

Prevalence survey of nosocomial infections in the Inner Mongolia Autonomous Region of China [2012-2014]

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Background: To investigate the prevalence of nosocomial infections, the distribution of nosocomial infection sites, the use of antibiotic and the situation of detected nosocomial infection pathogens in the Inner Mongolia Autonomous Region of China from 2012 to 2014, to grasp the current conditions of regional nosocomial infections in timely, for the development of infection prevention and control measures to provide a basis for effective hospital.

Methods: A survey of the prevalence of nosocomial infections was conducted in target hospitals using the combination of a bedside survey and medical record review.

Results: In total, 101,907 inpatients were surveyed from 2012 to 2014. There were 1,997 cases of nosocomial infections, accounting for an average prevalence of 1.96%. The infection site was mainly the lower respiratory tract. Higher prevalence of nosocomial infections occurred in the comprehensive intensive care unit (ICU), Neurosurgery Department, and Hematology Department. The average rate of antibiotic use was 33.72%, and the average submission rate for bacterial cultures for patients who received therapeutic treatment with antibiotics was 28.26%. The most common pathogens associated with nosocomial infections were Gram-negative (G⁻) bacteria, and frequently detected bacterial pathogens included *Escherichia coli*, *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, *Acinetobacter baumannii*, and *Staphylococcus aureus*.

Conclusions: The survey of the prevalence of nosocomial infections helped to identify problems in the control process of nosocomial infections and to develop targeted measures for the prevention and control of these infections accordingly.

Keywords: Nosocomial infection; prevalence; antibiotics

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Introduction

With the development of medical technology, the problem of nosocomial infection has become serious increasingly, which affect the life safety of patients and medical staff seriously. Reducing the occurrence of hospital infection effectively not only can reduce the patient's medical expenses, but also can avoid the medical resources waste. This study reports the findings from a survey of the

prevalence of nosocomial infections in the Inner Mongolia Autonomous Region of China from 2012 to 2014. The objectives were to investigate the current situation and trends of nosocomial infections in the Inner Mongolia Autonomous Region and provide theoretical support for developing effective measures for the prevention and control of nosocomial infections to facilitate regional nosocomial infection management.

Materials and methods

Survey subjects

The subjects included all inpatients on the days that the survey was conducted in the target hospitals from 2012 to 2014, including patients discharged or dead on the days the survey was conducted, but patients newly admitted to the hospital were excluded. In total, 26,940, 31,504, and 43,463 inpatients were surveyed in 2012, 2013, and 2014, the hospital is divided into 66, 91, 118 were investigated, respectively.

Survey methods

A cross-sectional survey was conducted, and the survey plan was implemented in accordance with the survey method developed by the National Nosocomial Infection Surveillance and Management Training Base. According to the situation, each hospital was surveyed by full-time staff of the nosocomial infection management team in cooperation with the physicians and nurses of responsible for nosocomial infection control from different clinical departments. The investigators were divided into two groups: one group reviewed medical records, and the other group performed the bedside survey. These two sets of survey data were summarized and input into a "Case Registration Form of the Nosocomial Infection Prevalence Survey" by full-time staff of the nosocomial infection management team.

Diagnostic criteria

Nosocomial infection was diagnosed according to the Diagnostic Criteria for Nosocomial Infection (Trial) issued by the original Ministry of Health of the People's Republic of China in 2001. When a discrepancy regarding a diagnosis occurred, a decision was reached by discussion among the investigators.

Quality control

One week prior to the survey, a notice that included the survey methods and diagnostic criteria was issued to the clinical departments. Two days before the survey, pre-survey training of investigators was conducted by full-time staff of the nosocomial infection management team, which included the survey plan, diagnostic criteria, and instructions for completing the survey form. In the case

of a disagreement, the survey team members discussed the situation to reach a decision. After the completion of the survey, the survey forms were checked by full-time staff, and problems were fixed in a timely manner. The survey data were imported into the National Nosocomial Infection Control Office Automation System (<http://oa.yygr.cn/>) and reported by full-time staff. Staff at the National Nosocomial Infection Management and Quality Control Center reviewed the reported data again to ensure the accuracy of the survey data.

Statistical analysis

The survey data were imported into the National Nosocomial Infection Control Office Automation System and then exported for statistical analysis using SPSS 19.0. Categorical data were compared by χ^2 tests, and a P value of less than 0.05 was considered to indicate statistical significance.

Results

Prevalence of nosocomial infection

The prevalence of nosocomial infections were 2.05% in 2012, 1.82% in 2013, and 2.00% in 2014, with a 3-year average of 1.96%. There were no significant differences in the prevalence of nosocomial infections between different years ($\chi^2=4.91$, $P=0.09>0.05$) (Table 1). Table 2 shows the prevalence of nosocomial infections from 2012 to 2014 in different areas of Inner Mongolia.

Nosocomial infections in different clinical departments

The results of the 2012-2014 survey showed that comprehensive intensive care unit (ICU) and the Neurosurgery Department, Hematology Department, Neonatology Group of the Pediatrics Department, Gynecology Department, Thoracic Surgery Department, and Nephrology Department were associated with high prevalence of nosocomial infections (Table 3).

Distribution of nosocomial infection sites

The 3-year survey data showed that nosocomial infections were mainly distributed in the lower respiratory tract, upper respiratory tract, urinary tract, and superficial incisions (Table 4).

Table 1 The survey rates (%) and prevalence (%) of nosocomial infections in the Inner Mongolia Autonomous Region of China [2012-2014]

Year	Number of expected patients	Number of surveyed patients	Survey rate (%)	Number of infected patients	Infection rate (%)	Frequency of infection	Frequency rate of infection (%)
2012	27,285	26,940	98.74	553	2.05	586	2.18
2013	32,013	31,504	98.41	573	1.82	614	1.95
2014	43,720	43,463	99.41	871	2.00	919	2.11
Total	103,018	101,907	98.92	1,997	1.96	2,119	2.08

Table 2 Prevalence of nosocomial infections from 2012 to 2014 in different areas of Inner Mongolia

Inner Mongolia (City/league)	2012			2013			2014		
	Number of surveyed patients	Number of infected patients	Infection rate (%)	Number of surveyed patients	Number of infected patients	Infection rate (%)	Number of surveyed patients	Number of infected patients	Infection rate (%)
Hohhot	6,874	178	2.59	7,126	163	2.29	7,450	157	2.11
Baotou	1,905	42	2.20	2,275	29	1.27	4,608	78	1.69
Ordos	1,665	31	1.86	1,908	37	1.94	2,261	46	2.03
Hulun Buir	3,621	54	1.49	3,898	40	1.03	5,914	90	1.52
Hinggan	1,857	32	1.72	2,034	49	2.41	2,775	82	2.95
Tongliao	2,654	53	2.00	3,007	34	1.13	3,752	52	1.39
Chifeng	3,813	75	1.97	4,896	105	2.14	9,617	245	2.55
Xilin Gol	356	6	1.69	353	6	1.70	732	23	3.14
Ulan Qabu	962	20	2.08	967	18	1.86	1,241	14	1.13
Bayan Nur	2,168	44	2.03	3,581	68	1.90	3,676	63	1.71
Wuhai	882	16	1.81	1,221	20	1.64	1,177	15	1.27
Alxa	183	2	1.09	238	4	1.68	260	6	2.31
Total	26,940	553	2.05	31,504	573	1.82	43,463	871	2.00

Table 3 Top five clinical departments with respect to nosocomial infection rates from 2012 to 2014

Year	Infection rates in different departments (%)				
2012	Comprehensive ICU (18.27)	Neurosurgery Department (6.75)	Otolaryngology Department (3.57)	Gynecology Department (3.37)	Hematology Department (Group) (3.29)
2013	Comprehensive ICU (12.92)	Neurosurgery Department (6.72)	Hematology Department (Group) (6.14)	Thoracic Surgery Department (3.83)	Neonatology Group of the Pediatrics Department (3.49)
2014	Comprehensive ICU (26.70)	Neurosurgery Department (7.53)	Hematology Department (Group) (6.04)	Neonatology Group of the Pediatrics Department (3.90)	Nephrology Department (Group) (2.56)

ICU, intensive care unit.

Table 4 Constituent ratios of the nosocomial infection sites (%) from 2012 to 2014

Infection site	2012		2013		2014	
	Case number	Constituent ratio (%)	Case number	Constituent ratio (%)	Case number	Constituent ratio (%)
Upper respiratory tract	89	15.19	76	12.38	104	11.32
Lower respiratory tract	216	36.86	303	49.35	425	46.25
Urinary tract	81	13.82	93	15.15	124	13.49
Gastrointestinal tract	23	3.92	10	1.63	33	3.59
Gallbladder bile	4	0.68	2	0.33	3	0.33
Intra-abdominal tissue	11	1.88	5	0.81	21	2.29
Superficial incision	74	12.63	56	9.12	75	8.16
Deep incision	20	3.41	9	1.47	24	2.61
Organ cavity	1	0.17	0	0.00	11	1.20
Vascular-related	5	0.85	5	0.81	7	0.76
Blood flow	9	1.54	8	1.30	6	0.65
Skin/soft tissue	32	5.46	24	3.91	34	3.70
Burned area	2	0.34	0	0.00	2	0.22
Others	19	3.24	23	3.75	50	5.44
Total	586	100.00	614	100.00	919	100.00

Table 5 The rates (%) of antibiotic use and submissions for examination of disease etiology before therapeutic treatment with antibiotics from 2012 to 2014

Year	Number of patients under surveillance	Antibiotic use		Purposes			Therapy			Examination of etiology by bacterial culture	
		Number of patients	Rate (%)	Treatment	Prophylaxis	Treatment + prophylaxis	Mono therapy	Dual therapy	Triple (or multi-drug) therapy	Number of cases submitted	Submission rate (%)
2012	26,940	9,722	36.08	5,580	3,084	1,058	7,354	2,229	139	1,581	23.82
2013	31,504	10,382	32.95	6,139	3,172	1,071	7,823	2,417	142	1,974	27.38
2014	43,463	14,262	32.81	8,308	4,667	1,287	10,722	3,309	231	3,069	31.99
Total	101,907	34,366	33.72	20,027	10,923	3,416	25,899	7,955	512	6,624	28.26

Antibiotic use

The rates of antibiotic use were 36.08% in 2012, 32.95% in 2013 and 32.81% in 2014, with a 3-year average of 33.72%. From 2012 to 2014, the rate of antibiotic use decreased from 36.08% to 32.81%, which was a statistically significant difference ($\chi^2=91.78$, $P=0.00<0.05$). Meanwhile, the rate of bacterial cultures submitted before therapeutic use of antibiotics increased from 23.82% to 31.99%, which was a statistically significant difference ($\chi^2=133.08$, $P=0.00<0.05$). Increases in the constituent ratio of monotherapy and the therapeutic use of antibiotics were observed (Table 5). On

average, the rates of antibiotic use followed a decreasing trend, while the submission rate for bacterial cultures before therapeutic treatment with antibiotics displayed an increasing trend (Figure 1).

Pathogens of nosocomial infections

The consecutive 3-year survey showed that G⁻ bacteria were the most common pathogens (>60%) of nosocomial infections, followed by G⁺ bacteria. Fungi and other pathogens were detected less frequently (Table 6). The

constituent ratios of pathogens that caused nosocomial infections from 2012 to 2014 are shown in *Figure 2*.

Discussion

Authorized by the Inner Mongolia autonomous region health and family planning commission, organized by the Nosocomial Infection Management and Quality Control

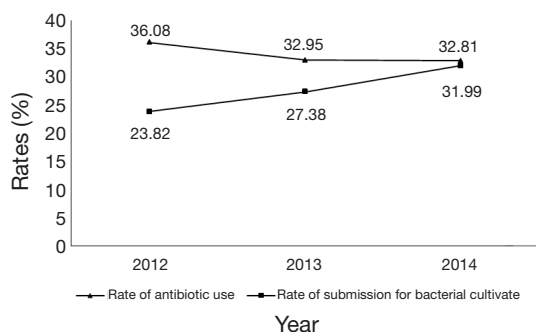


Figure 1 Rates (%) of antibiotic use and submission for examination of the disease etiology by bacterial culture before therapeutic use of antibiotics from 2012 to 2014.

Center of the Inner Mongolia Autonomous Region to carry out the hospital infection rate survey. Through the investigation to understand the prevalence of nosocomial infections, the distribution of nosocomial infection sites, the use of antibiotic and the situation of detected nosocomial infection pathogens in the Inner Mongolia Autonomous Region of China from 2012 to 2014, to grasp the current conditions of regional nosocomial infections in timely, for the development of infection prevention and control measures to provide a basis for effective hospital.

Prevalence of nosocomial infections

The actual survey rates over the 3-year period from 2012 to 2014 remained greater than 96.00%, which is consistent with the findings of the survey. The 3-year average prevalence of nosocomial infections was 1.96% in Inner Mongolia. This value is lower than that reported by Wu et al. in a national survey in 2012 (3.22%, $\chi^2=477.79$, $P=0.00<0.05$) and the survey results reported in Sichuan in 2011 (2.64%, $\chi^2=90.79$, $P=0.00<0.05$). Moreover, the

Table 6 Distribution and constituent ratios of pathogens that caused nosocomial infections from 2012 to 2014 (%)

Pathogen	2012		2013		2014	
	Number of cases	Constituent ratio (%)	Number of cases	Constituent ratio (%)	Number of cases	Constituent ratio (%)
G ⁻ bacteria	158	71.82	203	67.22	298	70.28
<i>Acinetobacter baumannii</i>	16	7.27	40	13.25	46	10.85
<i>Klebsiella pneumoniae</i>	41	18.64	40	13.25	55	12.97
<i>Escherichia coli</i>	46	20.91	51	16.89	81	19.10
<i>Pseudomonas aeruginosa</i>	30	13.64	26	8.61	61	14.39
<i>Enterobacter spp</i>	4	1.82	18	5.96	18	4.25
Other G ⁻ bacteria	21	9.55	28	9.27	37	8.73
G ⁺ bacteria	47	21.36	74	24.50	98	23.11
<i>Staphylococcus aureus</i>	27	12.27	32	10.60	44	10.38
Other <i>Staphylococcus</i>	8	3.64	19	6.29	22	5.19
<i>Enterococcus spp</i>	6	2.73	11	3.64	22	5.19
Other G ⁺ bacteria	6	2.73	12	3.97	10	2.36
Fungi	10	4.55	19	6.29	21	4.95
<i>Candida albicans</i>	3	1.36	8	2.65	10	2.36
Other fungi	7	3.18	11	3.64	11	2.59
Other pathogens	5	2.27	6	1.99	7	1.65
Total	220	100.00	302	100.00	424	100.00

G⁻, Gram-negative.

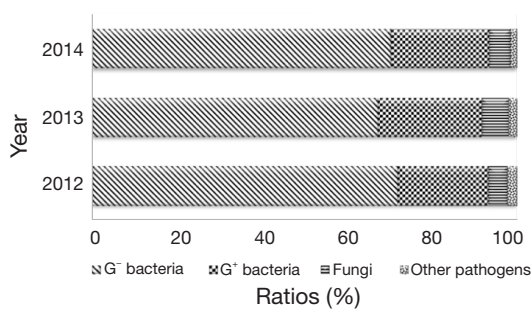


Figure 2 Constituent ratios of pathogens that caused nosocomial infections from 2012 to 2014 (%).

average prevalence of nosocomial infections in Inner Mongolia is far lower than the survey result reported by the European Centre for Disease Prevention and Control in 2010 (7.1%) (1-4). No significant differences were found in the prevalence of nosocomial infections during the individual years from 2012 to 2014, indicating that the prevalence of nosocomial infections was relatively stable in Inner Mongolia. From 2012 to 2014, the prevalence of nosocomial infections displayed different trends in various areas of the study region. Specifically, declines in the prevalence of nosocomial infections were observed in Hohhot City, Ulan Qabu League, Bayan Nur League, and Wuhai City, while an increasing trend was found in Ordos City, Hinggan League, Chifeng City, Xilin Gol League, and Alxa League. Moreover, the prevalence of nosocomial infections first decreased and then increased in Baotou, Hulun Buir, and Tongliao City. The increase in the prevalence may be related to different survey periods and a high underreporting rate of nosocomial infections. It is also possible that the prevalence of nosocomial infections actually increased during the study period. This finding suggests that hospitals of highly prevalence of nosocomial infections should continue to strengthen prevention and control measures and implement associated measures for nosocomial infections. In recent years, the Nosocomial Infection Management and Quality Control Center of the Inner Mongolia Autonomous Region has organized hospitals for targeted surveillance of nosocomial infections in the ICU and neonatal and surgical sites and has conducted surveillance of antibiotic use. Good results were achieved, and the conditions that promote nosocomial infections have been effectively controlled. The survey results reflect the current conditions of nosocomial infections and further reflect the future trend of nosocomial infections in the Inner Mongolia Autonomous Region.

Nosocomial infections in different clinical departments

Based on the 3-year survey results, the comprehensive ICU, Neurosurgery Department., and Hematology Department were identified as the clinical departments with the highest prevalence of nosocomial infections. This finding is consistent with previous studies in China and other countries (5-7). The majority of the patients admitted to the comprehensive ICU have undergone invasive operations, more basic diseases, a long period of hospitalization, and long-term use of antibiotics. Moreover, these patients mostly carried multidrug-resistant bacteria. As a consequence, the comprehensive ICU was the clinical department with the highest prevalence of nosocomial infections. In the surgical system, the Neurosurgery Department exhibited the highest prevalence of nosocomial infections. Most patients admitted to the Neurosurgery Department had undergone a craniotomy, resulting in coma and prolonged bed rest. These patients commonly received assisted breathing and catheterization and were prone to respiratory and intracranial infections. Therefore, the Neurosurgery Department should be a high priority for nosocomial infection management. In the Hematology Department, the inpatients had commonly received immunosuppressive drugs, hormones, and chemotherapy drugs. Due to their compromised immunity, these patients were at high risk of nosocomial infections. Compared to the results of the survey in 2012 and 2013, the prevalence of nosocomial infections in 2014 were relatively higher in the Comprehensive ICU, Neurosurgery Department, Hematology Department, and Nephrology Department. The above departments will be priorities for future management of nosocomial infections in the study region.

Nosocomial infection sites

The survey results showed that nosocomial infections mainly occurred in the lower respiratory tract, which is consistent with previous reports in China and other countries (8-10). A monitoring was conducted by the Hu B, data from 2,631 patients hospitalized in ICU.VAP, catheter related bloodstream infection, Catheter-associated urinary tract infection were 10.46 per 1,000 bed day, 7.66 per 1,000 bed day, 1.29 per 1,000 bed day respectively (11). Thus it can be seen that, high-risk factors which cause respiratory infections is invasive procedure. Respiratory infections are an important and difficult point of nosocomial infection prevention and control. High-risk factors that cause

respiratory infections include the use of a ventilator, intubation and incision, non-standardized performance of sputum aspiration, improper oral care, and poor ward environment. We will take hand hygiene assessment, disinfection and isolation systems, aseptic operation systems, visiting procedures, and invasive procedure assessment into consideration in the quality assessment system. A series of measures for training, education, and examination can be applied to improve the awareness of medical staff, cleaning staff, patients, and their families regarding the prevention and control of nosocomial infections. These measures could reduce the risk of nosocomial infections effectively (12). To increase hand hygiene compliance of medical staff, we should take a series of measures which included the following elements: administrative support, supplies availability, education and training, reminders in the workplace, process surveillance and performance feedback, etc. (13). Currently, the Inner Mongolia Nosocomial Infection Management and Quality Control Center has stated that the hospitals registered in the surveillance network which should carry out targeted surveillance of nosocomial infections at important sites. Prevention of nosocomial infections at these sites, especially for infections caused by invasive procedures, is a future priority.

Antibiotic use

In this survey, the rates of antibiotic use and bacterial culture submitted for examination of disease etiology before the therapeutic use of antibiotics were both lower than the national survey results in China (2). In the first half of 2011, the State Planning Commission initiated a special rectification action towards the clinical application of antibiotics. Moreover, the "Management Approach for Clinical Use of Antibiotics in Medical Institutions" was promulgated, which further specified the clinical use of antibiotics in China. Currently, the hospitals in the study region all include indicators of antibiotic use in the hospital management and quality assessment system and implement targeted surveillance of antibiotic use. This effort has attenuated the abuse of antibiotics. Discover and correct the phenomenon timely that antibiotic was unreasonable used the therapeutic use of antibiotics for bacterial culture rate still remain lower. Empirical and broad-spectrum uses of antibiotics are common problems in clinical departments, which urgently need to be addressed. The rational use of antibiotics will not only reduce medical risks but also diminish the health burden on the patient.

Pathogens of nosocomial infection

The survey results showed that Gram-negative (G^-) bacteria were the primary pathogens of nosocomial infections, while fungi, viruses, and other pathogens were detected less frequently. Among G^- bacteria, *E. coli*, *P. aeruginosa*, *K. pneumoniae*, and *A. baumannii* were detected more frequently. With respect to G^+ bacteria, staphylococci and enterococcus were commonly found. These results are generally consistent with the results of the 2012 National Survey (2). From 2012 to 2014, the constituent ratio of G^- bacteria for pathogens that cause nosocomial infections followed a downward trend, while the ratios of G^+ bacteria and other pathogens were relatively increased. These changes are worthy of attention, and hospitals should notice these trends in future efforts for nosocomial infection prevention and control. A portion of the bacterial pathogens exhibited broad-spectrum or multi-drug resistance to antibiotics. The inherent characteristics of multi-drug resistant strains could make it difficult to cure the resultant diseases. Rationally using antibiotics, increasing the culture submission rate for examination of the disease etiology, and improving the compliance and accuracy of hand hygiene of the medical staff are the keys to reducing infections with multi-drug resistant bacteria.

Conclusions

The survey of the prevalence of nosocomial infections helped to identify problems in the control process of nosocomial infections and to develop targeted measures for the prevention and control of these infections accordingly.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

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