidemic. *Clin Microbiol Rev*. 2010;23(3):616–87. https://doi.org/10.1128/CMR.00081-09.
2. Klein EY, Sun L, Smith DL, Laxminarayan R. The changing epidemiology of methicillin-resistant Staphylococcus aureus in the United States: a national observational study. *Am J Epidemiol*. 2013;177(7):666–74. https://doi.org/10.1093/aje/kws273.
3. Deurenberg RH, Stobberingh EE. The molecular evolution of hospital- and community-associated methicillin-resistant Staphylococcus aureus. *Curr Mol Med*. 2009;9(2):100–15.
4. Deurenberg RH, Stobberingh EE. The evolution of Staphylococcus aureus. *Infect Genet Evol J Mol Epidemiol Evol Genet Infect Dis*. 2008;8(6):747–63. https://doi.org/10.1016/j.meegid.2008.07.007.
5. Gould IM. Antibiotics, skin and soft tissue infection and meticillin-resistant Staphylococcus aureus: cause and effect. *Int J Antimicrob Agents*. 2009;34(Suppl 1):S8–11. https://doi.org/10.1016/S0924-8579(09)70542-4.
6. Ebright JR, Pieper B. Skin and soft tissue infections in injection drug users. *Infect Dis Clin N Am*. 2002;16(3):697–712.
7. Wagner R, Agusto FB. Transmission dynamics for Methicilin-resistant Staphalococous areus with injection drug user. *BMC Infect Dis*. 2018;18(1):69. https://doi.org/10.1186/s12879-018-2973-4.
8. Bassetti S, Battegay M. Staphylococcus aureus infections in injection drug users: risk factors and prevention strategies. *Infection*. 2004;32(3):163–9. https://doi.org/10.1007/s15010-004-3106-0.
9. Stringfellow EJ, Kim TW, Gordon AJ, Pollio DE, Grucza RA, Austin EL, et al. Substance use among persons with homeless experience in primary care. *Subst Abus*. 2016;37(4):534–41.
10. Struening EL, Padgett DK. Physical health status, substance use and abuse, and mental disorders among homeless adults. *J Soc Issues*. 1990;46(4):65–81.
11. Spinelli MA, Ponath C, Tieu L, Hurstak EE, Guzman D, Kushel M. Factors associated with substance use in older homeless adults: results from the HOPE HOME study. *Subst Abus*. 2017;38(1):88–94.

12. Leibler JH, León C, Cardoso LJ, et al. Prevalence and risk factors for MRSA nasal colonization among persons experiencing homelessness in Boston, MA. *J Med Microbiol*. 2017;66(8):1183–8.
13. Ottomeyer M, Graham CD, Legg AD, Cooper ES, Law CD, Molani M, et al. Prevalence of nasal colonization by methicillin-resistant Staphylococcus aureus in persons using a homeless shelter in Kansas City. *Front Public Health*. 2016;4:234. https://doi.org/10.3389/fpubh.2016.00234.
14. Landers TF, Harris RE, Wittum TE, Stevenson KB. Colonization with Staphylococcus aureus and methicillin-resistant S. aureus among a sample of homeless individuals, Ohio. *Infect Control Hosp Epidemiol Off J Soc Hosp Epidemiol Am*. 2009;30(8):801–3. https://doi.org/10.1086/599018.
15. Ku BS, Fields JM, Santana A, Wasserman D, Borman L, Scott KC. The urban homeless: super-users of the emergency department. *Popul Health Manag*. May 2014;17:366–71. https://doi.org/10.1089/pop.2013.0118.
16. Kushel MB, Perry S, Bangsberg D, Clark R, Moss AR. Emergency department use among the homeless and marginally housed: results from a community-based study. *Am J Public Health*. 2002;92(5):778–84.
17. Hogea C, van Effelterre T, Acosta CJ. A basic dynamic transmission model of Staphylococcus aureus in the US population. *Epidemiol Infect*. 2014;142(3):468–78. https://doi.org/10.1017/S0950268813001106.
18. Kowalski TJ, Berbari EF, Osmon DR. Epidemiology, treatment, and prevention of community-acquired methicillin-resistant Staphylococcus aureus infections. *Mayo Clin Proc*. 2005;80(9):1201–7; quiz 1208. https://doi.org/10.4065/80.9.1201.
19. Turabelidze G, Lin M, Wolkoff B, Dodson D, Gladbach S, Zhu B-P. Personal hygiene and methicillin-resistant Staphylococcus aureus infection. *Emerg Infect Dis*. 2006;12(3):422–7.
20. Pittet D, Hugonnet S, Harbarth S, Mourouga P, Sauvan V, Touveneau S, et al. Effectiveness of a hospital-wide programme to improve compliance with hand hygiene. *Lancet*. 2000;356(9238):1307–12.
21. Boyce JM. MRSA patients: proven methods to treat colonization and infection. *J Hosp Infect*. 2001;48:S9–S14.
22. Marimuthu K, Pittet D, Harbarth S. The effect of improved hand hygiene on nosocomial MRSA control. *Antimicrob Resist Infect Control*. 2014;3(1):34.
23. Lederer JW Jr, Best D, Hendrix V. A comprehensive hand hygiene approach to reducing MRSA health care–associated infections. *Jt Comm J Qual Patient Saf*. 2009;35(4):180–5.
24. McKay JR. *Treating substance use disorders with adaptive continuing care*. Washington, DC, US: American Psychological Association; 2009. https://doi.org/10.1037/11888-000.
25. Gorwitz RJ, Kruszon-Moran D, McAllister SK, et al. Changes in the prevalence of nasal colonization with Staphylococcus aureus in the United States, 2001-2004. *J Infect Dis*. 2008;197(9):1226–34. https://doi.org/10.1086/533494.
26. Tenover FC, McAllister S, Fosheim G, McDougal LK, Carey RB, Limbago B, et al. Characterization of Staphylococcus aureus isolates from nasal cultures collected from individuals in the United States in 2001 to 2004. *J Clin Microbiol*. 2008;46(9):2837–41.
27. Hidron AI, Kourbatova EV, Halvosa JS, Terrell BJ, McDougal LK, Tenover FC, et al. Risk factors for colonization with methicillin-resistant Staphylococcus aureus (MRSA) in patients admitted to an urban hospital: emergence of community-associated MRSA nasal carriage. *Clin Infect Dis Off Publ Infect Dis Soc Am*. 2005;41(2):159–66. https://doi.org/10.1086/430910.
28. Schechter-Perkins EM, Mitchell PM, Murray KA, Rubin-Smith JE, Weir S, Gupta K. Prevalence and predictors of nasal and extranasal staphylococcal colonization in patients presenting to the emergency department. *Ann Emerg Med*. 2011;57(5):492–9. https://doi.org/10.1016/j.annemergmed.2010.11.024.
29. StataCorp. *Stata Statistical Software: Release 15*. College Station, TX: StataCorp LLC; 2017.
30. Moran GJ, Amii RN, Abrahamian FM, Talan DA. Methicillin-resistant Staphylococcus aureus in community-acquired skin infections. *Emerg Infect Dis*. 2005;11(6):928–30.
31. Gilbert M, Macdonald J, Louie M, et al. Prevalence of USA300 colonization or infection and associated variables during an outbreak of community-associated methicillin-resistant Staphylococcus aureus in a marginalized urban population. *Can J Infect Dis Med Microbiol J Can Mal Infect Microbiol Médicale AMMI Can*. 2007;18(6):357–62.
32. Young DM, Harris HW, Charlebois ED, et al. An epidemic of methicillin-resistant Staphylococcus aureus soft tissue infections among medically underserved patients. *Arch Surg*. 2004;139(9):947–53.
33. Hota B, Ellenbogen C, Hayden MK, Aroutcheva A, Weinstein RA. Community-associated methicillin-resistant Staphylococcus aureus skin and soft tissue infections at a public hospital: do public housing and incarceration amplify transmission? *Arch Intern Med*. 2007;167(10):1026–33.
34. Ahmed OB, Sirag B. Microbial contamination of doorknobs in public toilets during Hajj. *Asian J Sci Technol* 2016;7(10):3676–3679.
35. Kim J-G, Kim A, Kim J-S. Assessment of bioaerosols in public restrooms. *Korean J Environ Health Sci*. 2014;40(4):304–12.
36. Mkrtchyan HV, Russell CA, Wang N, Cutler RR. Could public restrooms be an environment for bacterial resistomes? *PLoS One*. 2013;8(1):e54223.
37. Mkrtchyan HV, Xu Z, Cutler RR. Diversity of SCCmec elements in Staphylococci isolated from public washrooms. *BMC Microbiol*. 2015;15(1):120.
38. Pedersen PV, Grønbæk M, Curtis T. Associations between deprived life circumstances, wellbeing and self-rated health in a socially marginalized population. *Eur J Pub Health*. 2012;22(5):647–52.
39. Baldwin D. The subsistence adaptation of homeless mentally ill women. *Hum Organ*. 1998;57(2):190–9.
40. Hwang SW, Ueng JJ, Chiu S, et al. Universal health insurance and health care access for homeless persons. *Am J Public Health*. 2010;100(8):1454–61.
41. Mitchell D. The end of public space? People's park, definitions of the public, and democracy. *Ann Assoc Am Geogr*. 1995;85(1):108–33.

42. Stolte O, Hodgetts D. Being healthy in unhealthy places: health tactics in a homeless lifeworld. *J Health Psychol*. 2015;20(2):144–53.
43. Kushel M. Hepatitis A outbreak in California—addressing the root cause. *N Engl J Med*. 2018;378(3):211–3.
44. Syed NA, Hearing SD, Shaw IS, Probert CSJ, Brooklyn TN, Caul EO, et al. Outbreak of hepatitis A in the injecting drug user and homeless populations in Bristol: control by a targeted vaccination programme and possible parenteral transmission. *Eur J Gastroenterol Hepatol*. 2003;15(8): 901–6.
45. Tjon GMS, Götz H, Koek AG, de Zwart O, Mertens PLJM, Coutinho RA, et al. An outbreak of hepatitis A among homeless drug users in Rotterdam, The Netherlands. *J Med Virol*. 2005;77(3):360–6.
46. Foster M, Ramachandran S, Myatt K, Donovan D, Bohm S, Fiedler J, et al. Hepatitis A virus outbreaks associated with drug use and homelessness—California, Kentucky, Michigan, and Utah, 2017. *Morb Mortal Wkly Rep*. 2018;67(43):1208–10.
47. Larson EL, Aiello AE, Cimiotti J. Assessing nurses' hand hygiene practices by direct observation or selfreport. *J Nurs Meas* 2004;12(1)
48. Jenner EA, Fletcher BC, Watson P, Jones FA, Miller L, Scott GM. Discrepancy between self-reported and observed hand hygiene behaviour in healthcare professionals. *J Hosp Infect*. 2006;63(4):418–22.
49. Haas JP, Larson EL. Measurement of compliance with hand hygiene. *J Hosp Infect*. 2007;66(1):6–14.