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Brief Original Article

Risk factors for lower respiratory tract infections in a psychiatric hospital: a retrospective study

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Abstract

Introduction: Locked pediatric inpatient psychiatric units are vulnerable to the emergence and spread of infections, and nosocomial infection, especially respiratory tract infection is potentially a major problem. This study aimed to explore the risk factors for lower respiratory tract infection (LRI), in particular, pneumonia.

Methodology: We conducted a retrospective study comprising 4643 patients with schizophrenia (SZ) and 1826 patients with major depressive disorder (MDD), and the chi-square test was performed to analyze the categorical variables.

Results: The risk ratio for LRI, including pneumonia, in intensive care unit (ICU) was higher than in the general ward, and electroconvulsive therapy (ECT) increased the patients' susceptibility to LRI and pneumonia. Our data have revealed that patients treated with restraint or clozapine showed a higher prevalence of LRI and pneumonia, and the results indicated that the increased risk of LRI, not pneumonia, was dose-dependently observed in patients with clozapine treatment.

Conclusions: Our study shows that ICU and ECT treatment were risk factors for LRI and pneumonia in patients with SZ or MDD, and patients with SZ has a prevalence of hospital-acquired infection because of restraint and clozapine treatments.

Key words: Nosocomial infection; lower respiratory tract infection; pneumonia; risk factors; schizophrenia; major depressive disorder; intensive care unit; electroconvulsive therapy; clozapine.

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Introduction

Psychiatric institutions play a crucial role in the support and treatment of patients with mental illness while ensuring a psychologically and physically safe environment [1]. Nosocomial events occur frequently in hospitals, and they have become an important issue in the field of public health, because nosocomial infection results in serious medical and social problems [2]. Several studies have reported that locked pediatric inpatient psychiatric units are vulnerable to the emergence and spread of infections, such as gastroenteritis and metapneumovirus infection [3-8]. However, respiratory infections pose the greatest challenge, with the respiratory syncytial virus (RSV) being particularly problematic [9]. So respiratory infection is potentially a major problem in a psychiatric ward. In this study, we, therefore, performed the retrospective cohort study to elucidate the related factors for lower respiratory tract infection, in particular, pneumonia, in 5,588 admitted inpatients in psychiatric wards in Nantong Mental Health Center, Nantong, China, from January 2016 to December 2020.

Methodology

Study population

A total of 10,912 inpatients at the department of Clinical Psychiatry in Nantong Mental Health Center from January 2016 to December 2020 were retrospectively reviewed. Based on the criteria of Diagnostic and Statistical Manual of Mental Disorders, 5th edition (DSM-V), 42.5% of patients were diagnosed with schizophrenia (SZ), and 16.7% of patients were confirmed to have major depressive disorder (MDD) by two psychiatrists independently. Therefore, SZ and MDD are the main types of mental diseases among hospitalized patients, and they were chosen for the current study. In order to explore the risk factors for nosocomial infection, psychiatric patients with smoking, respiratory diseases, cardiovascular diseases, and other basic diseases, which are susceptible to

respiratory tract infections were excluded. Finally, 5,588 inpatients were successfully recruited in the retrospective study. A schematic of the participants flow is shown in Figure 1.

We examined each patients' physical characteristics and clinical parameters on admission, and internal medicine physicians diagnosed lower respiratory infections based on clinical symptoms, signs and the results of laboratory tests (cough, fever, productive sputum, dyspnea, chest pain, abnormal breath sounds and blood composition), and pneumonia was verified by chest X-ray or computed tomography scan (CT).

Statistical analysis

All statistical analyses were conducted with SigmaPlot 13.0 (Systat, California, USA) and IBM SPSS Statistics 26 software (SPSS Inc, Chicago, USA). The chi-square test was performed to analyze the categorical variables in the retrospective study, and $p < 0.05$ was considered to be significant. The quantitative data were analyzed by *t*-test, and presented as the mean ± standard deviation.

Results

A clinical chart of 4,643 patients with SZ and 1,826 patients with MDD during the study period was reviewed. Of the 6,469 patients, 5,588 patients were included in the study, and they aged 43.9 ± 16.7 years, and 42.1% were male (n = 2354). Among these participants, 386 patients were diagnosed with lower respiratory tract infections (LRI) (Figure 1).

To identify the risk factors related to LRI, we performed chi-square analysis to test the effect of gender, psychiatric disorders, intensive care unit (ICU), electroconvulsive therapy (ECT), restraint, and clozapine on the rate of LRI in inpatients (Table 1). The patients with LRI tended to be male (male vs female, 9.303% vs 5.164%, $p < 0.001$), and be diagnosed with SZ (SZ vs MDD, 7.546% vs 5.239%, $p = 0.002$, Table 1). In addition, ICU, ECT, restraint and clozapine treatment increased the ratio of LRI (ICU: with vs without, 7.956% vs 3.367%, $p < 0.001$; ECT: with vs without, 12.681% vs 4.476%, $p < 0.001$; restraint: with vs without, 14.037% vs 5.006%, $p < 0.001$; clozapine: with vs without, 10.953% vs 6.041%, $p < 0.001$, Table 1). Then, we identified the reasons for higher tendency of LRI in male patients. Table 2 showed that the proportion of ICU, clozapine, and patients with schizophrenia was higher in males than females, but fewer male patients were treated with ECT. Because SZ, ICU, ECT, restraint, and clozapine treatment increased the ratio of LRI, we analyzed the rate of these factors (Table 2).

Figure 1. A schematic of the participant flow (SZ, Schizophrenia; MDD, Major depressive disorders).

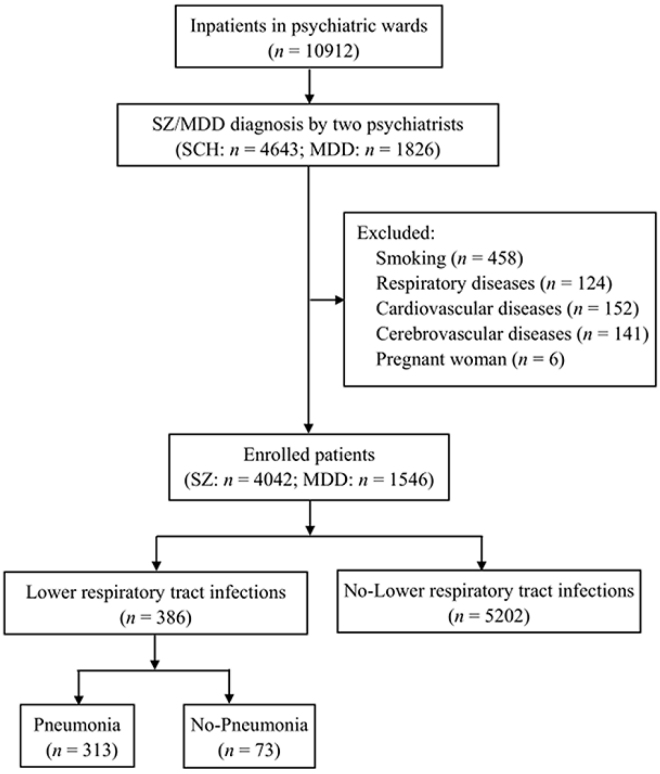


Table 1. Risk factors associated with lower respiratory tract infections in patients.

	LRI (n = 386)	Non-LRI (n = 5202)	Percentage of LRI (%)	x2/t	*p*
Age (years)	44.7 ± 16.6	43.8 ± 16.8	-	0.956	0.339a
Gender (male/female)	219/167	2135/3067	9.303/5.164	36.302	< 0.001
SZ/MDD	305/81	3737/1465	7.546/5.239	9.251	0.002
ECT (With/Without)	210/176	1446/3756	12.681/4.476	121.994	< 0.001
ICU (With/Without)	343/43	3968/1234	7.956/3.367	32.265	< 0.001
Restraint (With/Without)	161/225	986/4216	14.037/5.006	114.063	< 0.001
Clozapine (With/Without)	108/278	878/4324	10.953/6.041	30.474	< 0.001

LRI: Lower respiratory infections; SZ: Schizophrenia; MDD: Major depressive disorders; ECT: Electroconvulsive therapy; ICU: Intensive care unit; a: t-test.

Table 2. Risk factors associated with lower respiratory tract infections in male and female patients.

	Male (n = 2354)	Female (n = 3234)	x2/t	*p*
ECT (With/Without)	643/1711	1013/2221	10.496	0.001
SZ/MDD	1853/501	2189/1045	82.822	< 0.001
Clozapine (With/Without)	497/1857	489/2745	33.665	< 0.001
Restraint (With/Without)	488/1866	659/2575	0.104	0.747
ICU (With/Without)	1991/363	2320/914	127.431	< 0.001
Total	5472/6298	6670/9500	75.958	< 0.001

ECT: Electroconvulsive therapy; SZ: Schizophrenia; MDD: Major depressive disorders; ICU: Intensive care unit.

Table 3. Risk factors associated with lower respiratory tract infections in patients with SZ and MDD.

	SZ (n = 4042)	MDD (n =1546)	x2/t	*p*
ECT (With/Without)	1188/2854	468/1078	0.416	0.519
ICU (With/Without)	3481/561	830/716	667.250	< 0.001
Restraint (With/Without)	1083/2959	64/1482	351.808	< 0.001
Clozapine (With/Without)	986/3056	0/1546	457.931	< 0.001

SZ: Schizophrenia; MDD: Major depressive disorders; ECT: Electroconvulsive therapy; ICU: Intensive care unit.

Table 4. Risk factors associated with pneumonia in lower respiratory infections patients.

	Pneumonia (n = 313)	Non-pneumonia LRI (n = 73)	Percentage of pneumonia (%)	x2/t	*p*
Age (years)	45.2 ± 16.6	42.3 ± 16.8	-	1.341	0.181
Gender (Male/Female)	181/132	38/35	82.648/79.042	0.804	0.370
SZ/MDD	254/59	51/22	83.279/72.840	4.548	0.033
ECT (With/Without)	178/135	32/41	84.762/76.705	4.054	0.044
ICU (With/Without)	285/28	58/15	83.090/65.116	8.050	0.005
Restraint (With/Without)	142/171	19/54	88.199/76.000	9.107	0.003
Clozapine (With/Without)	96/217	12/61	88.889/78.058	5.950	0.015

LRI: Lower respiratory infections. SZ: Schizophrenia; MDD: Major depressive disorders. ECT: Electroconvulsive therapy. ICU: Intensive care unit.

Table 5. Risk factors associated with pneumonia in patients.

	Pneumonia (n = 313)	Non-pneumonia (n = 5275)	Percentage of pneumonia (%)	x2/t	*p*
Age (years)	45.2 ± 16.6	43.8 ± 16.8	-	-1.450	0.147
Gender (Male/Female)	181/132	2173/3102	3.239/2.362	33.529	0.000
SZ/MDD	254/59	3788/1487	4.545/1.056	12.879	0.000
ECT (With/Without)	178/135	1478/3797	3.185/2.416	117.935	0.000
ICU (With/Without)	285/28	4026/1249	5.100/0.501	36.373	0.000
Restraint (With/Without)	142/171	1005/4270	2.541/3.060	125.428	0.000
Clozapine (With/Without)	96/217	890/4385	1.718/3.883	38.716	0.000

SZ: Schizophrenia; MDD: Major depressive disorders; ECT: Electroconvulsive therapy; ICU: Intensive care unit.

Table 6. Risk factors associated with pneumonia in SZ and MDD patients with lower respiratory infections patients.

	SZ (n = 305)	MDD (n =81)	x2/t	*p*
ECT (With/Without)	174/131	36/45	4.099	0.043
ICU (With/Without)	299/6	44/37	123.540	< 0.001
Restraint (With/Without)	155/150	6/75	49.612	< 0.001
Clozapine (With/Without)	108/197	0/81	39.825	< 0.001

SZ: Schizophrenia; MDD: Major depressive disorders; ECT: Electroconvulsive therapy; ICU: Intensive care unit.

The results suggested that the higher rate of ICU, clozapine, and patients with schizophrenia in male patients led to the tendency of LRI. Clozapine and restraint are commonly used in the treatment of SZ, and SZ predisposed the patients to LRI. Table 3 confirmed that the higher rate of LRI in SZ patients because of restraint and clozapine, especially in ICU patients (Table 3).

Pneumonia is one kind of LRI, and previous studies have revealed that pneumonia accounts for about half of all deaths in psychiatric hospitals. Thus, the tendency of pneumonia was higher in patients, who were in ICU (with vs without, 83.090% vs 65.116%, $p = 0.005$), and were diagnosed SZ (SZ vs MDD, 83.279% vs 72.840%, $p = 0.033$), and had an ECT, restraint and clozapine treatment (ECT: with vs without, 84.762% vs 76.705%, $p = 0.044$; restraint: with vs without, 88.199% vs 76.000%, $p = 0.003$; clozapine: vs without, 88.889% vs 78.058%, $p = 0.015$) (Table 4). In order to confirm the finding, we also assessed these risk factors for pneumonia in all of patients, who were recruited in the study (Table 5). We also tested the factors for the more tendency of pneumonia in SZ patients. The results showed that ECT, restraint and clozapine treatment promoted the possibility of pneumonia in patients with SZ, especially in ICU (Table 6).

Clozapine is one of the important antipsychotic drugs, and it is the reason for higher rate of LRI and pneumonia in male patients with SZ. We examined the proportion of LRI and pneumonia in patients with different dosage of clozapine. Figure 2 showed the distribution of the patients according to the clozapine dose, and the tendency of LRI depended on the dosage of clozapine, and displayed a linear correlation (8.8% in low, 13.9% in medium, and 20% in high, $p = 0.027$). However, our data did not show the linear correlation between the propensity of pneumonia in LRI and the dose in clozapine, though the proportion of pneumonia relied on the clozapine dosage faintly (83.0% in low, 94.1% in medium, and 100.0% in high, $p = 0.153$). The results indicated that the increased risk of LRI, not pneumonia, was dose-dependently observed.

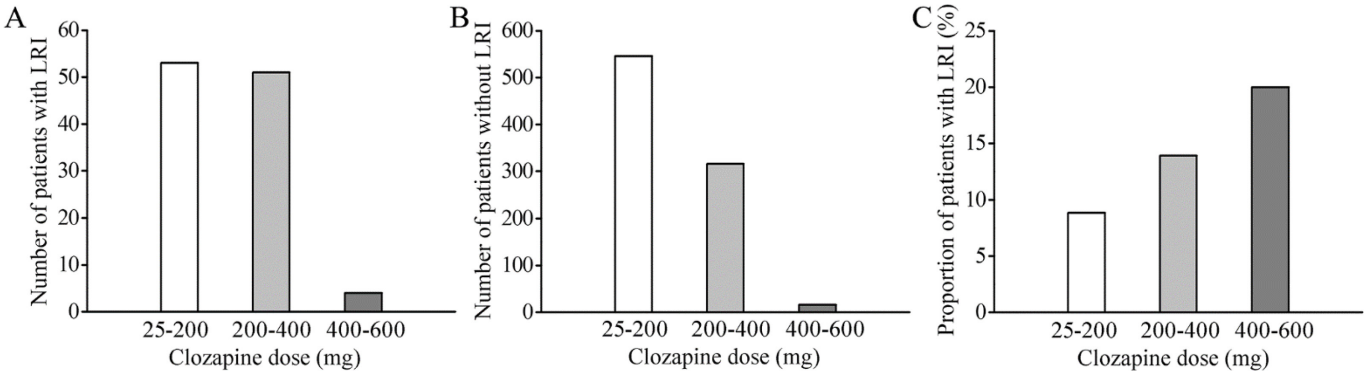
Discussion

In this study, inpatients with LRI accounted for 6.908% of the total included cases, with 313 cases of pneumonia. We identified significant risk factors for LRI, and pneumonia in inpatients, which were ICU, ECT, and diagnosis of SZ, which related to restrain and clozapine treatment.

Nosocomial infection, also called hospital-acquired infection or healthcare-associated infection, is not present or incubating at the time of admission of the patients [10]. Smoking habit is one of the significant risk factors for pneumonia [11]. In the current study, patients with smoking, respiratory diseases, and other basic diseases were excluded, and hospital-acquired LRI or pneumonia acquired at least 48 hours or beyond the average incubation period after admission, not present at the time of admission. The key factors that determine the rate of hospital-acquired infections include hospital indoor air pollutants, host susceptibility, types of host diseases and usage of drugs [12].

Heating, ventilation, and air conditioning (HVAC) system is a priority for improving the environmental factors that affect the indoor air quality of hospital [12,13]. In ICU of hospitals, outbreaks of infection, associated with the function of HVAC systems, are reported in many studies [14,15]. In the locked pediatric inpatient psychiatric units, the risk ratio for LRI in ICU was high (Table 1). Pneumonia accounts for about half of all deaths in psychiatric hospitals [16,17], so we also analyzed the possibility of pneumonia in ICU. The data showed that the risk ratio for pneumonia in ICU was also high (Table 4,5).

Figure 2. Distribution of patients with lower respiratory tract infections (LRI) according to clozapine dose. The patients were divided into groups with (**A**) or without (**B**) LRI, and the proportion of patients with LRI was calculated by dividing the number of patients with LRI by the total patients in the study (**C**).



In the psychiatric hospital, SZ and MDD are two major types of mental diseases. ECT is one of the most effective treatments in MDD and SZ, and its efficacy is related to seizure duration [18]. Previous studies showed that respiratory tract infection was associated with seizure duration [19]. Our results indicated that ECT increased the patients' susceptibility to LRI and pneumonia (Tables 1,4,5). However, restrain and clozapine are the treatments mainly for SZ, and clozapine is probably the antipsychotic most frequently associated with the risk of pneumonia [20,21]. Our data have revealed that patients treated with restrain or clozapine showed a higher prevalence of LRI and pneumonia (Tables 1,3,4,5,6), which may partly explain why patients with schizophrenia showed a higher prevalence of hospital-acquired infection than MDD patients (Tables 1,3). In addition, our data showed that male patients had a higher prevalence of LRI than female patients (Table 1). However, the ratio of SZ to MDD in male patients was higher than in female patients, as well as in clozapine and restraint treatments, which are special for SZ (Table 2). Therefore, high prevalence of LRI resulted from high proportion of SZ in male patients, and gender could not be a risk factor for LRI or pneumonia. For clozapine, the dose dependence in the risk of LRI, not pneumonia, was observed (Figures 2,3). However, the distribution of the patients with different dosage of clozapine was analyzed in a small sample size, particularly in the group of the high dosage in clozapine. In the future research, a larger and more representative sample is need to confirm the findings.

Conclusions

Our study demonstrated that ICU and ECT treatment were risk factors for LRI and pneumonia in patients with SZ or MDD, and patients with SZ have the prevalence of hospital-acquired infection because of restrain and clozapine treatment, and the risk of LRI is dose-dependent in patients with clozapine treatment. Further study based on our results is needed to analyze risk factors in detail and establish preventive strategies to reduce hospital-associated infection among patients in psychiatric wards.

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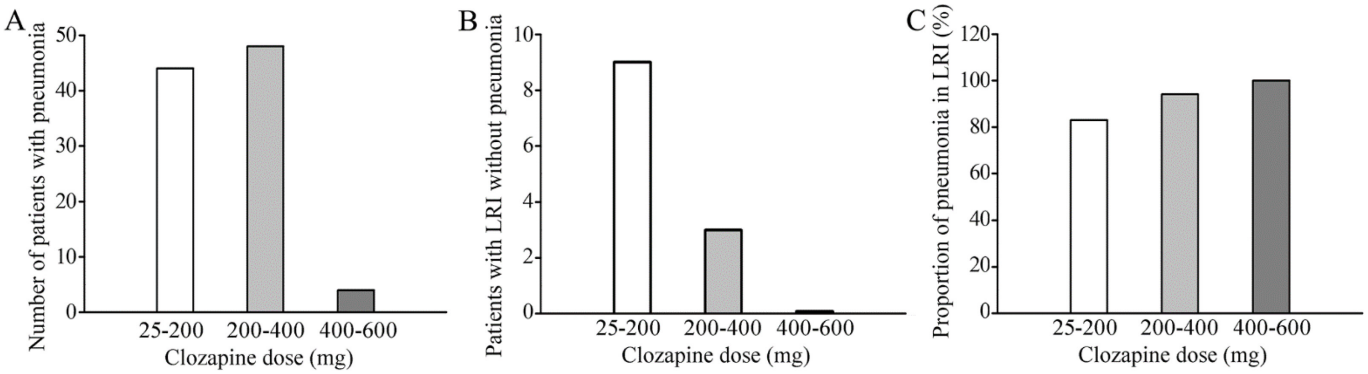
Figure 3. Distribution of pneumonia in patients with lower respiratory tract infections (LRI) according to clozapine dose. The patients were divided into groups with (**A**) or without (**B**) pneumonia, and the proportion of pneumonia in LRI patients was calculated by dividing the number of patients with pneumonia by the total patients with LRI (**C**).



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