Pattern of infections in French and migrant homeless hospitalised at Marseille infectious disease units, France: A retrospective study, 2017–2018

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Abstract.

Background. No research was conducted on the clinical characteristics and outcomes of Infectious Disease Units (IDU) managed homeless patients (HP).

Methods. We conducted retrospectively a survey among 98 HP and 98 non-HP admitted between 2017-2018 in several IDUs in Marseille, France.

Results. HP were more likely to be migrant, to report frequent alcohol consumption or illicit drug use, and to present with respiratory symptoms at admission compared to controls. The most common final diagnoses in HP were respiratory tract infections (other than pulmonary tuberculosis [PTB], 35.7%), sexually transmitted infections (20.4%), cutaneous and mucosal infections (19.4%) and tuberculosis (12.2%). Sexually transmitted infections and ectoparasite infestations were significantly more frequent in HP compared to controls. One HP died from pleural effusion as a complication of PTB. The surviving HP had a longer length of stay (LOS, average 11.6±13.6 days, $p<0.0001$) than controls; independent factors of increased LOS were tobacco use ($p=0.009$), tuberculosis infection ($p<0.0001$), urinary tract infection ($p=0.018$) and bacteraemia ($p=0.018$). After hospital discharge, attendance at subsequent planned consultations was significantly lower in HP (0.72±1.25 times/persons) compared to controls (2.03±2.2).

Conclusions. We suggest that HP present specific demographic characteristics and patterns of infectious diseases compared to other patients and require adapted management.

Keywords: homeless, Migrants, Infectious Disease Units, tuberculosis, sexually transmitted infections, illicit drug use

Introduction

People experiencing homelessness face numerous obstacles to accessing appropriate healthcare and frequently present at hospital with advanced disease conditions and potentially life-threatening illness [1]. Given their lack of a secure, stable place to live, deficiencies in the quality of care and disproportionate exposure to substance and frequent alcohol consumption, homeless people may exhibit increased rates of prior acute health service use, including emergency department, hospital admissions [2,3] unplanned readmissions [4], prolonged hospital lengths of stay (LOS) and more costly care than those who are domiciled [5-8].

With regard to intensive care unit (ICU) admission, the demand for critical care services was higher among the homeless population compared to controls [9]. Three recent studies from Korea (2012–2017), France (2000–2012) and Canada (2009–2011) showed higher severity of illness, resource use, and hospital mortality of ICU-managed homeless patients compared to non-homeless people [5, 7, 10]. A high rate of infectious diseases among homeless adults has been observed in many epidemiological studies [11, 12] and has been identified as a leading cause of increased morbidity and mortality in this community. Among hospitalised homeless people, the description of infectious disease in previous studies has primarily focused on emergency department visits [6,13]. In the literature, there is no research on the clinical characteristics and outcomes of IDU-managed homeless patients.

Therefore, we aimed to characterize illnesses in homeless in-patients at IDUs in Marseille, France, in comparison with matched non-homeless groups as a control. We also assessed the factors having an impact on the hospital LOS.

Methods

Homeless population

Study location and patients

This was a historically retrospective study. Ethical approvals were obtained from the Marseille Institutional Review Board and Ethics Committee (Protocol: 2010-A01406-33). Use of this data is governed by Axigate access at the Assistance Publique–Hôpitaux de Marseille (APHM). The study investigated the causes, experiences, and outcomes of homeless patients hospitalised in four IDUs in one Marseille hospital (APHM), the Infectious and Tropical Diseases unit (ITD), the Chronic Diseases and Osteoarticular Infections unit (CDOI), the Acute Infectious Diseases unit (AID) where patients may stay for <72 hours after hospitalisation, and the Post-Emergency unit (PE), between 1 January 2017 and 31 December 2018. We enrolled all adults (≥ 16 years of age) who gave no address on admission and were thus labelled as homeless as described [14] and who had an infectious disease diagnosis. Patients hospitalised only for follow-up were excluded.

Study parameters and classification of infection

We extracted from our database the following variables: socio-demographics, addictions, physical and chronic conditions, medical histories and diagnosis. A Simplified Acute Physiology Score II (SAPS) II was calculated within the first 24 hours, as recommended [15], and the length of IDU stay was recorded. Infectious disease status was confirmed through a written diagnosis from the physicians wherever possible. We excluded non-infectious diagnoses from our analytical data set. The International Classification of Diseases (ICD-10-CM, version 2019) was applied for the presence and classification of infectious disease diagnoses documented by physicians during the observation period.

Control group

Each homeless patient was randomly matched to a non-homeless patient based on the following criteria: gender, age at first admission, first admission date between 2017 and 2018 and the IDU to which the patient was admitted. Age and gender were our primary matching criteria since these are most commonly used by clinicians during the initial assessment. In the case of multiple

matches within the same calendar year, those with the closest first admission date were chosen; when no match was found, the age range was broadened progressively by ±1 year. We added the year of admission to minimise the effects of temporal trends in outcomes over the course of the study, as well as the type of IDU, because diagnoses and outcomes differ substantially between the IDUs in our hospital.

Case definition

The case definition for confirmed pulmonary tuberculosis (PTB) was (i) the presence of acid-fast bacilli in the sputum, identified by real-time PCR as *Mycobacterium tuberculosis* complex (MTC) organisms and (ii) MTC organisms from at least one respiratory tract specimen.

Statistical analysis

Statistical analyses were performed using STATA (version 11.1). Descriptive statistics (frequency and percentages for categorical variables; mean and standard deviation for continuous variables) were used to characterise the study population. Statistical differences in baseline characteristics were evaluated using the Pearson's chi-square or Fisher's exact tests as categorical variables. The means of the quantitative data were compared using the Student's t-test. A two-tailed p-value of <0.05 was considered as statistically significant. Two regression models were developed. Only variables with a prevalence of $\geq 5.0\%$ were considered for statistical analysis. Variables with p-values of <0.2 from the univariate analysis were included in the multivariable regression, which was then created by stepwise regression. Analysis of multicollinearity among the independent variables was performed using the ϕ coefficient to test for correlation among binary variables; and for pairs of variables that were highly correlated (absolute value of correlation coefficient >0.7), only one variable was entered into the multivariate model.

The first model (a logistic regression model) was generated to compare the distribution of potential risk factors among homeless and control groups; univariate analysis was used to examine unadjusted distributions of multiple factors (socio-demographic factors, physical and mental health status, chronic medical condition, and medical histories), symptoms or physical finding between homeless and control groups. The second model (multiple linear regressions) was applied to identify factors associated with the LOS of each admission (continuous variable). We recorded potential risk factors (socio-demographic factors, chronic medical conditions, and medical histories) and diagnosis.

Results

General characteristics of homeless patients and controls

During the two-year study period, we enrolled 98 homeless patients including 12 women (12.4%) and 86 men (87.6%) with a mean age (± SD) of 43.3 (± 16.8) years old (range, 16–89 years) (Table 1 and Table 2). Of those, 30% were French, while the rest (70%) were migrants born in North Africa (18.9%), sub-Saharan Africa (23.3%), other European countries (22.2%), and Asia (5.6%). Eleven migrant subjects (11.8%, 10 from sub-Saharan Africa, 1 from North Africa) were found to have a complex migration route with transit through different countries (including Algeria and Morocco [n=1], Spain [n=1], Greece [n=1], Libya [n=3], The Netherlands [n=1], Germany [n=2] and Italia [n=5]), before arrival to France. Three quarters of migrant had lived in France for less than one year before their first hospitalisation. About 83% of patients were housed in shelters or hostels while the rest (17%) had been living on the street or in their cars. One-third of this group reported frequent alcohol consumption. About 58% of patients reported smoking tobacco, with a mean 33.2±15.1 (± SD) pack-years of smoking. Among tobacco smokers, 11.4% also reported smoking cannabis. Fifteen subjects (18.5%) reported a history of drug use, including snorted drug use in nine cases (11.1%). About 18% reported a history of pulmonary tuberculosis and 14% reported suffering from hepatitis before the date of

first admission. Twenty-nine percent had no health insurance and 34.3% reported language barriers. Thirteen percent were admitted to hospital by ambulance at least once over the two years. At first admission, half of these patients were admitted to the ITD, followed by the PE (23.4%), the AIT (16.3%) and the CDOI (11.2%).

Overall, there were 121 acute admissions that accounted for 1.6% of all acute admissions in the four units during the observation period. Eighty-one (66.9%) occurred in 2018 and 40 (33.1%) in 2017. Eighty-five patients (86.7%) had a single admission and 13 individuals (13.3%) had multiple admissions for different infectious disease diagnoses. Missing data (including notably socio-demographic factors, history of homelessness, symptoms) occurred in 32 people who experienced language barriers. Within the first 24 hours of admission, the mean SAPS II (±SD, min-max) score was 15.5 (±8.8, 6-62). Sixty-one percent of subjects reported at least one respiratory symptom or sign at admission with 45.9% having a cough. About 38.8% were febrile and 22.4% presented with chills. About 15.3% had skin lesions. History of diseases, other symptoms and clinical finding of homeless population are summarised in Tables 1 and 2.

The 98 homeless patients were successfully matched to 98 non-homeless control patients with the same proportion of gender, age (exact match; except for eight patients who were different ±1 year), with the same period of first hospital admission (±1 month) and similar admitting IDU (p=0.8) (Table 2). We found that the numbers of acute admission per patient were similar in the two groups. Through multivariate analysis, homeless people were identified as being 22 times more likely to be migrants, 19 times more likely to report illicit drug use and three times more likely to report frequent alcohol consumption. Finally, homeless people were twice as likely to present with respiratory symptoms at admission (Table 3).

Final diagnoses (Table 4 and Supplementary Table 1)

Respiratory tract infections (other than tuberculosis) were the most common diagnosis affecting 35.7% of homeless patients (35 of 98) at least once over the two-year observation period,

including community-acquired pneumonia (16.3%), followed by acute exacerbation of chronic obstructive pulmonary disease (COPD) (10.2%) and influenza-like illness (ILI). Other infections included sexually transmitted infections (20.4%), cutaneous and mucosal infections (19.4%), confirmed tuberculosis infection (12.2%), particularly PTB (10.2%), urinary tract infections (11.2%), bacteraemia (10.2%), orthopaedic infections (6%), ectoparasite infestations (6.1%), gastro-intestinal infections (6.1%), *Plasmodium falciparum* malaria (2.1%), systemic bartonellosis (1%) and uncomplicated varicella (1%). Overall, 83 patients (84.7%) had only one diagnosis while the remaining 15 patients (15.3%) presented with more than two diseases during the two-year study period. One homeless patient died due to pleural effusion as a complication of PTB. The overall prevalence of sexually transmitted infections and the prevalence of ectoparasite infestations were significantly higher in homeless patients than in controls while orthopaedic infections were less frequent. Infection with tuberculosis was diagnosed twice as often in homeless patients, but the difference was not statistically significant; details of each disease with the ICD-10 CM code are shown in Table 4.

Microbiological investigations performed on homeless patients revealed that, compared to controls, they were more likely to be tested for TB (80 people tested out of 98 compared to 54/98, $p<10^{-4}$), tested for respiratory viruses (72 respiratory specimens out of 98 compared to 37/98, $p<10^{-4}$), and tested for sexually transmitted infections (92 serum out of 98 compared to 70/98 $p<10^{-4}$). Overall, the positivity rates in tested samples were similar in the two groups (Supplementary Table 1)

Factors associated with LOS among surviving homeless people (n=97) (Table 5)

The median LOS (± SD) for each admission among the 97 surviving homeless people was 11.6 (±13.6) days and was significantly higher than in controls [5.8 (± 6.7), $p<10^{-4}$]. The longest hospital stay (62 days) was for one homeless patient with PTB and an *Escherichia coli* urinary and blood infection. The mean accumulated LOS over the two years for homeless was 19.8

(±21.0), which was significantly higher than in controls [7.4 (± 8.0), $p<10^{-4}$]. Using multivariate analysis, the duration of the LOS according to each IDU admission of homeless patients was significantly higher among those who reported smoking tobacco and those with a diagnosis of PTB, urinary tract infections or bacteraemia, compared to the others.

The mean duration of the LOS among homeless patients admitted with a diagnosis of tuberculosis infection, urinary tract infection or bacteraemia (n=31 admissions, 21.0±19.6 days) was significantly higher than that of controls with similar diagnoses (21 admissions, 8.9±11.6 days), p=0.008.

Treatment and outcome

Similar proportions of homeless and non-homeless patients were treated with medical treatment or surgical procedures. Homeless people were significantly more likely to receive ventilation assistance. After hospital discharge, attendance at subsequent planned consultations was significantly lower in the homeless group compared to controls. Loss of follow-up treatment occurred only in the homeless group (Table 6).

Homeless pulmonary tuberculosis diagnosis and surveillance

The screening strategy for active pulmonary tuberculosis detection based on TB symptoms or risk factors [16] was applied to 80% of homeless patients during the study period. We identified a sub-population of 78 homeless patients with clinically suspected PTB (a cough for at least 3 weeks and/or haemoptysis, fever, night sweats, weight loss, or chest x-ray abnormalities) or who were at high risk (migrants, history of TB or history of contact with TB patients, HIV infection). Ten positive cases were confirmed (of 98, 10.2%) and received TB treatment, including two rifampicin resistant cases detected by PCR. Of those, nine (of nine who were documented, 100%) were migrants being born in Algeria (three cases, 33.5%, and one of whom transited in Greece and in the Netherlands), in Mauritania (one case, 11.1%, who transited in Libya, Italia,

and Germany), in Romania (two cases, 22.2%), in Pakistan (two cases, 33.3%), and in Armenia (one case, 11.1%). Four (of eight who were documented, 50%) had been residing in France for less than three months before their first hospitalisation.

Of these 10 patients, four (40%) were successfully treated, three (30%) were still under treatment at the time of concluding this survey, one died with acute respiratory failure due to complications from pleural effusion and two were lost to follow-up. Of 68 patients who were negative for TB, we conducted follow-up for at least three months in 13 cases which presented with a cough lasting ≥3 weeks, abnormal CRX or CCT, or infection with HIV. Of those, six (44.1%) were attended follow-up medical consultations and seven (55.9%) were lost to follow-up.

Discussion

In our study, homeless people suffering from infectious diseases presented several risk factors for infections, including poor living conditions, migrant status, history of addiction to licit and illicit drugs, lack of health insurance coverage, and language barriers. These characteristics of homeless patients align with those previously reported in the literature in other clinical settings [7, 10, 17, 18].

The prevalence of respiratory diseases and PTB, blood-borne and sexually transmitted infections, and skin infections still remains at high levels among homeless people [11, 12, 19, 20] and varies according to living conditions. Respiratory infections, including PTB transmission, may be higher among homeless people residing in shelters due to living in rooms with other people. PTB has been reported to be frequent in the homeless population and has been extensively studied [21, 22]. In low TB burden countries, concentrated epidemic tends to occur among hard-to-reach groups such as migrants (who come from high TB burden countries or have disruptions in treatment during migration and on arrival in host countries) and homeless people [16]. Systematic screening is recommended for such populations to ensure that active TB is detected

early to help reduce TB transmission within shelters [16, 23]. Blood-borne and sexually transmitted infections among homeless people have been showed to be associated with illicit drug use and risky sexual behaviour, as well as housing in single-room hotels or with living with friends [11]. Hepatitis B and C virus infection and respiratory diseases have been reported to be the conditions most frequently associated with deaths among homeless individuals [24, 25]. Secondary bacterial infections of pre-existing skin lesions may be encouraged by sleeping on the street or outdoors due to exposure to unhygienic environments and ectoparasite infestations, and arthropod-borne infections may be encouraged by exposure to animals (dogs, cats, raccoons, birds, and bats) which carry arthropods, and to human body lice [12, 26]. In line with these results, the reasons for admission among homeless population in our study was disproportionately driven by respiratory infections (44.9%), including 10 cases of PTB and blood-borne and sexually transmitted infections (20.4%), with high rates of hepatitis C virus infection, HIV infection, and skin and mucosal infections (19.4%). Homeless in-patients were also significantly more likely to suffer respiratory symptoms and clinical signs, in line with previous studies conducted on homeless people living in shelters in Marseille, where a prevalence of 35–50% of respiratory symptoms was observed [11, 20]. In our survey, we identified few cases of ectoparasite infestations (6.1%) and only one case of *Bartonella* infection in line with a decreasing trend of body louse infestations in homeless people living in shelters in Marseille that has been observed over time [27]. Importantly, we showed that homeless people had significantly longer hospital LOS for each stay compared to controls. Homeless patients admitted with TB infections, urinary tract infections and bacteraemia had a longer hospital LOS than both those with other infections, and those in the control group with similar infections. Nathanson and colleagues showed that sepsis could prolong the hospital LOS in homeless populations compared to non-homeless patients [6].

We noticed that homeless patients benefited from the same level of healthcare during hospitalisation when compared to controls. In particular, they did not undergo fewer diagnostic tests and did not receive less treatment. However, a lower adherence to follow-up consultations with a higher rate of “lost- to follow-up” for severe diseases (including PTB and HIV infections) was observed in the homeless population. These findings emphasise the need for health services and management systems for chronic diseases and regular clinical follow-ups for these patients, in order to effectively prevent unplanned medical admissions and lower the costs of healthcare for the homeless population. In 1992, the CDC recommended the establishment of special treatment–housing centres to provide continuous shelter, food, and treatment for homeless TB patients for the duration of their treatment [28], which could lower the loss of follow-up within such a highly mobile population.

The present study suggests that appropriate preventable measures should be implemented to protect homeless people from numerous communicable and non-communicable diseases. Access to primary care such as vaccination centres remains an important component to reducing vaccine-preventable diseases including measles-mumps-rubella, diphtheria-pertussis-tetanus and poliomyelitis, varicella and hepatitis B (notably in migrant populations from high-burden countries) [29]. In addition and based on our results, we recommended vaccination against influenza, invasive pneumococcal disease and *Hemophilus influenzae* type b and control parallelly chronic respiratory diseases and provide education to get rid of smoking in sheltered homeless people. To prevent blood or sexually transmitted diseases, distribution of free condoms, provision of oral substitutive opioid treatments and psychological follow-up, and implementation of needle-syringe distribution programs should be implemented in sheltered homeless population. Improvement of personal, clothing, and room hygiene is a major measure to prevent from skin infections and body-lice infestation. Screening for latent and active TB and parasitological infections in newly arrived migrants is also advisable [30, 31]. Additionally, we

also suggest using diagnostic set kits for most frequent infectious diseases among homeless people at hospital admission, including respiratory virus multiplex PCR testing and serological testing against sexually transmitted diseases.

Several adapted management have been literately or could be tried to better care for homeless people [32]. The patient-centred case-management interventions may improve knowledge and self-efficacy in the context of infectious diseases that require long-term care or treatment (such as HIV, HCV and TB infection) [33]. Support housing and intensive case management (ICM) could improve adherence to antiretroviral therapy and biological outcomes among HIV-infected homeless at hospital discharge [34, 35] ICM had been also shown to have a significant benefit in reducing illicit substance use and frequent alcohol consumption [32].

Certain limitations should be noted in our study. Homeless status was determined from an administrative database that could not provide information on the duration of homelessness. The difficulty of communication due to the language barrier among migrants may bias the presence of symptoms. To some extent, the LOS may vary based on provider practice patterns rather than the severity of the condition.

In summary, the present study shows that homeless people present several risk factors for infections due to poor living conditions, migrant status, history of addiction, lack of health insurance coverage and language barriers. Compared to other patients, they present more frequently with respiratory, sexually transmitted and skin infections, including ectoparasite infestations. Hospital LOS is longer in homeless people, notably when suffering from tuberculosis infections, urinary tract infections or bacteraemia, and their adherence to follow-up consultations is lower. Therefore, homeless patients present specific demographic characteristics and patterns of infectious diseases compared to other patients and require adapted management. With 10% of PTB being recorded in hospitalised homeless patients, this population is likely to be an important focus of contagious TB and active screening with early isolation and treatment

should be initiated with efficient directly observed therapy and follow-up in order to avoid the transmission of drug susceptible and resistant TB in a developed country [36]. Shortening TB treatment by using efficient, cheap and oral drugs with few adverse events should be advocated to improve compliance with medication and survival.

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Potential conflicts of interest

No reported conflicts of interest.

Author Contributions Statement

TD and PG contributed to experimental design, data analysis, statistics, interpretation and writing. VT, TL, DB, PB, JC, PP contributed to critically reviewing the manuscript. PG coordinated the work.

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Table 1. Patient characteristics.

Characteristics	Homeless (n=98 participants)	Non-homeless (n=98 participants)	Univariate analysis OR (95% CI)	p-value
Gender			NA	1.00
Male	86 (87.6)	86 (87.6)		
Female	12 (12.4)	12 (12.4)		
Age[a] (years), mean±SD, range	43.3±16.8 (16-89)	43.6±17.1 (16-88)	NA	0.92
Birthplace, n (%)				
France	27 (30)	79 (83.2)	Ref	
Migrants	63 (70)	16 (16.8)	11.52 (5.7-23.23)	$<10^{-4}$
North Africa	17 (18.9)	9 (9.4)		
Sub-Saharan Africa	21 (23.3)	2 (2.1)		
Europe	20 (22.2)	3 (3.1)		
Asia	5 (5.6)	2 (2.1)		
Unknown	8 (-)	3 (-)		
Mean duration of residence in France for migrants (±SD, min-max) (years)	1.1±1.5, (0-5)	NA	NA	NA
Range of duration of residence in France for migrants (years)				
≤ 1 year	30 (73.2)			
≥ 1 years	8 (19.5)			
≥ 5 years	3 (7.3)			
Not documented	22 (-)			
Status of homelessness, n (%)		NA	NA	NA
sheltered homeless	69 (83.1)			
unsheltered homeless living in the street	12 (14.4)			
unsheltered homeless living in their cars	2 (2.4)			
Not documented	15 (-)			
Alcohol consumption, n (%)				
Rare or never	60 (65.9)	82 (83.7)	Ref	
Frequent	31.6 (34.1)	16 (16.3)	2.64 (1.33-5.26)	$<5.10^{-3}$
Not documented	7 (-)	0 (-)		
Smoking tobacco, n (%)	51 (58.0)	37 (37.8)	2.27 (1.26-4.46)	$<6.10^{-3}$
Mean number of pack-years for smokers (SD, min-max) (pack-years)	33.2±15.1, (10-80)	18.9±10.8, (2-40)	NA	$<10^{-4}$
Not documented	10 (-)	0 (-)		
Cannabis consummation, n (%)	10 (11.4)	7 (7.1)	1.66 (0.6-4.58)	0.32
Illicit drug and opioid agonist treatment use, n (%)	15 (18.5)	4 (4.1)	5.35 (1.69-16.9)	$<10^{-4}$
Snorting illicit substances	9 (11.1)	3 (3.1)	NA	
Injecting illicit substances	8 (9.9)	4 (4.1)	NA	
Using opioid agonist treatment	5 (6.2)	0	NA	
Not documented	17 (-)	0 (-)		
Chronic conditions and medical histories[b], n (%)				
Previous PTB	15 (18.3)	8 (8.2)	2.51 (1.01-6.28)	0.043

Acute hepatitis	12 (14.6)	4 (4.1)	4.03 (1.24-12.9)	0.02
Asthma	8 (9.8)	2 (2.0)	5.8 (1.06-25)	0.045
COPD	7 (8.5)	6 (6.1)	1.43 (0.45-4.44)	0.53
HIV infection	7 (8.4)	3 (3.1)	2.95 (0.74-11.8)	0.19
Pneumopathy	6 (7.2)	4 (4.1)	1.88 (0.50-6.80)	0.51
Diabetes mellitus	5 (6.0)	4 (4.1)	1.50 (0.39-5.8)	0.55
TB in family member(s)	5 (6.0)	0	NA	$<10^{-4}$
Depressive disorder	4 (4.8)	5 (5.1)	1.2 (0.29-4.97)	0.79
Schizophrenia	4 (4.8)	5 (5.1)	1.2 (0.29-4.97)	0.79
Cancer	2 (2.4)	5 (5.1)	0.47 (0.08-2.42)	0.36

Abbreviations: SD, standard deviation; BMI, Body mass index; NA, not applicable; Ref, Reference category. COPD, Chronic Obstructive Pulmonary Disease; TB, tuberculosis; HIV, human immunodeficiency virus.

a Age was calculated at the first admission

b Before the first admission

Table 2. Infectious disease unit admission data.

Characteristics	Homeless (n=98 participants)	Non-homeless (n=98 participants)	Univariate analysis OR (95% CI)	p-value
Admission by ambulance	13/98 (13.3)	5/98 (5.1)	2.8 (0.97-8.31)	0.048
No health assurance at first admission	30/98 (30.6)	3/98 (3.1)	13.9 (4.10-47.6)	$<10^{-4}$
IDU (the first admission), n (%)			NA	0.78
ITD	48 (49.0)	46 (47.0)		
PE	23 (23.4)	22 (22.4)		
AIT	16 (16.3)	18 (18.3)		
CDOI	11 (11.2)	12 (12.3)		
Number of acute admissions in study period, (total) n	121	126	NA	
Mean±SD, min-max	1.23±0.98 (1-10)	1.26±0.64 (1-4)	NA	0.66
Year of study			NA	0.62
2017	40/121 (33.1)	38/126 (30.2)		
2018	81/121 (66.9)	88/126 (69.8)		
Distribution			NA	0.27
1 admission	85 (86.7)	79 (80.6)		
2 admissions	10 (10.2)	11 (11.2)		
3 admissions	2 (2.0)	7 (7.1)		
≥4 admissions	1 (1.0)	1 (1.0)		
Language barrier[a], n (%)	34 (34.7)	3 (3.1)	16.8 (4.95-57.1)	$<10^{-4}$
SAPS II, mean±SD, min-max	15.5±8.8 (6-52)	14.1±8.9 (6-44)	NA	0.22
Symptoms at admission during study periods				
At least one respiratory symptom	60 (61.2)	39 (39.8)	2.38 (1.34-4.23)	0.003
Cough	45(45.9)	31(31.6)	NA	
Expectoration	32 (32.7)	20 (20.4)	NA	
Chest pain	24 (24.5)	15 (15.3)	NA	
Pulmonary rales	20 (20.4)	15 (15.3)	NA	
Dyspnoea	14 (19.4)	12 (12.2)	NA	
Rhinorrhoea	14 (14.3)	9 (9.2)	NA	
Haemoptysis	3 (3.1)	1 (1.0)	NA	
Acute respiratory failure	4 (4.1)	1 (1.0)	NA	
Fever (measured or subjective)	43 (43.9)	52 (53.1)	0.69 (0.38-7.49)	0.19
Chills	22 (22.4)	14 (14.3)	1.91 (0.91-4.02)	0.09
Night sweats	19 (20.0)	13 (13.1)	1.58 (0.72-3.39)	0.25
Skin lesions	18 (18.4)	22 (22.9)	0.75 (0.37-1.52)	0.43
Diarrhoea	15 (15.3)	20 (20.4)	0.70 (0.33-1.47)	0.35
Pruritus	15 (15.3)	18 (18.4)	0.80 (0.37-1.7)	0.56
Abdominal pain	8 (8.2)	8 (8.2)	1.00(0.35-2.78)	1.00
Vomiting or nausea	7 (7.6)	3 (3.1)	2.43 (0.61-9.71)	0.33
Loss of consciousness	4 4.1)	2 (2.0)	1.82 (0.32-10.2)	0.68
Headache	4(4.1)	7 (7.1)	0.55 (0.15-1.95)	0.73
Back pain	2 (2.0)	5 (5.1)	0.38 (0.07-2.04)	0.44

Abbreviation: OR, odd-ratio; CI, confidence interval; ITD, Infectious and tropical diseases; CDOI, Chronic diseases and osteoarticular infections; AID, Acute infectious diseases; PE, Post-emergency; SD, standard deviation; SAPS II, Simplified Acute Physiology Score (SAPS) II; NA, not applicable; Ref, Reference category

[a] difficulties communicating with medical staff or loss of consciousness

Table 3. Multivariate logistical analysis of distribution of demographics, chronic medical conditions and clinical findings between the two groups (homeless people versus controls).

Characteristics	Multivariate analysis OR (95% CI)
Origin (Migrant vs French)	22.0 (8.85-54.7), $p<10^{-4}$
Smoking tobacco (Yes vs No)	-
Alcohol consumption (Frequent vs rare/never)	3.21 (1.21-8.51), p=0.019
Illicit drug and opioid agonist treatment use (Yes vs no)	18.6 (4.75-72.8), $p<10^{-4}$
Previous PTB diagnosis (Yes vs no)	-
History of hepatitis (Yes vs no)	-
History of asthma (Yes vs no)	-
History of HIV infection (Yes vs no)	-
Admission by ambulance (Yes vs no)	-
Health assurance at first admission (No vs Yes)	-
Language barrier (Yes vs No)	-
At least one respiratory symptom (Yes vs No)	2.39 (1.04-5.49), p=0.04
Fever (measured or subjective)	-
Chills	-

Abbreviation: OR, odds-ratio; CI, confidence interval; vs, versus, TB, tuberculosis; HIV, human immunodeficiency virus.

Table 4. Final diagnoses and hospital length of stay (LOS) for survivors.

Characteristics	Homeless (n=98 participants)	Non-homeless (n=98 participants)	p-value	ICD-10-CM Codes
Final diagnosis[a]				
Respiratory tract infections (other than PTB)	**35/98 (35.7)**	**30/98 (30.6)**	**0.44**	
Community-Acquired Pneumonia	16/98 (16.3)	17/98 (17.3)	0.98	J18
Haemophilus influenzae + *Streptococcus pneumoniae*	1/98 (1.0)	0/98 (0)		
Klebsiella pneumoniae	1/98 (1.0)	0/98 (0)		
Staphylococcus aureus	1/98 (1.0)	0/98 (0)		
Rhinovirus	2/98 (2.0)	2/98 (2.0)		
Influenza A	0/98 (0)	2/98 (2.0)		
Respiratory syncytial virus	2/98 (2.0)	0/98 (0)		
Aspergillus fumigatus	1/98 (1.0)	1/98 (1.0)		
Pneumocystis jiroveci	0/98 (0)	2/98 (2.0)		
Non-documented	8	10		
Acute exacerbation of COPD, n (patients)	10/98 (10.2)	6/98 (6.1)	0.12	J44.1
Number of admissions, n	21	7		
Mean±SD (times/COPD person), min-max	2.1±2.7, 1-10	1.1±0.4, 1-4	0.42	
Haemophilus influenzae	2/98 (2.0)	1/98 (1.0)		
S. pneumoniae	1/98 (1.0)	2/98 (2.0)		
Rhinovirus	1/98 (1.0)	0/98 (0)		
Influenza A virus	1/98 (1.0)	1/98 (1.0)		
Respiratory syncytial virus	0/98 (0)	2/98 (2.0)		
Non-documented	5	2		
Influenza-Like Illness	10/98 (10.2)	9/98 (9.2)	0.98	J11.1
Confirmed influenza	4/98 (5.1)	4/98 (5.1)		
Influenza A virus	2/98 (2.0)	3/98 (3.1)		
Influenza B virus	1/98 (1.0)	2/98 (2.0)		
Rhinovirus	2/98 (2.0)	0/98 (0)		
Non-documented	6	5		
Acute upper respiratory infection	8/98 (8.1)	5/98 (5.1)		J06.9
Rhinovirus	4/98 (4.1)	1/98 (1.0)		
Respiratory syncytial virus	2/98 (2.0)	0/98 (0)		
S. pneumoniae	0/98 (0)	2/98 (2.0)		
Non-documented	1	2		

Acute exacerbation of chronic bronchitis	3/98 (3.1)	2/98 (2.0)		J20.9
Pseudomonas aeruginosa	1/98 (1.0)	1/98 (1.0)		
Non-documented	2	1		
Abscess of lung without pneumonia	0/98 (0)	1/98 (1.0)	NA	J85.2
Streptococcus constellatus	0/98 (0)	1/98 (1.0)		
Sexually transmitted infections	**20/98 (20.4)**	**11/98 (11.2)**	**8.10^{-3}**	
Acute or chronic hepatitis C	12/98 (12.2)	3/98 (3.1)		B17, B18
HIV disease	8/98 (8.2)	6/98 (6.1)		B20-B24
Primo-infection	2/98 (2.0)	1/98 (1.0)		
HIV complications	6/98 (6.1)	5/98 (5.1)		
Acute or chronic hepatitis B	2/98 (2.0)	1/98 (1.0)		B16,B18
Latent syphilis	2/98 (2.0)	1/98 (1.0)		A53
Skin, cutaneous and mucosal infections	**19/98 (19.4)**	**24/98 (24.5)**	**0.25**	
Cutaneous abscess	13/98 (3.1)	17/98 (7.1)		L02
methicillin-sensitive Staphylococcus aureus	1/98 (1.0)	2/98 (2.0)		
Enterobacter cancerogenus	0/98 (0)	1/98 (1.0)		
Staphylococcus epidermidis	0/98 (0)	1/98 (1.0)		
Enterobacter cloacae	0/98 (0)	1/98 (1.0)		
Streptococcus pyogenes	0/98 (0)	1/98 (1.0)		
Streptococcus intermedius	0/98 (0)	1/98 (1.0)		
Non-documented	12	10		
Ulcers	5/98 (5.0)	4/98 (4.0)		L98
Klebsiella oxytoca	1/98 (1.0)	0/98 (0)		
Streptococcus anginosus- S. constellatus coinfection	1/98 (1.0)	0/98 (0)		
Non-documented	3	4		
Impetigo	2/98 (2.0)	4/98 (4.1)		L01
MSSA	2/98 (2.0)	2/98 (2.0)		
Cutibacterium acnes	0/98 (0)	1/98 (1.0)		
Non-documented	0	1		
Post-traumatic wound infection	2/98 (2.0)	1/98 (1.0)		T79
MSSA	1/98 (1.0)	0/98 (0)		
C. acnes	1/98 (1.0)	1/98 (1.0)		
Cellulitis	0/98 (0)	1/98 (1.0)		L03
Tuberculosis infection	**12/98 (12.2)**	**6/98 (6.1)**	**0.14**	

PTB	10/98 (10.2)	2/98 (2.0)		A15.0
Extra PTB	2/98 (2.0)	4/98 (2.1)		
Lymph node TB	2/98 (2.0)	3/98 (2.0)		A15.4
Tuberculous meningitis	0/98 (0)	1/98 (1.0)		A17.0
Urinary tract infections	**11/98 (11.2)**	**8/98 (7.1)**	**0.47**	
Acute pyelonephritis/pyonephrosis	11/98 (3.1)	7/98 (6.1)		N10, N12, N16
Prostatitis	0/98 (0)	1/98 (1.0)		N41
Escherichia coli	6/98	6/98 (6.1)		
MSSA	1/98	0		
Enterococcus faecalis	2/98	0		
Klebsiella oxytoca	1/98	0		
S. pneumoniae	0/98	1/98		
K. pneumoniae	0/98	1/98 (1.0)		
C. acnes	0	1/98 (1.0)		
Candida lusitaniae	1/98	0		
Candida parapsilosis	1/98	0		
Bacteraemia	**10/98 (10.2)**	**7/98 (7.1)**	**0.25**	**A49.9**
Staphylococus aureus	4/98 (4.1)	4/98 (5.1)		
MSSA	4/98 (4.1)	4/98 (5.1)		
MRSA	0/98 (0)	0/98 (0)		
E. coli	1/98 (1.0)	3/98 (3.1)		
H. influenzae	1/98 (1.0)	0/98 (0)		
Klebsiella pneumoniae	1/98 (1.0)	0/98 (0)		
P. aeruginosa	1/98 (1.0)	0/98 (0)		
Acinetobacter baumannii	1/98 (1.0)	0/98 (0)		
Streptococcus agalactiae	1/98 (1.0)	1/98 (1.0)		
Corynebacterium ureicelerivorans	1/98 (1.0)	0/98 (0)		
S. pneumoniae	0/98 (0)	1/98 (1.0)		
Orthopaedic infections	**6/98 (6.1)**	**16/98 (16.3)**	**2.10^{-3}**	
Pyogenic arthritis and prosthetic joint infections	6/98 (6.1)	16/98 (16.3)		M00, T845
MSSA	2/98 (1.0)	1/98 (1.0)		
Staphylococcus lugdunensis	0/98 (0)	2/98 (2.0)		
S. pyogenes	0/98 (0)	1/98 (1.0)		
Enterobacter cloacae	0/98 (0)	1/98 (1.0)		

Non-documented	4	11		
Osteomyelitis	0/98 (0)	3/98 (4.1)		M86
S. epidermidis	0/98 (0)	1/98 (1.0)		
Enterobacter cloacae	0/98 (0)	1/98 (1.0)		
S. constellatus	0/98 (0)	1/98 (1.0)		
Ectoparasite infestations	**6/98 (6.1)**	**0/98 (0)**		
Body-louse infestation	4/98 (4.1)	0/98 (0)		B85
Scabies infestation	2/98 (2.0)	0/98 (0)		B86
Digestive infection	**6/98 (6.1)**	**8/98 (8.1)**	**0.48**	
Diarrhoea	6/98 (6.1)	7/98 (7.1)		
Enterocolitis due to *Clostridium difficile*	2/98 (2.1)	3/98 (3.1)		A04.7
Salmonella enteritis	0/98 (0)	1/98 (1.0)		A02
Aeromonas caviae	0/98 (0)	1/98 (1.0)		A04
Non-documented	2	3		A04
Gastrointestinal infection	1/98 (1.0)	0/98 (0)		A09
Intestinal schistosomiasis	1/98 (1.0)	0/98 (0)		B65
***Plasmodium falciparum* malaria**	**2/98 (2.1)**	**2/98 (2.1)**	**1.00**	**B50**
Systemic bartonellosis	**1/98 (1.0)**	**0/98 (0)**	**NA**	**A44.0**
Varicella without complication	**1/98 (1.0)**	**0/98 (0)**	**NA**	**B01**
Number of diagnostic ID			**0.8**	
1- disease	83/98 (84.7)	87/98 (88.8)		
2- diseases	12/98 (12.2)	9/98 (9.2)		
3- diseases	3/98 (3.1)	2/98 (2.0)		
Length of each stay (days), mean±SD, min-max	11.6±13.6 (1-62)	5.8±6.7 (1-49)	$<10^{-4}$	
Length of stay (days) accumulated during study period, mean±SD (min-max)	19.8±21.0, (1-67)	7.4±8.0, (1-49)	$<10^{-4}$	

Abbreviations: ICD-10-CM, international classification diseases-10- Clinical Modification ; ID, infectious disease.

ICU, intensive care unit; SD, standard deviation; BMI, Body mass index; NA, not applicable; Ref, Reference category. COPD, Chronic Obstructive Pulmonary Disease; TB, tuberculosis; ID infectious disease. MSSA, *methicillin-sensitive Staphylococcus aureus*.

[a] At least once during the two-year observation.

Table 5. Univariate and multivariate analysis: Potential factors associated with length of each hospital stay in homeless population (n=120 admissions).

Variable n (admissions)	Mean LOS±SD (days)	Univariate analysis			Multivariate analysis[a]		
		β-coefficient	95% CI for B	p-value	β-coefficient	95% CI for B	p-value
Demographic factors							
Age[b]							
≤46 years of age (n=58), ref	12.3±14.6						
>46 years of age (n=62)	11.0±12.8	-0.04	-6.17; 3.72	0.62			
Gender							
Female (n=12), ref	6.0±5.3						
Male (n=108)	12.2±14.1	**0.138**	**-1.90; 14.4**	**0.13**	-	-	-
Birthplace							
France (n=34), ref	12.6±12.6						
Migrant (n=76)	11.1±14.1	-0.05	-7.1; 4.04	0.59			
Status of homelessness							
Sheltered homeless (n=69), ref	12.8±14.7						
Unsheltered homeless living in the street (n=16)	12.4±14.2	-0.01	-8.41; 7.72	0.93			
Language barrier							
No (n=82), ref	11.3±12.4						
Yes (n=39)	12.7±16.3	-0.04	-4.15; 6.48	0.66			
Smoking tobacco							
No (n=37), ref	6.6±5.2						
Yes (n=60)	14.9±16.7	**0.29**	**2.65-13.8**	**0.004**	**0.23**	**1.68; 11.46**	**0.009**
Frequent alcohol consumption							
No (n=76),ref	10.1±12.7						
Yes (n=38)	12.7±12.8	0.09	- 2.45; 7.53	0.32			
Cannabis use							
No (n=87), ref	11.2±13.8						
Yes (n=10)	16.6±4.8	0.12	-3.82, 14.7	0.248			
Illicit drug and opioid agonist treatment use							
No (n=88), ref	10.9±13.2						
Yes (n=16)	14.8±12.9	0.11	-3.13; 11.0	0.27			
Admission by ambulance							
No (n=107), ref	11.9±14.1						
Yes (n=13)	8.92±8.98	-0.07	-11.0; 4.9	0.45			
Health insurance							
Yes (n=87), ref	12.9±15.4						

No (n=33)	8.2±6.0	-0.15	-10.2; 0.72	0.09			
Patient factors							
History of diabetes mellitus							
No (n=92)	10.9±12.6						
Yes (n=13)	15.7±16.0	0.12	-2.85; 12.5	0.22			
Hospitalisation factors							
SAPS II[b]							
6-13 (n=64), ref	12.5±14.6						
14-52 (n=54)	10.8±12.1	-0.06	-6.97 ; 3.27	0.49			
Acute exacerbation of COPD							
No (n=98), ref	12.5±14.5						
Yes (n=22)	7.6±7.1	**-0.14**	**-11.3; 1.40**	**0.125**	**-**	**-**	**-**
Community-Acquired Pneumonia (other than COPD)							
No (n=104), ref	12.3±14.4						
Yes (n=16)	7.0±5.5	**-0.12**	**-12.6; 1.89**	**0.14**	**-**	**-**	**-**
Influenza-Like Illness							
No (n=109), ref	11.6±14.1						
Yes (n=11)	11.7±7.3	0.002	-8.46; 8.66	0.98			
Acute upper respiratory infection							
No (n=111), ref	11.5±13.5						
Yes (n=9)	13.4±16.2	0.04	-7.42; 11.4	0.68			
TB							
No (n=106), ref	9.7±10.6						
Yes (n=14)	25.9±23.4	**0.38**	**9.1; 23.3**	**$<10^{-4}$**	**0.38**	**9.62; 25.1**	**$<10^{-4}$**
Sexually transmitted infections							
No (n=97), ref	11.0±13.4						
Yes (n=23)	14.4±14.8	0.10	-2.77; 9.73	0.273			
Skin, cutaneous and mucosal infections							
No (n=99), ref	12.2±14.3						
Yes (n=21)	8.8±9.7	-0.10	-9.89; 3.07	0.30			
Orthopaedic infections							
No (n=114), ref	11.3±13.3						
Yes (n=6)	17.3±19.3	0.10	-5.29; 17.3	0.3			
Urinary tract infection							
No (n=19), ref	10.6±12.6						
Yes (n=11)	21.9±19.1	**0.24**	**2.99; 19.9**	**0.008**	**0.21**	**1.63; 16.9**	**0.018**
Bacteraemia							

No (n=110), ref	10.6±12.3						
Yes (n=10)	22.7±21.5	**0.25**	**3.40; 20.7**	**0.007**	**0.21**	**1.89; 19.7**	**0.018**
Ectoparasite infestations							
No (n=114), ref	12.0±14.0						
Yes (n=6)	7.0±4.7	-0.07	-16.2; 6.4	0.40			
Digestive infections							
No (n=114), ref	11.3±13.3						
Yes (n=6)	18.3±19.5	0.11	-4.21; 18.3	0.22			
Number of diagnostic diseases							
1 disease (n=104), ref	11.7±13.5						
2 or 3 diseases (n=16)	10.9±14.6	-0.02	-8.07; 6.49	0.82			

* Abbreviation: LOS, length of stay; SD, standard deviation; SAPS II, Simplified Acute Physiology Score (SAPS) II; COPD, Chronic Obstructive Pulmonary Disease, TB, tuberculosis.

Bold lines indicate the variables recruited in the initial multivariate model.

The model provides the difference in mean LOS between the modalities of a variable.

[a]Fitness of model F=10.7, adjusted R square=0.29, p<0.0001

[b]Median of the variable is used for analysis.

[c]Including injecting illicit or snorting illicit substances or using opioid agonist treatment.

Mean duration of LOS among homeless patients admitted with at least one diagnosis tuberculosis infection, *urinary tract* infection or bacteraemia (n=31 admissions, 21.0±19.6 days) were likely higher than that of controls (21 admissions, 8.9±11.6 days), p=0.008.

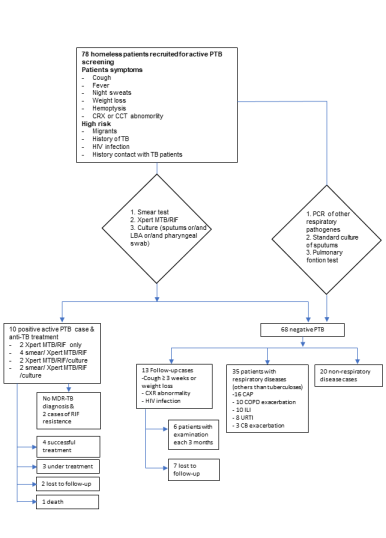
Table 6. Treatment and outcomes

Treatment	Homeless	Non-homeless	p-value
Ventilation assistance	4/98 (4.1)	0/98 (0)	0.043
Non-invasive	3/98 (3.1)	0/98 (0)	
Invasive	1/98 (1.0)	0/98 (0)	
Antibiotics	69/98 (70.4)	80/98 (81.6)	0.08
Antifungals	5/98 (5.1)	4/98 (4.1)	0.73
Corticoids	14/98 (14.2)	10/98 (10.2)	0.39
Surgical procedure	4/98 (4.1)	2/98 (2.0)	0.68
Hospital mortality (%)	1/98 (1.0)	0/98 (0)	1.00
Medical appointments, n (times), mean±SD (times/person), min-max	71, 0.72±1.25	199, 2.03±2.2	$<10^{-4}$
Loss of follow-up for antiretroviral HIV-1 follow up treatment among HIV patients	2/8 (25%)	0/6 (0%)	NA
Loss of follow-up for PTB treatment	2/10 (20%)	0/2 (0%)	NA
Loss of follow-up for suspected PTB	7/13 (55.9%)	0/1 (0%)	NA

Abbreviation: SD, standard deviation; PTB, pulmonary *Mycobacterium tuberculosis*; TB, tuberculosis; HIV, human immunodeficiency virus.

Figure 1. Flow chart for pulmonary tuberculosis assessment among homeless patients.

Abbreviation: CRX, Chest-X Rays; PTB, pulmonary tuberculosis; COPD, Chronic Obstructive Pulmonary Disease; URTI, Upper Respiratory Tract Infection; ILI, Illness Like Infection; RIF, Rifampicin; MTB, *Mycobacterium tuberculosis*, HIV, Human Immunodeficiency Virus; BAL, Bronchoalveolar Lavage.


78 homeless patients recruited for active PTB screening
Patients symptoms
- Cough
- Fever
- Night sweats
- Weight loss
- Hemoptysis
- CRX or CCT abnormality
High risk
- Migrants
- History of TTB
- HIV infection
- History contact with TB patients
1. Smear test
2. Xpert MTB/RIF
3. Culture (sputums or/and LBA or/and pharyngeal swab)
1. PCR of other respiratory pathogenes
2. Standard culture of sputums
3. Pulmonary fonction test
10 positive active PTB case & anti-TB treatment
- 2 Xpert MTB/RIF only
- 4 smear/ Xpert MTB/RIF
- 2 Xpert MTB/RIF/culture
- 2 smear/ Xpert MTB/RIF /culture
No MDR-TB diagnosis.8
2 cases of RIF resistence
4 successful treatment
3 under treatment
2 lost to follow-up
1 death
68 negative PTB
13 Follow-up cases
-Cough ≥ 3 weeks or weight loss
- CXR abnormality
- HIV infection
6 patients with examination each 3 months
7 lost to follow-up
35 patients with respiratory diseases (others than tuberculoses)
-16 CAP
- 10 COPD exacerbation
- 10 ILI
- 8 URTI
- 3 CB exacerbation
20 non-respiratory disease cases