

Exploring the Path of Laboratory Security Management in Local Universities

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Abstract: Due to the shortage of funds for local universities, the investment in laboratory safety cannot be fully guaranteed, and the construction of safety protection supporting facilities and safety management is lagging behind, so safety is seriously challenged. In recent years, labs have been opened and shared more, and the potential safety risk factors have increased. Laboratory safety accidents occur from time to time, which seriously threaten the lives of teachers and students. Therefore, the safety management of laboratories in local universities needs to be strengthened. By summarizing the current situation of laboratory safety management in local universities, this study analyzes the obvious shortcomings of laboratory safety management in terms of system and regulations, site planning, team building and informationization level from physical and human factors. For example, unclear authority and responsibility between departments, there is insufficient safety management front in laboratory planning and construction, and the safety awareness of personnel is weak. In view of the risks in safety management work, suggestions are made in four aspects: laboratory management system, laboratory technical team construction, regularization of safety education, and optimization of safety management information platform, with a view to providing reference for the effective operation of laboratory safety work in local universities.

Keywords: Local Universities, Laboratory, Security Management

1. Introduction

Laboratory is an important platform for experimental teaching and scientific research in universities, as well as a window for high quality social services, and plays an important role in cultivating students' comprehensive practical ability. With the increasing investment in laboratory construction, the conditions of software and hardware facilities have been improved, and the demand for openness and sharing of laboratory resources has increased, as are the risk factors for potential safety incidents [1]. In 2019, the Chinese Ministry of Education issued the Opinions on Strengthening Laboratory Safety in Universities, which emphasized the importance of deeply understanding laboratory safety and effectively enhancing the capacity and level of laboratory safety management in universities in order to address safety weaknesses [2]. Therefore, the task of laboratory safety in university management cannot be ignored.

Laboratory security is a task that cannot be neglected in

university management. At present, universities directly under the central ministries and commissions have gradually realized the intelligence and informationization of laboratory safety management. However, due to the shortage of educational resources and unbalanced regional economic development, the construction of laboratory safety protection facilities and safety management in local universities is lagging behind, and laboratory safety is facing serious challenges. Therefore, it is important to discuss the potential risks in laboratory safety under the new situation and put forward corresponding ideas and suggestions to maintain the security and stability of local universities.

2. Potential Risk Factors for Laboratory Security Management

2.1. Inadequate Management System, Unclear Authority and Responsibility

In terms of organizational system, the scope of laboratory

safety management involves many aspects such as personnel, equipment and premises, which is a systematic work and requires a special management organization responsible for planning and coordinating, providing service support and management control of laboratory safety in the whole university. A survey by Cha et al on 91 local universities showed that 33.3% did not have a laboratory safety management organization at the university level [3]. Even for those universities that have established laboratory safety management functions, the proportion of full-time staff is low, and they have to undertake other work, so they cannot devote themselves to laboratory safety management. Local universities implement teaching laboratories and research laboratories are managed by the Academic Affairs Office and the Research Office respectively. At the same time, asset management, security department, logistics department, etc. are closely connected with safety. The cross-function and vacuum coexist, which easily blur the authority and responsibility of management subjects, resulting in insufficient effectiveness of supervision of the whole process and cycle of laboratory safety and failure to find hidden dangers in time. Vertically, local colleges and universities adopt the management mode of "school-led and secondary colleges as the main body". The second-level colleges only fulfill the school's requirements and tasks for laboratory safety management, and do not work creatively with the professional characteristics of the faculty, and to a certain extent, they still have the rough management concept of "waiting, relying and asking", and rely excessively on the higher departments to solve problems [4].

In terms of the system of safety rules and regulations, the system at the university level is not yet perfect, and the absence of special sub-systems is more common. For example, special systems such as laboratory safety accountability and safety education. The systems developed by some universities at the laboratory level are poorly targeted, and the implementation of laboratory safety management systems is far from adequate.

2.2. Laboratory Planning and Construction Is Not Reasonable Enough

The expansion of the laboratory has effectively alleviated the contradiction of the tight room and expanded the experimental space. However, new challenges have emerged. On the one hand, there is a lack of standardized design and construction norms, and after the building rooms are converted into laboratories, the supporting safety protection facilities are missing. Due to financial constraints, local universities cannot invest too much in the construction of laboratory infrastructure, which leads to the inability to meet the requirements of safety specifications for professional laboratories. For example, the location and size of exhaust wells and sewage outlets do not meet the safety standards, and the power distribution load is not enough. Cha et al pointed out that when local universities build new experimental places, there is a general situation of insufficient safety management front, and the use of laboratories is not fully planned when the

building is designed and constructed [3]. On the other hand, as the purchase of teaching and research equipment in universities increases year by year, in the absence of reasonable layout, abandoned miscellaneous items and old equipment to be scrapped are stacked in the building, which seriously affects the safe passage of laboratories and takes up valuable space. The storage room for hazardous chemicals does not meet the specifications, and these all sow the hidden dangers of laboratory safety.

2.3. Insufficient Professional Capacity of Security Management Team

The staffing of laboratory technicians is lagging behind the rate of laboratory growth [5]. Laboratory managers require comprehensive and professional safety knowledge and skills in plumbing, electrical, hazardous chemical, fire protection, etc. Local universities do not train enough laboratory safety managers, and the stability of the management team is poor. Due to the narrow space for career development and tedious work, it is difficult for them to study their own work for a long time, and they may change jobs at their own choice. Most of the existing laboratory safety management personnel are working in several positions, and they are not professional in their background, and their safety quality varies, resulting in a low degree of professionalism in management. Lack of enthusiasm in safety management, insufficient awareness of the importance of safety, low implementation of safety management, inadequate safety risk assessment, and the inability to find safety loopholes in a timely manner. Therefore, the experimental team is in urgent need of further construction and improvement.

2.4. Weak Safety Awareness and Safety Education Is Not Taken Seriously

Heinrich's law believes that accidents occur as a result of accumulation of quantity to a certain level. The perfect technology and system cannot replace the quality and responsibility of people [6]. Laboratory safety risks boil down to a weak perception of people's safety awareness. Li analyzed 100 laboratory safety accidents in Chinese universities and found that the number of fire accidents and explosions accounted for 86% of all types of accidents, with improper human operation being the main cause of accidents [7]. The importance of safety prevention technology and management system is beyond doubt, but the safety awareness and literacy of personnel is more important. Laboratory personnel mobility, some teachers and students have a "safety accident is only a small probability event" of the fluke mentality, the sense of security responsibility is not strong [8].

The lack of safety training before students and faculty enter the laboratory, experimental operations do not comply with the safety procedures, and protective measures are not in place, resulting in an obvious increase in safety uncertainties. In recent years, the frequent occurrence of laboratory safety accidents has sounded an alarm to campus

safety. Local universities have started to pay attention to laboratory safety education, but compared with top universities, the development is generally lagging behind, in a "didactic and fragmented" state, without achieving the desired effect [9].

In order to have a more in-depth understanding of the current situation of laboratory safety education in local universities, a questionnaire survey was conducted for senior students in colleges and universities. The survey was conducted anonymously and voluntarily, and a total of 267 valid questionnaires were collected. The results in the table 1 showed that 89.14% recognized the necessity of laboratory safety education, and students received special safety education with low frequency, only 23.22% participated in two or more trainings. In the mastery of safety knowledge and

skills, 50.57% said they were not proficient or even did not master it at all. 43.07% did not receive access assessment before entering the laboratory. 47.19% of students were not clear about laboratory safety rules and regulations and emergency plans, and 38.95% had participated in emergency drills. Combined with previous studies, it is found that safety education in local universities is mostly formal, laboratory safety education is not incorporated into the school curriculum teaching system, safety education content is mostly based on theoretical education such as fire safety knowledge, lack of practical operation and emergency disposal practice, and emergency disposal ability needs to be improved. The assessment of safety education is not strict, and the laboratory access system is not really implemented. This shows that laboratory safety education has a long way to go.

Table 1. Laboratory safety education in local universities.

		No. of people	Percentage (%)
Is it necessary to conduct laboratory safety education and training?	Yes	238	89.14
	No	29	10.86
Whether to receive safety assessment before entering the laboratory for the first time?	Yes	152	56.93
	No	115	43.07
	2 times and above	62	23.22
Number of laboratory safety education received?	1	151	56.56
	0	54	20.22
	Complete mastery	34	12.73
Acquired the knowledge and skills to enter the laboratory safely?	General mastery	98	36.7
	Not quite mastered	67	25.1
	Not at all	68	25.47
	Very clear	40	14.98
Be aware of the laboratory's rules and regulations system emergency response plan?	Clearer	101	37.83
	Not really sure	67	25.09
	Not at all clear	59	22.1
Do you have participated in emergency drills organized by the laboratory?	Yes	104	38.95
	No	163	61.05

2.5. Laboratory Safety Information Technology Construction Lags Behind

The traditional safety management mode relies on manual work and faces difficulties in the effectiveness of risk control and the foresight of early warning, which makes it difficult to realize real-time and accurate control of hazardous sources and leads to blind spots in management, making it difficult to identify and eliminate potential risks in time. For example, the management of hazardous chemicals in some universities still relies on paper-based ledgers and complicated data statistics, which leads to unclear bottom and status of hazardous chemicals. At present, the information construction of local universities mainly focuses on equipment procurement, fire warning, safety examination and practical teaching, but the systems developed by different companies are single in content and low in integration, which are easy to form "isolated islands of information" and cannot truly realize the interoperability and sharing of laboratory data.

3. Countermeasures and Suggestions for Strengthening Laboratory Safety Management

3.1. Improving the Laboratory Management System

The prevention and control of potential risk factors for laboratory safety is multi-directional and requires standardized management, construction of operational mechanisms, and empowered safety management in order to travel steadily and far [10].

From the organizational system: the implementation of hierarchical, classified and graded organization and coordination, comprehensive treatment. On the basis of comprehensively sorting out all kinds of laboratories in the university and clarifying who is responsible for each laboratory, strengthen the horizontal linkage of functional departments of the university and the responsibility management system of 4-level vertical linkage of the

university - secondary college - laboratory - participants in experimental activities, and sign safety responsibility letters at every level [11]. Improve the "who is in charge, who is responsible", "who uses, who is responsible for" the safety responsibility system, the construction of the main responsibility, supervision, direct responsibility and guarantee responsibility, including the four-in-one responsibility system (See Figure 1). Clear responsibilities and tasks, and gradually realize the new pattern of joint management.

In terms of regulations, the regulations are the top-level design of university laboratory safety management. In addition to various safety management systems, the university should also include dynamic supervision, safety accident handling and reward and punishment system, access and other rules. According to their own characteristics, each institution should formulate and improve various safety rules and regulations for laboratories. Only a comprehensive and detailed system can protect the safe operation of laboratories.

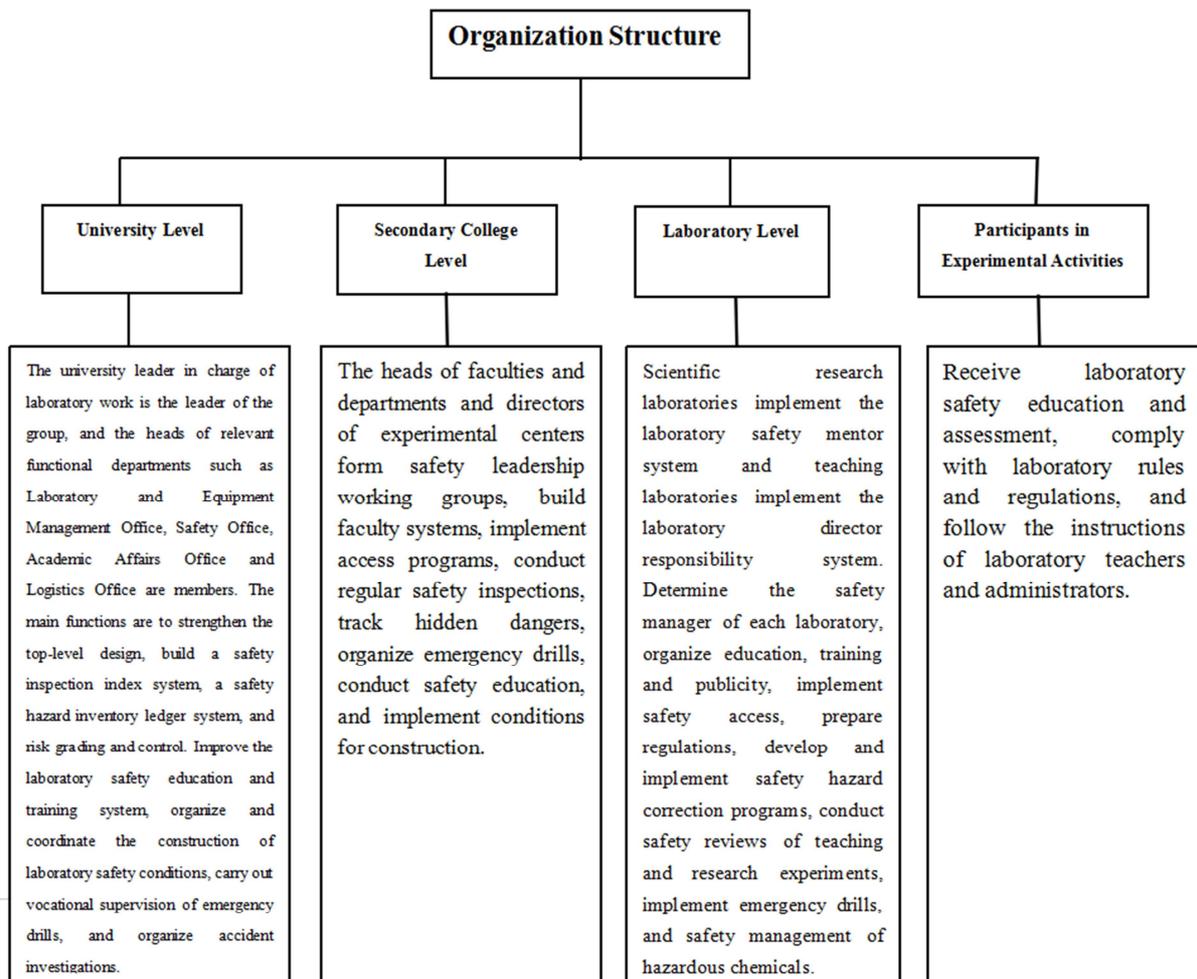


Figure 1. Organizational Structure and Positioning of Responsibilities.

3.2. Emphasis on Experimental Technology Team Building

The laboratory as the responsible subject for safety management, the wide range of safety categories involved, which requires technical managers not only to strictly comply with the rules and regulations, but also to have a solid safety expertise. The school should scientifically coordinate personnel management, strongly support the diversification, systematization and professional training of laboratory technicians, and expand safety business training channels. According to the characteristics of the work, an effective and quantitative assessment mechanism for safety managers. Clarify the job responsibilities of laboratory management personnel, to ensure dedicated posts, to avoid the lack of separation between

full-time and part-time jobs, and to include the workload of safety management in the assessment. A strong sense of responsibility and a high level of laboratory management team can effectively prevent and curb safety accidents.

3.3. Regular Safety Education

Efficient and scientific safety education can enhance the safety awareness and skills of teachers and students in an effective way, and can restrain unsafe behaviors in order to reduce the probability of accidents. Full, comprehensive and systematic safety education plays an important role in improving safety awareness and emergency response capability [12].

Full participation. Whether it is the person responsible for

the safety of a laboratory or the participants of experimental activities, all should enhance the awareness of safety protection. According to the characteristics of the discipline and management requirements, the administrative leadership, the person in charge of the experimental center, the person in charge of each laboratory, experimental teachers and students, and temporary staff to conduct safety training. We will set up a laboratory personal electronic file and manage it according to "one person, one file". After receiving training and passing the examination, we will sign a laboratory safety commitment and issue an access certificate.

Fully implement. Safety education should be incorporated into instruction as a routine. Improve the layered and staged laboratory safety education system. Conduct safety courses, knowledge lectures, competitions and other forms of theoretical education, while developing practical sessions, carrying out emergency drills, identifying safety hazards and improving emergency handling capabilities in case of emergencies. Creating a positive safety culture environment is a form of implicit safety education. Laboratory rules and regulations, operating procedures and safety manuals can be designed visually, transforming textual content into clear and concise views, and making full use of modern means to promote laboratory safety concepts on platforms such as laboratory management systems and WeChat public numbers.

Full dynamic management. Long-term implementation of the laboratory safety access system. The access that faculty and students receive after training and assessment is not a once and for all. Otherwise, there will be paralysis and blindness to the safety hazards around them. Therefore dynamic supervision is needed. Once the relevant personnel in the

process of experimental activities in violation of the operation, will be given penalties and cancel their access to retraining. Dynamic supervision is conducive to always strengthening the safety awareness of teachers and students. At the same time, a safety education evaluation system is established, including first-level indicators such as organization and implementation, implementation of rules and regulations, training faculty, and training files, which are then refined into second-level evaluation indicators and given corresponding scores, and incorporated into the assessment of laboratory management as an important part to build a long-term mechanism for safety education [13].

3.4. Optimize Safety Management Information Platform

The traditional human defense model is unable to prevent and control dangerous sources precisely. Therefore, local university laboratories urgently need to establish a comprehensive and intelligent safety management system [14]. Information management is to laboratory safety of people, events, objects 3 factors as the scope, through big data, mobile communications and other advanced technologies, fully developed to adapt to the PC and mobile end of the visualization, early warning security management system, to solve the current system independent of each other, the utilization rate is not high [15]. The laboratory safety information system integrates 6 subsystems: basic laboratory data, safety inspection, biochemical procurement and management, safety education and examination, monitoring and surveillance system, and intelligent access control reservation (See Figure 2).



Figure 2. Laboratory safety management information platform.

The basic laboratory data system can use 3D technology to accurately display the distribution and detailed information of each laboratory, especially the distribution of important

sources of danger. According to the laboratory hierarchy management approach, information on each laboratory category, risk level, precautionary measures, rules and

regulations, safety responsible persons, etc. are collected and docked with the laboratory equipment management platform in order to accurately grasp the basic laboratory information.

The safety inspection system is conducive to strengthening the key supervision of risky laboratories, forming a closed-loop whole process management of inspection plan, hidden danger ranking, hidden danger record, inspection report generation, rectification issuance, rectification completion, and feedback, improving the accuracy of safety inspection and significantly reducing safety hazards. According to the main points of safety inspection of the Ministry of Education, the inspection can be divided into four levels of linkage mode of school-faculty-laboratory-experimenter, and the majority of teachers and students can upload the pictures and problem descriptions of the safety hazards found to the system at any time through PC or cell phone, and automatically trigger a reminder to notify the relevant personnel to deal with them. Safety management at all levels can view laboratory safety inspection reports and correction notices according to management authority. The person responsible for laboratory safety will review, rectify and provide timely feedback on hidden dangers according to the rectification notice.

The biochemical procurement and management system is developed and designed from the perspective of application, procurement, warehousing, receipt and disposal. Demanding units submit requisition applications in the system and enter the procurement process after approval by the sub-department. Qualified suppliers are selected online to ensure traceability. After supplying, the laboratory administrator counts and keeps them properly, and uploads the biochemicals data to the system to form an electronic ledger to register the receipt and write off the waste, so that the source and status of biochemicals can be clearly grasped and the whole life cycle management of hazardous chemicals can be realized.

The security education and examination system is divided into two modules: learning management and examination management. Different safety training contents and exams can be customized according to professional characteristics, such as chemical, radiation, biological, general knowledge and first aid, etc. The system administrator can upload and update the content through the background, and make statistics on the learning progress and examination pass rate, and construct personal electronic files for safety training.

The intelligent access control reservation system can grasp the laboratory opening and closing status in real time, and efficiently count the usage rate. Students and teachers who have the need to use it apply for reservation through the authorization procedure, and after the application is approved, they can enter with the campus one-card or reservation QR code and identify their identity. At the same time, a dynamic access system is strictly implemented to restrict the entry of those who have not passed the security test and other unrelated personnel. If students do not follow the operating procedures in the process of use, resulting in damage to the instruments and equipment or safety hazards, the relevant personnel will be disqualified from access.

The surveillance and monitoring system installs video surveillance equipment in laboratories throughout the university to monitor experimental activities in real time, especially with the increased opening of laboratories, and can fill the gaps in supervision and management at night and on weekends. It can also provide a basis for the investigation and traceability of safety accidents. In laboratories with high risk levels in accordance with gas monitoring and alarm devices, multi-level alarms are set according to gas concentrations, and safety administrators can view the gas conditions in the laboratory. In the event of a dangerous situation, relevant personnel can receive alarm information in a timely manner.

4. Conclusion

Safety is no trivial matter, and laboratory safety is the focus of university work. Local universities should always implement the concept of "safety first", take "prevention first and comprehensive improvement" as the policy, establish a perfect standardized laboratory safety system, accelerate the information construction, strengthen effective supervision, enhance the vigilance of teachers and students on laboratory safety risks, and achieve campus peace and harmony. To ensure the safe operation of laboratories and to achieve campus peace and harmony.

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