Investigation and Analysis of Biosafety Awareness Among Hospital Laboratory Staff in Seven Provinces of China

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Research article

Keywords: Hospital, Laboratory staff, Biosafety awareness and cognition

Posted Date: July 16th, 2020

DOI: <https://doi.org/10.21203/rs.3.rs-43702/v1>

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Abstract

Background: To understand the biosafety awareness of hospital laboratory staff in seven provinces of China, and to provide a basis for medical staff to carry out laboratory biosafety education.

Methods: By using a stratified random sampling method, 188 laboratory staff from 41 hospitals in seven provinces were selected for a face-to-face questionnaire survey. In this survey, the biosafety awareness of the respondents was scored, and the biosafety awareness among hospital laboratory staff were evaluated based on the score.

Results: The overall average score of laboratory staff in the surveyed hospitals was 81.64 points, and the average score of the biosafety awareness in the laboratory was 95.57 points, while the average score of biosafety awareness in risk assessment and control was only 44.68 points. Among the respondents, 57.22% of the staff identified a lack of special funds relating to biosafety activities.

Conclusion: Biosafety awareness of laboratory staff is low, with laboratory funding, education level and years of laboratory work affecting the biosafety awareness of hospital laboratory staff. Biosafety training needs to be improved by paying attention to the biosafety training content, plus adding training effect evaluation and feedback loops, as well as exploring new training modes and increasing the support through special hospital biosafety funds.

Background

Laboratory biosafety assessment is a comprehensive preventive measure to establish laboratory risk factors, to prevent laboratory personnel from being exposed to these risks [1], and to prevent any biohazards from spreading outside the laboratory and causing public endangerment [2]. Laboratory biosafety is not only important in scientific research institutions, but also in medical institutions [3]. Its successful implementation includes adequate system documentation, personnel training, sample transportation, waste disposal, and emergency treatment [4]. The biosafety awareness of laboratory staff reflects the comprehensive ability of laboratory staff to identify and effectively deal with any potential risks that may compromise the safety of the laboratory workplace. If biosafety awareness is weak, there may be risks in all the previously mentioned areas [5]. Facing numerous and frequent patient encounters, the hospital is an important place for the spread of infectious diseases and the occurrence of cross-infection. The clinical laboratory staff of a hospital gets in contact with a patient's blood, body fluids, feces and other samples that may carry infectious pathogens at any time. It is a high-risk area for biohazards [6]. The incidence of the nosocomial infection rate was significantly higher in microbiological laboratories than other departments [7], which suggests that attention needs to be paid to the self-protection awareness of medical staff to reduce the risk of nosocomial infections. Laboratory testing is a key technology in the response to emerging infectious diseases, particularly considering the current global pandemic of COVID-19. Biosafety awareness is crucial to the accuracy and safety of laboratory testing, and it is an important guarantee for laboratory testing.

In order to understand the biosafety knowledge of hospital laboratory staff in several provinces of China, this study aimed to carry out a survey of laboratory staff in 41 hospitals in Shanghai, Zhejiang, Hunan, Guangdong, Guangxi Zhuang Autonomous region, Guizhou and Yunnan province from 2014 to 2015 to assess the knowledge of hospital laboratory staff on biosafety and provide data support for laboratory biosafety training.

Methods

Survey methods

The questionnaire on biosafety awareness and knowledge of laboratory staff was generated by collecting and reading the literature on the topic. It included questions relating to demographic characteristics and laboratory biosafety knowledge. The final questionnaire consisted of 26 questions that were distributed as follows: risk assessment and control, safety of laboratory facilities & equipment, individual protection, health monitoring, laboratory activities, transportation of infectious substances, collection and disposal of medical waste, and emergency management.

Data Collection

The information was collected from July 2014 to December 2015. The survey was stratified by provincial, municipal and county regions, and hospitals were selected from each province. The object of the investigation was the hospital laboratory staff which was mainly concerned with patient sample testing. All respondents were interviewed face-to-face, the researcher asked the respondent all questions and notes their responses. The response rate is 100%.

Statistical analysis

A database was created using the Statistical Package for the Social Sciences (SPSS) software, version 22 (IBM SPSS Inc.). The eligible participants totaled 188. Descriptive analysis was used to analyze baseline characteristics and scores, variance analysis was used for personnel stratification comparison. To evaluate which characteristics were associated with average scores of the participants, influencing factors analysis were performed using rank correlation. The statistical significance level was set at $p \leq 0.05$.

Results

Baseline characteristics

A total of 188 laboratory staff from 41 hospitals in seven provinces were surveyed. The majority of the respondents were female (61.17%), half of the respondents had a bachelor's degree, most had intermediate or junior professional titles, and 51.06% of the respondents were from municipal hospitals (Table 1).

Table 1
Demographic characteristics of the participants.

Characteristic	Category	General n (%)
Gender	Male	73 (38.83%)
	Female	115 (61.17%)
Education level	Master's degree and above	23 (12.23%)
	Bachelor's degree	94 (50.00%)
	Junior college degree	55 (29.26%)
	Junior college degree or less	16 (8.51%)
Professional title	Deputy senior and above	36 (19.15%)
	Intermediate	68 (36.17%)
	Junior	70 (37.23%)
	Junior titles or less	14 (7.45%)
Personnel distribution	Provincial hospital	23 (12.23%)
	Municipal hospital	96 (51.06%)
	County hospital	69 (36.70%)

Biosafety awareness of hospital laboratory staff

Through the comparison of the average scores to these questions, biosafety awareness of hospital laboratory workers was judged. The hospital laboratory staff displayed higher average scores for laboratory activities (95.57 points), laboratory facilities & equipment (91.36 points), and health monitoring (90.60 points). However, the average score of risk assessment and control was only 44.68 points, far lower than the overall score of 81.64, indicating that the awareness in this area was low (Table 2).

Table 2

□Average scores of biosafety awareness of laboratory staff in different regional hospitals.

Category	Provincial hospital	Municipal hospital	County hospital	Average scores
Risk assessment and control	50.00	45.31	42.03	44.68
Laboratory facilities & equipment	94.57	90.63	86.96	89.76
Individual protection	83.70	91.93	93.12	91.36
Health detection	85.51	90.97	91.79	90.60
Laboratory activities	97.10	96.53	93.72	95.57
Transportation of infectious substances	68.12	77.43	62.80	70.92
Collection and disposal of medical waste	79.71	79.17	83.58	80.85
Emergency management	75.36	73.61	66.18	71.10
Average scores	81.22	82.96	79.94	81.64

Biosafety awareness of laboratory staff in provincial, municipal and county hospitals

The average score of laboratory staff in provincial, municipal and county hospitals was similar, with the highest score at the municipal hospitals (82.96 points). The result of variance analysis was $F = 1.343$, and there was no statistical difference between the three groups ($P > 0.05$) (Table 3).

Table 3

Biosafety awareness of laboratory staff at all levels of hospitals.

Hospital level	N	Average scores	F	P
Provincial hospital	23	81.22	1.343	0.264
Municipal hospital	96	82.96		
County hospital	69	79.94		

Biosafety awareness of hospitals laboratory staff in different provinces

Among the seven provinces, Shanghai province hospital laboratory staff had the highest average score of biosafety awareness (86.67 points), while Zhejiang province hospital laboratory staff had the lowest average score of biosafety awareness (73.60 points). The result of variance analysis was $F = 0.992$, and there was no statistical difference between the seven groups ($P > 0.05$) (Table 4).

Table 4
Biosafety awareness of hospitals laboratory staff in different provinces.

Provinces	N	Average scores	F	P
Guizhou	25	81.12	0.992	0.432
Guangxi Zhuang Autonomous region	36	79.78		
Zhejiang	5	73.60		
Hunan	43	81.30		
Yunnan	29	83.59		
Guangdong	41	82.44		
Shanghai	9	86.67		

Influencing factors of biosafety awareness

Rank correlation was used to analyze the influencing factors of biosafety awareness of hospital laboratory staff, including gender, professional title, educational level, age, and years of laboratory experience. There was a positive correlation between education level and biosafety awareness ($P < 0.05$), and a negative correlation between years of laboratory work and biosafety awareness ($P < 0.05$). The results indicate that gender, professional title and age did not correlate with biosafety awareness ($P > 0.05$) (Table 5).

Table 5
Influencing factors of biosafety awareness in hospital laboratory staff.

Influencing factors	N	Average scores	r_s	P
Gender			0.016	0.827
Male	73	81.04		
Female	115	82.02		
Professional title			-0.039	0.598
Deputy senior and above	36	83.11		
Intermediate	68	79.88		
Junior	70	83.03		
Junior or less	14	79.43		
Educational level			0.292	0.000
Master's degree and above	16	77.00		
Bachelor's degree	55	77.75		
Junior college degree	94	83.53		
Junior college degree or less	23	86.43		
Age (years)			-0.136	0.062
< 30	56	83.36		
30–39	70	82.51		
40–49	47	82.21		
>=50	15	69.33		
Years of laboratory work			-0.149	0.041
< 5	52	83.69		
5–14	58	82.62		
15–29	65	81.66		
>=30	13	69.92		

Laboratory biosafety management

The survey on the management of laboratory biosafety found that only 11.76% of respondents thought there was no problem in any aspect of the laboratory, 60.96% of respondents thought that the laboratory staff lacked biosafety awareness, 57.22% of respondents identified a lack of special funds for laboratory

operation and maintenance, 48.66% of respondents indicated a shortage of full-time staff in laboratory biosafety management, and 44.39% of respondents thought that the laboratory equipment was outdated (Fig. 1).

Discussion

Biosafety awareness of hospital laboratory workers with low educational background

It has been reported that educational level is one of the factors that affect the biosafety awareness of laboratory staff [8]. In this survey, the education level of the respondents was mainly at bachelor's degree and below. The study also found that education level was positively correlated with biosafety awareness ($P < 0.05$). At present, most of the colleges and vocational schools in China lack laboratory biosafety knowledge courses [9], and medical students' cognition of laboratory biosafety was not encouraging [10, 11]. It has been suggested to set up biosafety courses from junior college majors, to train the students who were ready to engage in biosafety work as soon as possible [12], which has been shown to be beneficial to the cultivation of biosafety awareness and formation of good habits at work, as well as having significance to practical work [13].

This study showed that years of experience in laboratory work also was a factor affecting biosafety awareness. The biosafety awareness average score of those who had worked for more than 30 years was only 69.92 points, lower than the average score of those who had worked for less than 30 years. By working in a safe environment for a long time, people tend to pay less attention to detail, which may pose a higher risk of accidents [14]. Therefore, attention to the training of long-term laboratory testing staff should be paid by regularly monitoring and updating the standard operating procedures, and cultivate the ability of risk identification and control, so as to improve the biosafety awareness.

Training of risk assessment and control ability

In this survey, hospital laboratory staff had the lowest score (44.68 points) for risk assessment and control, with risk management being shown to reduce the incidence of hospital infections [15]. It is necessary for hospital testing staff to train comprehensively on biosafety knowledge, with emphasis on risk assessment, i.e. identifying and assessing risks and proposing measures to control risks.

Biosafety training of laboratory testing staff in hospitals

Biosafety training of laboratory personnel is an internationally recognized strategy for improving the ability to handle potentially infectious samples [16]. In this survey, 60.96% of participants believed that laboratory staff lacked safety awareness. It was noted that there was little training on biosafety in the hospitals or less time for the staff to participate in training, so the staff was unable to develop a high biosafety awareness, which can only be gained through continuous training at work.

Special funds for hospital biosafety

The clinical laboratory of a hospital is responsible for the detection of many pathogens potentially risky to human health, which need to be managed in a Biosafety Level 2 laboratory [17]. The facilities and equipment of a biosafety laboratory and the personal protective equipment are different from an ordinary laboratory. Regular testing and maintenance of equipment, as well as the collection, transportation and disposal of medical waste need special funds to support these actions. At the same time, with the improvement of medical and detection technologies, the technology and components of biosafety facilities & equipment should be constantly updated. Modern instruments and equipment can provide more effective, convenient and accurate biosafety detection abilities for personnel and patients. Therefore, it is suggested that the hospital or the relevant department grants special funds to the biosafety laboratory to ensure that the laboratory testing can be carried out more efficiently.

Training effect evaluation and new training modes

This study revealed that the laboratory staff identified the training as not sufficient in terms of frequency and content, leading to low biosafety awareness. In the future, biosafety training courses should include a training feedback and evaluation loop, which can assess whether the trainees understand the content, but also whether the training has achieved the set goal. The received feedback can also provide ideas for new training content and methods. By exploring online training delivery and optimizing the training method, the efficiency of the biosafety training can effectively be improved [18–20].

Conclusions

Enhancing biosafety awareness among hospital laboratory staff is a long-term and complex task. It requires staff and managers to recognize the importance of biosafety assessment and risk aversion. By using new training modes and focusing on the training of key staff and key contents, staff should be encouraged to participate in the training, so as to effectively improve the biosafety awareness. Future research may expand on the investigation scope, increase the sample size and improve the accuracy of the analysis.

Declarations

Ethics approval and consent to participate

The study received approval from Chinese Center for Disease Control and Prevention. All interviews were conducted with the participants' written informed consent. Each participant in the study was clearly explained of the study objectives, informed of their rights to deny participation and assured for the confidentiality of the information provided.

Consent for publication

Not applicable.

Availability of data and material

All data generated or analysed during this study are included in the article.

Competing interests

The authors declare that they have no competing interests.

Funding

This study was funded by National Major Science and Technology Projects of China, grant number 2018ZX10734-401. The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Author Contributions

CHZ designed the study. CJY and BL actively participated during the data collection. SSL conducted the study and were responsible for data analysis. SSL wrote the manuscript. CHZ and JL supervised the overall research process since the study design through manuscript writing. CHZ and SSL revised and finalized the manuscript. All authors read and approved the final manuscript.

Acknowledgments

We would like to acknowledge director Hong Chen and Kai Kang of Emerging Infectious Diseases Cooperation Program and all the Respondents for their cooperation and participation in this study.

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Figures

Figure 1

Problems identified in laboratory biosafety management.

Supplementary Files

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- [Questionnaire.doc](#)