Evaluation Of New Technologies And Methodologies For Improving Laboratory Safety Practices

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Abstract

Maintaining laboratory safety is vital for safeguarding public health workers and limiting the transmission of illnesses acquired inside the laboratory. This research assesses novel technology and approaches designed to enhance laboratory safety standards. The text explores the many risks found in labs, such as biological, chemical, physical, and radioactive risks, and highlights the need of thorough risk assessments. The research emphasizes the need of addressing aspects such as mental burden, leadership training, occupational ergonomics, and worker personality that contribute to ensuring workplace safety. Ensuring compliance with laboratory safety recommendations and regulations is crucial, but, there are inconsistencies between the proposed optimal methods and their actual application in labs. Laboratory Quality Management Systems (LQMS) may improve laboratory safety via the establishment of organized procedures, the implementation of risk assessments, and the prioritization of worker health and safety. Nevertheless, public health labs often emphasize patient safety and the accuracy of test results in LQMS. In order to establish an effective laboratory safety program, it is crucial to include safety measures that are supported by evidence. Obtaining meaningful data on laboratory safety is challenging due to restrictions in available safety data, the intricacy of dealing with many microorganisms and testing services, and the need to comply with different standards and laws. The research highlights the need of implementing standardized methods that combine evidence-based safety

measures with quality management systems in public health labs.

Keywords: laboratory safety, risk assessment, hazard identification, laboratory quality management systems, occupational health, safety.

Introduction

Ensuring laboratory safety is primarily a matter of occupational health for the approximately 290,988 public health professionals in the United States (Beck et al., 2014). Nonetheless, staff who are contaminated or diseased might potentially spread infections acquired via their profession outside of the laboratory, which poses a significant risk for the safety of public health laboratories. This issue has been highlighted by many studies (Fleck, 2004; Blaser and Lofgren, 1981; Hawkes, 1979). In 2014, a number of safety accidents occurred in various federal agencies, which received significant coverage in the national media and brought attention to the problem of safety in public health labs (McCarthy, 2014). The occurrence of safety failures might undermine confidence in the public health system (Cohen, 2014), perhaps leading to less adherence to recommendations from public health agencies (Ward, 2017). Hence, the repercussions of laboratory accidents in public health labs may be significant and far-reaching, even in cases when the occupational health hazards are minimal (Centers for Disease Control and Prevention, 2014).

Although discussions about laboratory safety often center around incidents involving biological hazards, it is widely recognized that laboratories also pose various other potential hazards, such as chemical, physical, and radiological hazards (World Health Organization, 2004; Chosewood and Wilson, 2009; Occupational Health and Safety Administration, 2011). Regrettably, acquiring current data on laboratory mishaps is challenging due to the absence of a uniform reporting system for such accidents (Chamberlain et al., 2009; Dirnagl et al., 2016; Blaine, 2012). Nevertheless, valuable information about laboratory accidents may be obtained by analyzing the Bureau of Labor data. These figures reveal that the incidence rate (2011-2016) of nonfatal occupational injuries and illnesses resulting in days away from work in medical and diagnostic laboratories is 100 per 10,000 full-time workers. Out of the 100 illnesses or injuries, 1% of them were

caused directly by chemicals and chemical compounds. The remaining 99% of illnesses and injuries are caused by a range of possible chemical, physical, and biological dangers that form the basis of the Occupational Injury and Illness Classification System. The source categories of containers, furniture, and fixtures account for 15% of the total. Machinery contributes 5%, while components and materials make up 8%.

Persons, plants, animals, and minerals provide 26%, structures and surfaces account for 17%, and tools, instruments, and equipment contribute 4%. Vehicles make up 10% of the total and other sources account for 13%. Although it is difficult to establish a direct correlation between the above source types and the associated risks, the wide range of event sources clearly highlights the need of conducting comprehensive laboratory safety risk assessments that include all potential dangers, not limited to biological ones. Aside from different types of hazards, there is an increasing amount of information about different factors that contribute to workplace safety. These factors include the impact of mental workload (Charles and Nixon, 2019), the necessity of leadership training (Gravina et al., 2019), the significance of occupational ergonomics (Fasanya and Shofoluwe, 2019), and the influence of worker personality on safety behavior (Jong-Hyun et al., 2018). However, these factors have not been extensively studied in laboratory settings.

Laboratory safety

Although laboratory safety has been a top concern in public health laboratories for a long time, there are still several discrepancies between the recommended best practices and their actual implementation in laboratories. There are numerous regulations, guidelines, and standards that are relevant to the work conducted in laboratories. However, the responsibility for implementing these guidelines lies with individual laboratories, which must develop their own strategies for doing so. These regulations and standards include those outlined by the World Health Organization (2004), Chosewood and Wilson (2009), Richmond and Nesby-O'Dell (2002), Ned-Sykes et al. (2015), 7 CFR Part 331, 9 CFR Part 121, and 42 CFR Part 73 - Select Agent Regulations (2018), the International Organization for Standardization (2017, 2018, 2003, 2012), Miller et al. (2012), 42 CFR 493 (2018), United States Code (1988), and 29 USC, 1910 (2018). Laboratory Quality Management Systems (LQMS) can establish a structure

for managing documents and processes, as well as implementing risk assessment and monitoring procedures to enhance laboratory safety (Ahlin and Weiss, 2007; Lord, 1990; Nichols, 2011). However, LQMS in public health laboratories often prioritize patient safety and the accuracy of test results rather than occupational health and safety (Allen, 2013; Lippi and Guidi, 2007; Njoroge and Nichols, 2014).

The laboratory managers and staff responsible for creating, recording, and executing laboratory procedures bring their individual beliefs, knowledge, education, training, attitudes, and experience to their work, which can influence how they recognize and understand laboratory hazards (Buxton et al., 2011; Steelman and Alexander, 2016; Senthil et al., 2015). The complexity of laboratory risk evaluations and their variability across different laboratories makes it challenging to establish a uniform strategy for risk assessment. Collecting data on worker views of laboratory safety may enhance risk management (Xia et al., 2017; Tziaferi et al., 2011). The necessity for improved integration of safety and quality management in public health labs is supported by strong evidence (Sciacovelli et al., 2007).

Successful laboratory safety program

Developing a successful laboratory safety program necessitates the use of data to create evidence-based safety measures (Cote et al., 2016; Yarahmadi et al., 2016; Smith and Morrato, 2014; Kimman et al., 2008; Birnbaum et al., 2016). However, there are many limitations when it comes to obtaining data on laboratory safety. The limitations of published safety data are that they are only applicable to a specific pathogen, a particular type of laboratory, or a single laboratory process. Implementing these lessons in public health laboratories is challenging due to the intricate nature of working with a vast array of microorganisms and conducting a wide range of testing services using diverse laboratory equipment and processes, all while adhering to multiple standards, regulations, and guidelines.

There is a need for more thorough and standardized approaches to integrate evidence-based safety with quality management systems in public health laboratories. This has been highlighted by several studies (Pedrosa and Cardoso, 2011; Salerno and Gaudioso, 2015; Westgard, 2013; Person, 2013; Jairaman et al., 2017; Janssens, 2014; Lentz et al., 2015).

Effective measures to enhance safety include training (Coelho and García Díez, 2015; Olson et al., 2009; Pallozzi et al., 2003) and the implementation of fundamental skills for biosafety (Chamberlain et al., 2009). Public health labs must prioritize the establishment and maintenance of rigorous safety standards. Nevertheless, the wide range and intricacy of tasks carried out in public health labs pose challenges in ensuring the consistent maintenance, monitoring, and ongoing enhancement of laboratory safety management.

Conclusion

Ultimately, ensuring laboratory safety is of utmost importance in safeguarding the welfare of public health practitioners and restricting the transmission of illnesses beyond the confines of the laboratory. This assessment of novel technology and approaches for enhancing laboratory safety protocols emphasizes a number of significant discoveries. Firstly, it underscores the need for thorough risk assessments that take into account not just biological dangers but also chemical, physical, and radioactive hazards. Laboratories may enhance the efficacy of their safety processes by identifying and mitigating various possible hazards.

Furthermore, there are disparities between the indicated optimal methods and their actual execution in laboratory settings. Although there are legislation, guidelines, and standards, it is the individual labs that are accountable for formulating their own methods to apply these measures. This emphasizes the need of cultivating a safety-oriented culture and ensuring that laboratory management and personnel has the requisite training and experience to identify and minimize laboratory dangers.

Furthermore, laboratory quality management systems (LQMS) have a substantial impact on improving laboratory safety. Nevertheless, it is necessary to redirect the attention of LQMS in public health labs from mostly focusing patient safety and test result accuracy to giving more importance to workplace health and safety. To do this, one must include risk assessment and monitoring protocols into LQMS and advocate for a comprehensive approach to safety management.

Moreover, the research highlights the need of taking into account several elements that contribute to workplace safety, including mental burden, leadership training, occupational

ergonomics, and worker personality. The influence of these elements on laboratory safety has not been well investigated in laboratory settings, necessitating future study for a better understanding.

In order to establish an effective laboratory safety program, it is crucial to include safety measures that are supported by scientific evidence and to use procedures that are guided by data analysis. Nonetheless, acquiring extensive and uniform data on laboratory safety continues to be a difficulty. It is necessary to make efforts to build more comprehensive reporting systems and combine evidence-based safety with quality management systems in public health labs.

To summarize, our assessment emphasizes the need for ongoing improvement in laboratory safety protocols. By acknowledging and tackling the specific difficulties and adopting the suggested approaches, labs may provide a more secure working environment for public health experts and improve the overall safety and reliability of laboratory operations.

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