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Occupational Exposure Assessment Tools for Healthcare Workers: A Scoping Review

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Abstract: *Up to 2 million healthcare workers suffer from biological occupational exposure each year, which is a serious threat to the physical and mental health of the healthcare workers and increases the safety hazards in clinical work. This problem seriously threatens the physical and mental health of medical personnel and increases the safety risks in clinical work.Eight Chinese and English databases were searched from CNKI, Wanfang Data, CQVIP, Sinomed, PubMed, Web of Science, CINHAL, and Cochrane Library using scope review. Information on the assessment population, type, and evaluation method of each tool was extracted and summarized for analysis. Sixteen assessment tools were finally included, and the assessment population of the included tools was mainly medical personnel, and all of them were self-assessed, and the assessment was mainly focused on the prevention stage. Currently, there are many assessment tools for medical staff's occupational exposure. In the future, researchers should select appropriate assessment tools according to the research questions and populations, and develop different types of specific assessment tools with multidimensional evaluation methods for various groups and departments.*

Keywords: *medical personnel; occupational exposure; tools; scoping review*

1. Introduction

Occupational exposure of healthcare workers is defined as the exposure of healthcare workers to toxic or hazardous substances or infectious pathogens during working[1]. Taking biological occupational exposure as an example[2], according to the World Health Organization (WHO), as many as 2 million medical personnel suffered from biological occupational exposure every year, and more than half of them felt a series of psychological reactions such as anxiety, fear, and even stress disorders due to occupational exposure. Occupational exposure poses a serious threat to healthcare workers' physical and mental health[3], and the COVID-19 outbreak has highlighted the critical impact of occupational exposure on healthcare workers. This scoping review aims to organize and analyze the basic information of existing occupational exposure assessment tools to provide a reference for future research.

2. Methods

2.1 Identification of Research Questions

The relevant literature was reviewed, and the research questions were identified as follows:(1) What are the existing assessment tools for healthcare workers' occupational exposure? (2) What are the specifics of these assessment tools in terms of assessment populations, assessment contents and assessment methods? (3) What are the implications for future research?

2.2 Retrieval Strategy

This review is based on the Joanna Briggs Institute (JBI) approach to scoping review. It is guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Extension for Scoping Reviews (PRISMA-ScR)[4, 5].

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2.2.1 Initial Search Strategy

According to the purpose of the study, the strategy was to use “Occupational Exposure” as the Chinese search term and “Occupational Exposure”as the English search term.The preliminary search was conducted in China National Knowledge Infrastructure (CNKI), Wan Fang Data in China (Wan Fang), China Science and Technology Journal Database(VIP), Sinomed, PubMed, Web of Science, CINHAL, and Cochrane Library, and the final results were determined according to the keywords of the literature.

2.2.2 Systematic Search

The literature search for this work was conducted using a combination of subject headings and free words with a search timeframe of the build date of July 14, 2024. Taking PubMed as an example, the search strategy is shown in Table 1.

Table 1: Search strategy using PubMed as an example

Serial number	Search term	Serial number	Search term
#1	"Occupational Exposure"[MeSH Terms]	#10	#5 OR #6 OR #7 OR #8 OR #9
#2	"Needlestick Injuries"[MeSH Terms]	#11	"tool*"[Title/Abstract]
#3	"Sharps Injury"[Title/Abstract]	#12	"scale*"[Title/Abstract]
#4	#1 OR #2 OR #3	#13	"instrument*"[Title/Abstract]
#5	"healthcare worker*"[Title/Abstract]	#14	"frame*"[Title/Abstract]
#6	"medical service personnel"[Title/Abstract]	#15	"questionnaire*"[Title/Abstract]
#7	"nurse*"[Title/Abstract]	#16	#11 OR #12 OR #13 OR #14 OR #15
#8	"doctor*"[Title/Abstract]	#17	#4 OR #10 OR #16
#9	"health professional*"[Title/Abstract]		

2.2.3 Supplementary Search

Additional searches for references included in the study were conducted using citation tracing.

2.3 Literature Inclusion and Exclusion Criteria

Inclusion criteria: (1) original literature on the development, testing, and application of occupational exposure assessment tools for healthcare workers; (2) tools recommended in occupational exposure-related reviews, guidelines, expert consensus, and evidence summaries. Exclusion criteria: (1) instruments that were not tested for reliability; (2) literature where the type of study was a conference abstract; (3) literature where the full text was not available; and (4) literature that was not in Chinese or English.

2.4 Literature Screening

The literature screening process was done jointly by two trained researchers. The literature titles were first imported into NoteExpress software to remove duplicate literatures, followed by further exclusion of irrelevant literature by reading the titles and abstracts. Finally, the full text was read to determine the final literature to be included. Any disagreement during the screening process was discussed with the third researcher.

2.5 Data Extraction and Analysis

Drawing on the research questions, the researcher entered and organized the critical information of the included articles into Excel. Among other things, the critical information included the name of the tool, author, year, country, subject of assessment, type of assessment, content of evaluation, entries, method of assessment, and reliability and validity.

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3. Results

3.1 Literature Screening Results

The initial search yielded 10,410 documents, and after reading the title, abstract, full text, and references, 16 papers were finally obtained. The details of the literature search flowchart are shown in Figure 1.

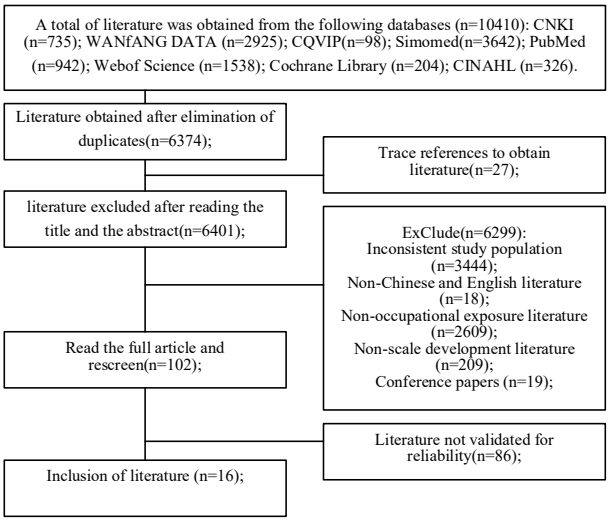

Figure 1: Search strategy using PubMed as an example

3.2 Summary of Essential Information and Content of Included Literature

The basic information of the literature included in this study is shown in Table 2. The literature was published over the period 2000-2024. Literature mainly came from eight countries, with the highest number of publications coming from China (n=8), followed by the United States (n=3), Italy (n=1), South Korea (n=1), Iran (n=1), Poland (n=1), and Chile (n=1). In terms of the population for which the assessment tool was intended, there were doctors[6], nurses[7-13], and nursing interns[14]. In terms of assessment type, 5 involved physical occupational exposures[8, 12, 14-16], 3 involved chemical occupational exposures[7, 13, 17], 4 involved biological occupational exposures[18, 19], and 4 involved all three types of occupational exposures[6, 10, 11, 20]. In terms of entries, the assessment tool entries ranged from 12 to 128, with an average of around 20. In terms of the evaluation method, all the assessment tools were self-assessed. Regarding the performance of the assessment tools, one assessment tool was not tested for reliability[7] and 3 assessment tools were not tested for validity[17-19].

Table 2: Basic Information of the Included Literature

Serial Number	Name	Author (Year)/Country	Subject of Assessment	Type of Assessment			Content of the Assessment	Entry	Evaluation Methods	Cronbach's α	Validity
				Physicality	chemical potential	biological					
①	Hospital Safety Climate	Gershon et al [18](2000)/USA	healthcare workers			√	Assesses medical staff perceptions of the bloodborne pathogen work environment.	20	self-evaluation	0.71~0.84	/
②	Asthma Questionnaire	Delclos et al [19](2005)/ USA	healthcare workers			√	Assessment of occupational asthma in healthcare workers.	43	self-evaluation	0.86	/
③	The Oncology Nurses Health Behaviors Determinants Scale	Abu-Alhaija et al [7](2022)/ USA	nurses		√		Assesses health behavior determinants of oncology nurses when dealing with chemotherapy.	34	self-evaluation	/	S-CVI=0.90
④	(Needlestick Stress Questionnaire	Moayed et al [8](2014)/ Iran	nurses	√			Assesses nurse stress due to needlestick injuries.	20	self-evaluation	0.92	CVI=0.8~1.0
⑤	Tool for Assessing Nurse Safety Behaviour Against Blood Borne Infections	HyunSoo et al [9](2015)/ Korea	nurses			√	Assesses nurses' safe behaviors in responding to bloodborne infections. Includes use of personal	12	self-evaluation	0.88	CVI=0.76-0.89

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							protective equipment, hygiene, and adherence to precautions				
⑥	Student Nurse Needlestick Injury Prediction	Bagnasco et al [14](2020)/ Italy	nurses	√			Assesses nursing students' perceptions of needlestick and sharps injuries during clinical placements.	18	self-evaluation	0.66~0.86	S-CVI=0.75, I-CVI=0.50~1.00
⑦	Scale of Exposure to Occupational Skin Diseases	Drozdowska et al [17](2022)/ Poland	healthcare workers		√		Evaluates risk factors for occupational exposure to allergic contact dermatitis in the work environment of medical personnel.	16	self-evaluation	0.91	/
⑧	Occupational Risks Scale	Cuadros-Carlesi et al [10](2023)/ Chile	nurses	√	√	√	Evaluates occupational risks for nurses.	128	self-evaluation	0.88~0.93	CVI=0.97
⑨	Nursing Occupational Risk Assessment Questionnaire	Li hong et al [11](2008)/ China	nurses	√	√	√	Assesses occupational risks for nurses.	29	self-evaluation	0.9496	I-CVI=0.9462
⑩	Motivational Questionnaire for Needle Stick Injury Prevention for Nursing Staff	Liang Peirong et al [12](2013)/ China	nurses	√			Assesses nurses' level of motivation to prevent needlestick injuries.	20	self-evaluation	0.83	S-CVI=0.91；I-CVI=0.80~1.00
⑪	Physician Occupational Risk Perception Scale	Feng Miao et al [6](2018)/ China	doctors	√	√	√	Assess the various types of occupational risks to which physicians are exposed.	32	self-evaluation	0.952~0.956	CVI=0.96
⑫	Hepatitis B Virus Occupational Protection Behavior Scale for Healthcare Workers	Huang Shengyan et al [21](2020)/ China	healthcare workers			√	Evaluates occupational protection behaviors for hepatitis B virus among healthcare workers. Includes sharps box use, emergency response, sharps injury prevention, immunoprophylaxis, standard prophylaxis	20	self-evaluation	0.841	S-CVI= 0.930，I-CVI=0.800～1.000
⑬	Chinese version of the Nurses' Perception of the Risk of Exposure to Anti-cancer Drugs Questionnaire (Chinese)	Huang Xiaohong et al [13](2020)/ China	nurses		√		Assesses nurses' perception of risk and level of protection against occupational exposure to anticancer drugs.	45	self-evaluation	0.738	S-CVI=0.923, I-CVI=0.800~1.000
⑭	Questionnaire on Occupational Protection against Excessive Carbon Dioxide Concentration in Operating Rooms	Qiao Chuanxun et al. [15](2020)/ China	healthcare workers	√			Measuring the level of protective knowledge, attitudes, and behaviors of medical personnel occupationally exposed to excessive carbon dioxide levels in the operating room	25	self-evaluation	0.901	S-CVI=0.96, I-CVI=0.85~1.00
⑮	Questionnaire on Reproductive Safety for Radiology Staff	Wu Baoyu et al [16](2021)/ China	healthcare workers	√			Assessment of healthcare workers' knowledge of reproductive safety protection, work attitude, radiation injury, radiation protection, and own behavior	28	self-evaluation	0.89	S-CVI=0.933, I-CVI=0.8~0.10
⑯	Perceived Risk of Occupational Exposure Scale for Sterilization Supply Center Staff	Zhu Qian et al. [20](2023)/ China	healthcare workers	√	√	√	Assesses the perceived risk of occupational exposure to healthcare workers.	33	self-evaluation	0.869	S-CVI/Ave=0.983,I-CVI=0.867~1.000

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4. Discussion

4.1 The Population for the Application of Occupational Exposure Assessment Tools

Despite the significant progress made by scholars in the developing assessment tools, existing assessment tools cannot yet cover all occupations and departments. In regards to occupations, assessment tools specifically for doctors[6] and nurses[7-13] exist, but there is a lack of assessment tools for other groups, such as technicians responsible for laboratory testing and cleaning staff accountable for maintaining ward hygiene. Testing technicians are exposed to a variety of chemical reagents and specimens on a daily basis and have a high risk of exposure to chemical substances and pathogenic microorganisms[22]. Cleaning staff clean the wards and dispose of various medical wastes every day and have a high risk of physical, chemical and biological occupational exposure[23].

In regards to departments, there are existing assessment tools for sterilized supply centers[20], oncology departments[7], and operating rooms[15], but some high-risk departments are still neglected. For example, ICU patients require bedside X-ray examinations more frequently, and medical staff in ICU are exposed to higher radiation risks compared to other departments. Hemodialysis laboratory staff have a high risk of blood contamination of the skin, mucous membranes, and eyes at work. Obstetrics staff can hardly avoid contacting patients' body fluids, blood, and urine during delivery, and also have a high risk of biological occupational exposure[23]. To accurately assess the occupational exposure risk faced by different occupations and departments, it is necessary to develop appropriate assessment tools for occupations or departments with high occupational exposure risk according to their characteristics.

4.2 Types of Assessments for Occupational Exposure Assessment Tools

Different types of occupational exposures need to be measured using different assessment methods and assessment indicators, and the existing assessment tools are not yet able to fully cover the common types of occupational exposures. Taking physical occupational exposure as an example, the main types include sharps injuries, radiation and noise damage, of which the highest incidence is sharps injuries[24]. Currently, there are 2 physical occupational exposure assessment tools for sharps injuries[9, 25], 1 for radiation[16], and no assessment tools for noise damage.

Research results have shown[26] that healthcare workers in the dressing room face a higher risk of exposure to Ultraviolet(UV) exposure, and healthcare workers with long-term exposure to monitoring equipment are prone to adverse effects such as tinnitus, auditory fatigue, and decreased attention[27]. Therefore, it is necessary to develop assessment tools about UV injury and noise injury to fully understand whether and how healthcare workers are exposed to such occupational injuries and the degree of harm caused by such injuries.

Chemical occupational exposures are mainly caused by disinfectants, chemotherapeutic agents, aerosols, etc[28]. There is 1 assessment tool for allergic asthma among healthcare workers[19], 1 for occupational dermatitis[17], and 2 for chemotherapeutic drug handling[7, 13]. It has been pointed out[29] that the average daily surgical smoke produced in an operating room is equivalent to the smoke produced by the combustion of 27-30 cigarettes. Moreover, the surgical smoke produced by the electrosurgical knife contains a variety of components such as inactive particles, viruses, and blood-borne transmitted pathogens in addition to harmful chemical components. The hazards of surgical smoke to operating room staff are clear, but no tools have been developed to measure occupational exposure to surgical smoke, and no protective measures against surgical smoke have been reported.

4.3 Types of Assessment for Occupational Exposure Assessment Tools

The evaluation method of the 16 included assessment tools were all self-assessments. Considering the measurement bias of self-assessment, future researchers may consider adding other-assessment to self-assessment when developing assessment tools[30].

Possible other-assessment modalities that can be used for occupational exposure include clinical mini-clinical evaluation exercise (Mini-CEX)[31], direct observation of procedural skills (DOPS)[32], and participatory observation. Mini-CEX is a real-time assessment of high-risk aspects of occupational exposure through scenario simulation. Its advantage is that it can assess multiple research subjects at the same time. However, its assessment time is short, and there may be the problem of intentional behavioral adjustment so that the evaluation results may differ from the real behavior to a certain extent. DOPS is a one-to-one formative evaluation of the pre-, mid-, and post-operational norms of occupational exposures

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of the assessed person. The researcher can collect more realistic information with DOPS, but it takes a longer time.

Participatory Observational Assessment is an in-depth approach to understanding occupational exposure behaviors by obtaining authentic and insightful observational data through the evaluator's hands-on participation. The advantage of participatory observational assessment is that the evaluator is familiar with the relevant field and can accurately identify the behavior of the observed person and understand the reasons behind the behavior[33]. However, the disadvantages are that it is time-consuming and there may be inter-observer differences and ethical issues. It is suggested that in the future, the selection of assessment tools can be based on the advantages and disadvantages of the assessment tools.

4.4 Assessment Sessions of the Occupational Exposure Assessment Tools

The sessions of occupational exposure assessment are mainly categorized into three phases: pre-exposure, intra-exposure, and post-exposure. All of the included studies are assessment tools for the pre-exposure evaluation, except for the Needlestick Stress Questionnaire[8], which is for post-exposure assessment of needlestick injuries. Although pre-exposure assessment can help healthcare workers to fully understand the potential risks of occupational exposure, and identify and solve the existing safety hazards promptly. However, pre-exposure assessment cannot cover the frequency and degree of occurrence of occupational exposure and the degree of harm, let alone analyze the consequences of occupational exposure that has occurred.

It is necessary to develop appropriate intra- and post-exposure assessment tools to help hospital administrators gain a deeper understanding of the causes and effects of occupational exposure events and develop effective corrective measures to avoid the recurrence of similar events[34]. Therefore, it is recommended that future researchers focus on the development of intra- and post-exposure assessment tools to further improve the existing occupational exposure assessment system.

5. Conclusions

In terms of evaluation methods, all the evaluation methods in the included assessment tools were self-assessments. Regarding the assessment population, the existing assessment tools cover the groups of doctors, nurses, and nursing students. However, healthcare workers, such as examiners and janitorial staff, are not currently in the spotlight. In terms of departments, occupational exposure assessment tools are available for departments such as sterilized supply centers, oncology departments, and operating rooms. Still, some high-risk departments, such as hemodialysis room, ICU, and obstetrics departments, have not been mentioned. Users should choose the appropriate assessment tool according to the research question and population. In addition, when conducting the development of new assessment tools, it is recommended that diversified evaluation methods be used to enhance the accuracy and reliability of the tools, and to increase the development of assessment tools for the middle and later stages of occupational exposure to improve the occupational exposure assessment system.

This study included and analyzed 16 assessment tools on occupational exposure of medical personnel based on the scoping review framework. The assessment methods of existing assessment tools were all self-assessment. In terms of the assessment population, the existing assessment tools covered the groups of doctors, nurses, and nursing students. Nonetheless, there are still high-risk groups such as testing staff and cleaning staff that have not been paid attention to yet. In terms of departments, there are existing assessment tools for departments such as sterilized supply centers, oncology departments, operating rooms, etc. Some high-risk departments such as hemodialysis rooms, ICU, and obstetrics departments have not been mentioned. It is recommended that future researchers choose the appropriate assessment tool according to the research question and population. It is also recommended that when developing new assessment tools, consideration should be given to adopting multi-evaluation methods to improve the accuracy and reliaility of the tools, and to increase the development of assessment tools for the mid- and post-occupational exposure sessions to improve the occupational exposure assessment system.

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