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STANDARDS – GUIDELINES

CONCEPT OF HEALTH SURVEILLANCE PROGRAMME FOR WORKERS EXPOSED TO RESPIRABLE CRYSTALLINE SILICA AT PRESENT AND IN THE PAST

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Abstract

In the paper authors present general assumptions of health surveillance programme concept for workers employed in respirable crystalline silica (RCS) exposure at present and in the past. There is no effective treatment for silicosis thus disease prevention is of paramount significance. For decades efforts of World Health Organization (WHO) and International Work Organization (ILO) have been focused on eliminating silicosis globally. Unfortunately silicosis is still one of the most lethal occupational diseases and the preventative programmes have not yet been successful. The authors identify main steps to complete an overview of RCS exposure and suggest lines of actions to be taken before launching the health surveillance programme. Introduction of the health surveillance programme would increase awareness of harmful health effects of the RCS exposure, emphasize the significance of preventive medical check-ups and early diagnostics of occupational diseases as well as the importance of using appropriate protective equipment. The programme development on a national level might be carried out with the cooperation of multiple backgrounds and institutions. This would allow for detailed planning, implementation, monitoring and effective evaluation of its results. Having a better and updated knowledge of silicosis epidemiology, early diagnostics, the possible sources of RCS occupational exposure and evaluation of undertaken preventive actions are crucial factors in disease prevention. The programme introduction would be of educational significance for all the stakeholders and the groups engaged in the project implementation, which would contribute to high effectiveness of the preventive activities and their improvement in the future. Med Pr Work Health Saf. 2023;74(4):341–6.

Key words: epidemiology, silicosis, lung diseases, occupational diseases, prevention and control, silicon dioxide

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INTRODUCTION

Silicosis is one of the most prevalent occupational lung diseases causing adverse health and economic effects in developed and developing countries, especially in those with low- and middle-incomes [1,2]. This medical condition is characterized by irreversible and incurable interstitial pulmonary fibrosis gradually leading to the deterioration of lung function, respiratory insufficiency and premature death [2–4].

According to the results of the Global Burden of Disease Study 2019 (GBD 2019) run by The Institute for Health Metrics and Evaluation (IHME) silicosis was the major cause of burden among all types of pneumoconioses accounting for nearly 70% of new cases and over 55% of deaths in 2019 [5].

The global estimated prevalence of silicosis in employees working in exposure to silica dust ranges 14–96% depending on the type of occupational activity [6]. Occupational exposure to high concentration of respirable crystalline silica (RCS) is traditionally associated with such industries as mining and quarrying, construction and building or metal casting [1,7]. Approximately 5.3 million of workers were exposed to crystalline silica in Europe in 2006, 23 million in China in 2009 and 3.2 million in Brazil in 2007 [6,8,9]. In India, >11 million workers are at risk of silicosis, and according to Occupational Safety and Health Administration (OSHA) there are about 2.3 million people occupationally exposed to crystalline silica in the United States of America [10,11]. In Australia, there are about 0.6 million workers exposed to silica dust [12]. The figures

quoted are indicative and presumably underestimated. The exact number of individuals employed in the exposure to respirable crystalline silica is nowadays difficult or impossible to evaluate due to the lack of occupational health surveillance programs as well as local, national and global registers of workers exposed to RCS [1]. Furthermore, there are other numerous factors such as migrant labour, unregistered employment, child labour and limited or unequal access to health care that make it hard to estimate the number of employees working in the RCS presently and in the past [4,13–16].

There is no effective treatment for silicosis thus disease prevention is of paramount significance. Prevention of silicosis is one of the major tasks of occupational healthcare. In 1995 World Health Organization (WHO) and International Labour Organization (ILO) started a campaign to eliminate silicosis worldwide by 2030 [17]. In 1996 National Institute of Occupational Health (NIOSH) formulated detailed recommendations to prevent silicosis among construction workers and suggested that those recommendations were applied to all the workers at all the workstations with RCS exposure. The preventive measures include obligatory medical check-ups conducted by Occupational Health Medical Practitioners (OHMP), providing safe silica dust exposure levels at the workplace by meeting the recommended exposure limits (REL) for RCS with engineering and administrative controls, technological methods reducing RCS exposure and replacement of silica containing materials with less hazardous substitutes as well as using the personal protective equipment (respirators, washable or disposable clothes) considered as the least efficient. The current NIOSH REL for RCS is 0,05 mg/m^3. The above mentioned measures are ranked by effectiveness in the hierarchy of hazard control system that is recognized by NIOSH as the key strategy in workplace safety [17–19].

Despite many efforts undertaken in recent years new silicosis cases have been emerging. The results of the GBD study show that between 2016 and 2019 the number of incident silicosis cases increased from about 44 000 to about 139 000 with about 23 700 cases recorded in 2017, yet the number of silicosis deaths increased from about 10 400 cases in 2016 through about 11 300 cases in 2017 to about 12 900 cases in 2019 worldwide [5,20,21].

In the 21st century some unexpected outbreaks of silicosis related to novel sources of RCS have been reported worldwide. Many of the cases developed within <20 years after RCS occupational exposure and were related to employment in industries traditionally not associated with risk of silicosis such as artificial stone benchtop manufacturing, denim jeans sandblasting, jewellery polishing and sanitary ceramics manufacturing [7,22].

Poland also registered cases of silicosis developed after a shorter RCS occupational exposure. This was verified by the analysis of data collected by the Central Register of Occupational Diseases run by the Nofer Institute of Occupational Medicine in Łódź, Poland. Between 2000 and 2019, 2066 confirmed cases of silicosis were reported in Poland. In 32 cases the occupational exposure was shorter than 5 years. Among the 32 cases, 14 (44%) of them were related to employment in manufacture of ceramic sanitary products mentioned above [7].

Furthermore, the new cases of silicosis occur in the developing countries where preventive measures are difficult to implement and the exact data on exposure to RCS as well as silicosis incidence are unknown [1]. This applies to both protecting the hygienic standards of the working environment and using both collective and personal protective equipment. The threshold limit values for RCS known as permissible exposure limit (PEL) or occupational exposure limit (OEL) vary between countries. Although silicosis prevention is a worldwide issue, no common global limit has been defined. Moreover, there are still countries with no set RCS exposure limits, which makes providing and controlling safe work conditions impossible [1].

The lack of consistent common global policy in preventing silicosis and early disease diagnostics is nowadays one of the major obstacles to eliminate the disease worldwide. The persistent occurrence of new silicosis cases is a burning issue of occupational medicine. In recent papers the authors have emphasized the importance of public health impact and cooperation in preventing silicosis locally and globally [1,22,23].

Having a better and updated knowledge of silicosis epidemiology, as well as disease early diagnostics and course, the possible sources of RCS occupational exposure and evaluation of undertaken preventive actions are crucial factors in disease prevention.

In practice this would be possible within a health surveillance program for workers employed in RCS exposure presently and in the past. Such a program would perfectly supplement the mandatory medical check-ups provided for workers.

The aim of the paper is to present the general assumptions of the health surveillance program concept for workers employed in RCS exposure at present and in the past.

SURVEILLANCE PROGRAMME OUTLINE

The health surveillance programme for former and present employees working in the RCS exposure should encompass the whole country, which would provide a full insight into issue of the RCS exposure. Main steps to complete an overview of respirable silica exposure include:

- evaluating the number of the employed in RCS exposure at present and in the past,
- identification of business branches and work stations related to the RCS exposure focusing mainly on the employment areas with the highest RCS exposure level,
- collecting data on co-exposure to RCS and other occupational hazards,
- collecting and analysing data on occupational diseases occurrence and development related to RCS exposure taking into account its fibrogenic, carcinogenic and inflammatory health effects.

The launch of the health surveillance program would increase the awareness of harmful health effects of the RCS exposure, emphasize the significance of preventive medical check-ups and early diagnostics of occupational diseases as well as the importance of using appropriate protective equipment.

The program development on a national level might be carried out with the cooperation of multiple backgrounds and institutions. This would allow for detailed planning, implementation, monitoring and effective evaluation of its results.

Suggested lines of actions to be taken before launching the programme are the following:

- information campaign aimed at present and former workers employed in the RCS exposure focusing on the adverse health effects of inhaling the silica dusts, advantages of the systematically performed medical assessments, following the prevention principles and possible compensation for occupational diseases;
- information campaign aimed at employers and specialists involved in the occupational health and safety focusing on the recent data on novel sources of the RCS exposure, adverse health effects of the exposure and possible preventive measures such as systematic medical check-ups and the implementation of modern methods to reduce or eliminate the RCS exposure following the hierarchy of controls;
- establishing the cooperation between medical societies in order to issue guidelines for the scope and frequency of preventive medical screenings, early silicosis diagnostics, differential diagnostics of interstitial lung diseases as well as training the medical professionals in radiological diagnostics of pneumoconioses according to the ILO classification system;
- building a multidisciplinary team to coordinate program implementation, collected data analysis, current criteria and guidelines verification;
- preparing legislation to implement the programme;
- gaining support from appropriate departments and institution involved in the field of occupational health care.

DISCUSSION

As some previous attempts to eliminate silicosis at the local and global level have failed, the idea of health surveillance programme for former and present employees working in the RCS exposure is based on the multidisciplinary cooperation and involves employees, employers, scientific communities and public authorities. There seems to be the lack of consistent common policy and successful preventive programmes including local and global controls of RCS exposure, health surveillance and education. There are places, for instance Australia, where some recommendations have been implemented to improve the periodic medical assessment of the workers exposed to RCS which appears to be a step into the right direction but it has not yet been turned into a complete health surveillance programme to be followed [1,23,24].

The purpose of the surveillance programme is to collect, analyse and report data needed to prevent and diagnose silicosis as well as other diseases related to the RCS occupational exposure. Chronic silicosis, the most common form of the disease developing after RCS exposure duration >10 years and latency period >20 years, is asymptomatic in its initial stages with a late disease onset [22]. The symptoms such as cough and shortness of breath usually occur later than radiological changes thus early diagnostic would be crucial for introducing the tertiary prevention of the disease [23]. The current situation in Poland shows that all workers exposed to RCS at present and in the past undergo an obligatory medical check-up whose scope and frequency is set out in the relevant regulatory acts and comprises physical examination, spirometry and chest X-ray. Employers provide their employees with referrals for medical examination which identify RCS exposure as one of the work hazards [25]. As the medical assessments can be carried out in different clinics some changes in physical state

can remain unnoticed. The programme goes beyond the framework of mandatory medical assessment and involves, among others, obtaining a detailed occupational history, collecting the results of medical examinations and analysing changes in the results. The programme implementation would also ensure the proper conduct of the preventive assessments for all employees working in the RCS exposure as well as would help assess properly the RCS exposure at the workstation and estimate the exact number of the workers. Nowadays, there is no register of workers exposed to the RCS at present and in the past, for example in Poland. Data available and reported to the Statistics Poland do not cover the smallest enterprises employing <10 people and are thus incomplete [26].

The ongoing analysis of the necessary data collected within the programme would help to adjust the scope and frequency of the medical assessment to the characteristics of the occupational exposure including the percentage of RCS and the dust concentration at the workstation. Some of the introduced modifications can also consider the latest research results. In recent papers the authors discuss the use of some other diagnostic tools and new methods for early silicosis detection, like high resolution computed tomography (HRCT), ultra-low dose computed tomography (ULD-CT), alveolar crystal burden quantification in bronchoalveolar lavage (BAL), biomarkers present in serum or exhaled breath condensate (EBC) [27–30].

Chest X-ray is the primary and authorized diagnostic tool for pneumoconiosis and must be categorized according to the ILO International Classification of Radiographs of Pneumoconioses [31]. The proper interpretation of the lung abnormalities requires good knowledge of the classification, yet the number of qualified and experienced physicians is constantly decreasing. Therefore, it is mandatory to train new groups of specialists in this area and upgrade their qualifications. The use of artificial intelligence (AI) for chest radiographs reading the screening for pneumoconioses is also discussed [28].

CONCLUSIONS

The results of the health surveillance programme would broaden the knowledge of the diagnostics and course of diseases related to the RCS exposure which, apart from silicosis and silicotuberculosis, are mainly chronic obstructive pulmonary disease (COPD) and lung cancer recognised as occupational diseases and also systemic autoimmune diseases like systemic sclerosis, rheumatoid arthritis or chronic renal disease [27]. The collected data would be helpful in differential diagnosis of other interstitial lung diseases or differentiating between silicosis and sarcoidosis [29]. Moreover, the health surveillance programme would reveal the importance of occupational history covering data on the past exposure in each diagnostic process led by general practitioners, pulmonologists and other medical specialists.

The added value of the programme introduction would be of educational significance for all the stakeholders and the groups engaged in the project implementation, which would not only contribute to high effectiveness of the preventive activities but also to their improvement in the future.

While the world is trying to recover from the COVID-19 pandemic it would be advisable to focus on yet another insidious disease. The disease which causes pulmonary fibrosis that develops mainly among young people who are not provided with safe working conditions, preventative primary, secondary and tertiary diagnostics and who often suffer from poverty yet are forced to work in hazardous conditions that pose risk to their lives – work that barely lets them make ends meet and support their families.

Author contributions

Research concept: Joanna Nowak-Pasternak, Beata Świątkowska, Agnieszka Lipińska-Ojrzanowska
Research methodology: Joanna Nowak-Pasternak, Beata Świątkowska, Agnieszka Lipińska-Ojrzanowska
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REFERENCES

1. Hoy RF, Jeebhay MF, Cavalin C, Chen W, Cohen RA, Fireman E, et al. Current global perspectives on silicosis-Convergence of old and newly emergent hazards. Respirology. 2022;27(6):387-398. https://doi.org/10.1111/resp.14242.
2. Chen S, Liu M, Xie F. Global and national burden and trends of mortality and disability-adjusted life years for silicosis, from 1990 to 2019: results from the Global Burden of Disease study 2019. BMC Pulm Med. 2022;22(1):240. https://doi.org/10.1186/s12890-022-02040-9.

3. Li J, Yin P, Wang H, Wang L, You J, Liu J, et al. The burden of pneumoconiosis in China: an analysis from the Global Burden of Disease Study 2019. BMC Public Health 2022; 22(1):1114. https://doi.org/10.1186/s12889-022-13541-x.
4. Hatman EA, Karagül DA, Oyman EK, Tüzün B, Şimşek KO, Kılıçaslan Z. Premature Deaths Due to Silicosis in Turkey, 2006-2017: A Twelve-Year Longitudinal Study. Balkan Med J. 2021;38(6):374-381. https://doi.org/10.5152/balkanmedj.2021.21208.
5. Institute for Health Metrics and Evaluation (IHME) [Internet]. Washington: The Research Center; 2019 [cited 2023 July 30]. Available from: GBD 2019 Cause and Risk http://www.healthdata.org/results/gbd_summaries/2019/silicosis-level-4-cause.
6. Souza TP, Watte G, Gusso AM, Souza R, Moreira JDS, Knorst MM. Silicosis prevalence and risk factors in semi-precious stone mining in Brazil. Am J Ind Med. 2017;60(6):529-536. https://doi.org/10.1002/ajim.22719.
7. Nowak-Pasternak J, Lipińska-Ojrzanowska A, Świątkowska B. Epidemiology of silicosis reported to the Central Register of Occupational Diseases over last 20 years in Poland. Int J Occup Med Environ Health. 2022;35(5): 561–570. https://doi.org/10.13075/ijomeh.1896.01950.
8. Cherrie JW, Gorman Ng M, Searl A, Shafrir A, van Tongeren M, Sanchez-Jimenez A, et al. Health, socio-economic and environmental aspects of possible amendments to the EU Directive on the protection of workers from the risks related to exposure to carcinogens and mutagens at work. Respirable crystalline silica. IOM Research Project: P937/8, May 2011. [Internet]. Edinburgh, 2011. [cited 2023 July 30]. Available from: https://ec.europa.eu/social/BlobServlet?docId=10161&langId=en).
9. Wang D, Yang M, Liu Y, Ma J, Shi T, Chen W. Association of Silica Dust Exposure and Cigarette Smoking With Mortality Among Mine and Pottery Workers in China. JAMA Netw Open. 2020;3(4):e202787. https://doi.org/10.1001/jamanetworkopen.2020.2787.
10. Jindal SK. Silicosis in India: past and present. Curr Opin Pulm Med. 2013;19(2):163-168. https://doi.org/10.1097/MCP.0b013e32835bb19e.
11. Occupational Safety and Health Administration, United States Department of Labor [Internet]. Washington: The United States Government; 2023 [cited 2023 July 30]. Safety and Health Topics. Available from: https://www.osha.gov/silica-crystalline.
12. Occupational Health and Safety Unit, Victorian Trades Hall Council [Internet]. Melbourne: Australian Council of Trade Unions; 2023 [cited 2023 July 30]. Available from: https://www.ohsrep.org.au/silica_e6w4qije5l8wpqjctec0iw.
13. Ehrlich R, Barker S, Tsang VWL, Kistnasamy B, Yassi A. Access of migrant gold miners to compensation for occupational lung disease: Quantifying a legacy of injustice. J Migr Health. 2021;4:100065. https://doi.org/10.1016/j.jmh.2021.100065.
14. Baş HD, Başer K, Nugent K. Silicosis in denim sandblasters in Turkey. Gaziantep Med J 2016;22(2):89-94.
15. Kyaw WT, Myint YM, Kuang X, Sakakibara M. Transdisciplinary Online Health Assessment of an Artisanal and Small-Scale Gold Mining Community during the COVID-19 Pandemic in the Mandalay Region of Myanmar. Int J Environ Res Public Health. 2021;18(21): 11206. https://doi.org/10.3390/ijerph182111206.
16. Williams H, Ehrlich R, Barker S, Kisting-Cairncross S, Zungu M, Yassi A. The Utility of Length of Mining Service and Latency in Predicting Silicosis among Claimants to a Compensation Trust. Int J Environ Res Public Health. 2022;19(6):3562. https://doi.org/10.3390/ijerph19063562.
17. The Global Occupational Health Network: Elimination of silicosis [Internet]. World Health Organization. The Global Occupational Health Network Newsletter; 2007 [cited 2023 July 30]. Available from: https://pdf4pro.com/amp/view/the-global-occupational-health-network-gohnet-2be147.html.
18. The National Institute for Occupational Safety and Health (NIOSH), Centers for Disease Control and Prevention, United States Department of Health and Human Services [Internet]. Washington: The United States Government; 1996 [cited 2023 July 30]. Available from: https://www.cdc.gov/niosh/docs/96-112/default.html#Recommendations.
19. The National Institute for Occupational Safety and Health (NIOSH), Centers for Disease Control and Prevention, United States Department of Health and Human Services [Internet]. Washington: The United States Government; 2023 [cited 2023 July 30]. Available from: https://www.cdc.gov/niosh/topics/hierarchy/default.html.
20. GBD 2016 Disease and Injury Incidence and Prevalence Collaborators. Global, regional, and national incidence, prevalence, and years lived with disability for 328 diseases and injuries for 195 countries, 1990-2016: a systematic analysis for the Global Burden of Disease Study 2016. Lancet. 2017;390(10100):1211-1259. https://doi.org/10.1016/S0140-6736(17)32154-2.
21. GBD 2017 Disease and Injury Incidence and Prevalence Collaborators. Global, regional, and national incidence, prevalence, and years lived with disability for 354 diseases and injuries for 195 countries and territories, 1990-2017: a systematic analysis for the Global Burden of Disease Study 2017. Lancet. 2018;392(10159):1789-1858. https://doi.org/10.1016/S0140-6736(18)32279-7.

22. Barnes H, Goh NSL, Leong TL, Hoy R. Silica-associated lung disease: An old-world exposure in modern industries. Respirology. 2019;24(12):1165-1175. https://doi.org/10.1111/resp.13695.
23. Wood C, Yates D. Respiratory surveillance in mineral dust-exposed workers. Breathe. 2020;16(1):190632. https://doi.org/10.1183/20734735.0362-2019.
24. Perret JL, Miles S, Brims F, Newbigin K, Davidson M, Jersmann H, et al. Respiratory surveillance for coal mine dust and artificial stone exposed workers in Australia and New Zealand: A position statement from the Thoracic Society of Australia and New Zealand. Respirology. 2020; 25(11):1193-1202. https://doi.org/10.1111/resp.13952.
25. [Regulation of the Minister of Health and Welfare of 30 May 1996 on medical examination of employees, workers' health care and medical certificates issued according to the Labour Code. J Laws 2023, item 607]. Polish.
26. Statistics Poland [Internet]. Warszawa 2022. [cited 2023 July 30]. Work conditions in 2021. https://stat.gov.pl/obszary-tematyczne/rynek-pracy/warunki-pracy-wypadki-przy-pracy/warunki-pracy-w-2021-roku,1,16.html.
27. Austin EK, James C, Tessier J. Early Detection Methods for Silicosis in Australia and Internationally: A Review of the Literature. Int J Environ Res Public Health. 2021; 18(15):8123. https://doi.org/10.3390/ijerph18158123.
28. Gowda V, Cheng G, Saito K. The B Reader Program, Silicosis, and Physician Workload Management: A Niche for AI Technologies. J Occup Environ Med. 2021;63(7):e471-e473. https://doi.org/10.1097/JOM.0000000000002271.
29. Apte SH, Tan ME, Lutzky VP, De Silva TA, Fiene A, Hundloe J, et al. Alveolar crystal burden in stone workers with artificial stone silicosis. Respirology. 2022;27(6): 437-446. https://doi.org/10.1111/resp.14229. .
30. Peruzzi CP, Brucker N, Bubols G, Cestonaro L, Moreira R, Domingues D, et al. Occupational exposure to crystalline silica and peripheral biomarkers: An update. J Appl Toxicol. 2022;42(1):87-102. https://doi.org/10.1002/jat.4212.
31. International Labour Office. Guidelines for the use of the ILO International Classification of Radiographs of Pneumoconioses, Revised edition 2011. Occupational Safety and Health Series No. 22. Office, Geneva 2011.

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