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Utilization of Predictive Models for Diagnosis of Occupational Diseases

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Abstract

Predictive models have long been used to assist clinical decision-making in medicine. Predictive models are made to estimate how likely a person is to have a disease (diagnostic model) or will experience a disease (prognostic model). In the field of occupational health, for example, diagnostic models can be used to increase the efficiency of surveillance programs by identifying groups of workers with occupational diseases without using complex and expensive diagnostic tests.
Work-related asthma (WRA) is the most common occupational lung disease in industrialized countries and the second most common in developing countries. Around the world, especially in developing countries, diagnosing WRA is still difficult due to the limitations of available diagnostic tests. Specific inhalation challenge (SIC), the best test for diagnosing occupational asthma, is only available in several research centres worldwide.
Several questionnaire-based models have been developed to diagnose work-related asthma at both the primary (general practitioner) and secondary (specialist) levels of care. A recent model for diagnosing occupational asthma was developed using data from Canada and has been validated using data from several European countries. A collaboration has been initiated to assess the application of this model among Indonesian workers.

Abstrak

Model prediksi sudah lama digunakan untuk membantu pengambilan keputusan klinis di kedokteran. Model prediksi dibuat untuk memperkirakan berapa besar kemungkinan seseorang memiliki suatu penyakit (model diagnostik) atau akan mengalami suatu penyakit (model prognostik). Di bidang kesehatan kerja misalnya, model diagnostik dapat dimanfaatkan untuk meningkatkan efisiensi program surveilans dengan mengidentifikasi kelompok pekerja yang memiliki penyakit akibat kerja tanpa menggunakan uji diagnostik yang kompleks dan mahal.
Asma yang berhubungan dengan pekerjaan (work related asthma, WRA) adalah penyakit paru akibat kerja yang paling umum di negara industri dan kedua paling umum di negara berkembang. Di seluruh dunia, terutama di negara berkembang, diagnosis WRA masih sulit dilakukan karena keterbatasan uji diagnosis yang tersedia. Uji inhalasi spesifik (specific inhalation challenge, SIC) sebagai uji terbaik untuk diagnosis asma akibat kerja hanya tersedia di beberapa pusat penelitian di seluruh dunia.
Beberapa model berbasis kuesioner telah dikembangkan untuk mendiagnosis asma yang berhubungan dengan pekerjaan baik di tingkat layanan primer (oleh dokter umum) maupun sekunder (oleh dokter spesialis). Model terbaru untuk diagnosis asma akibat kerja dikembangkan dengan menggunakan data dari Kanada dan telah divalidasi menggunakan data dari beberapa negara Eropa. Kerja sama telah dirintis untuk menilai aplikasi model ini di kalangan pekerja Indonesia.
Keywords: *occupational asthma; prediction model; occupational health; occupational disease*

Prevention of Occupational Diseases

In general, there are two very different approaches to preventing work-related illnesses. The first is primary prevention through exposure reduction and exposure control in the workplace. Unfortunately, this approach is not always possible or difficult to apply. Therefore, a secondary prevention approach is needed in the form of early detection of occupational diseases through periodic surveillance.

The purpose of secondary prevention is to detect disease early so that prompt treatment and management can be carried out to avoid complications of the disease. Occupational asthma is a chronic occupational respiratory disease common in developing and industrialized countries[1]. Occupational asthma includes work exacerbated asthma (WEA, pre-existing asthma worsens by occupational exposures) and occupational asthma (OA), which is asthma solely caused by occupational exposures[2]. OA is known to cause impaired productivity, impaired quality of life, and causes psychological stress[3,4]. The risk of experiencing respiratory problems extends beyond workers with high exposures; it has been shown that workers with intermittent or only occasional exposure may also be affected. Research shows that the risk of sensitization to allergens in the workplace may exist even at very low levels of exposure[5]. Therefore, in line with efforts to reduce exposure, it is necessary to carry out periodic surveillance to detect occupational asthma early.

The Role of Predictive Models in Prevention of Occupational Diseases

Clinical prediction models have long been used to estimate the likelihood that a person has or will experience a certain health condition[6]. These models can be used to aid clinical decision-making by categorizing workers into high, medium, or low-risk groups[6,7]. Using a standard and objective formula, an occupational physician can identify low-risk workers and exclude them from further clinical examination (Figure 1). This scientific approach will greatly assist occupational physicians in objective decision-making processes as well as increase the efficiency of worker surveillance by reducing the number of unnecessary tests (8).

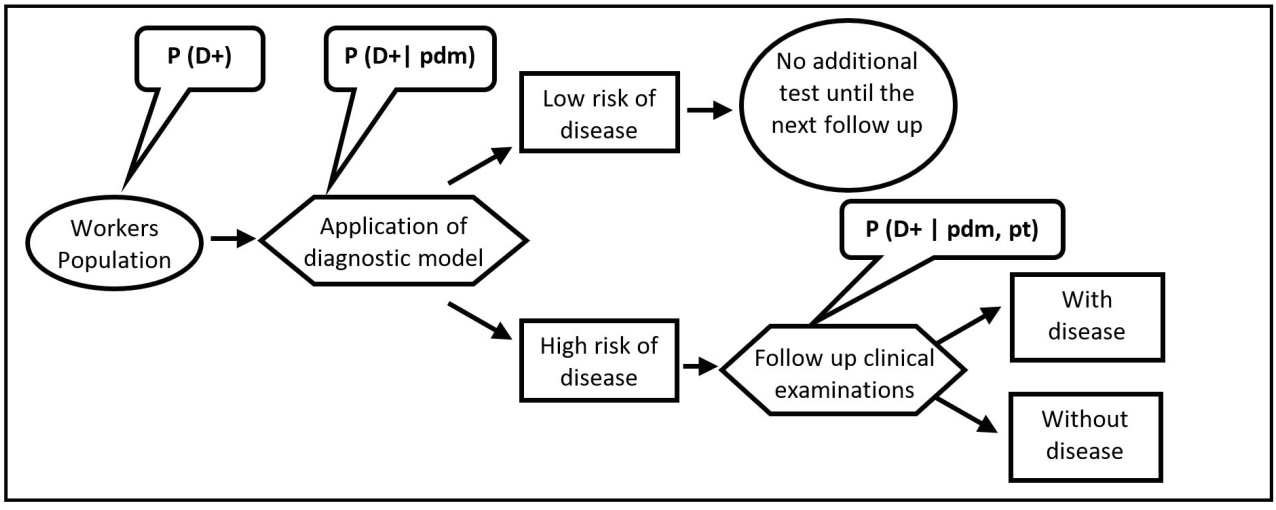

Figure 1. Application of diagnostic models in surveillance of occupational diseases. P(D+) is the probability of disease in the working population. P(D+ | pdm) is the probability of disease based on the diagnostic model. Workers will be grouped according to their disease risk; follow-up clinical examinations will only be performed on high-risk workers. P(D+ | pdm, pt) is the probability of disease based on the results of the diagnostic model and further clinical examination.

The development of a predictive model consists of three stages: [1] creation of model by identifying predictive factors; [2] evaluation model's validity. Internal validation is carried out using the same sample, while external validation is carried out on different samples to assess whether a model can be applied in a new population9,10; [3] evaluation of the benefits of the model in clinical decision-making[11].

Like other clinical diagnostic tests, diagnostic models can produce erroneous predictive results: sick subjects are categorized into the healthy group (false negative), creating a false sense of security. On the other hand, healthy subjects were categorized into the sick group (false positive), which could cause unnecessary stress and intervention. Therefore, determining the probability threshold (cut-off point) for risk grouping is important before the prediction model is applied in daily practice. Rational decision-making in determining this threshold is very dependent on how much benefit early diagnosis is; risk of disability if a disease is not diagnosed; availability of fees; the accuracy of the prediction model; availability and safety of follow-up clinical examination[12].

Diagnostic Model Application for Occupational Asthma

Protocols and tests used to diagnose occupational asthma are dependent on the availability of clinical examinations in each country or region. The examination begins with a complete history (clinical interview) about the symptoms and their relationship to work; tracing of employment history and potential direct or indirect exposures; non-specific bronchial provocation test using methacholine or histamine (i.e., non-specific bronchial hyper-responsiveness test or NSBHR) to confirm the diagnosis of asthma; and testing for sensitization to occupational exposure by skin-prick test or immunological testing. The best reference test for diagnosing occupational asthma is the specific inhalation challenge or SIC[13].

Around the world, especially in developing countries, the diagnosis of occupational asthma remains difficult due to delays in referrals by general practitioners due to lack of knowledge about the relationship between occupational exposures and workers' asthma or the inability of specialists to take appropriate diagnostic steps due to the limitations of the available diagnostic test[14,15]. The SIC test, for example, is only available in a few medical centres around the world. In Indonesia, there are no health centres with facilities for SIC testing. Diagnostic procedures for occupational asthma are complex and time-consuming; it might take months or years before a diagnosis is made. Often, the inspection process breaks down halfway.

Therefore, several questionnaire-based predictive models have been developed to diagnose occupational asthma[16-19]. The European Respiratory Society Task Force recommends using a short questionnaire as the first step in a worker surveillance program for occupational asthma[16,17]. A research team from the Netherlands, for example, used a self-administered questionnaire and medical history to develop a predictive model for bakers' asthma among bakers[19]. A research team from the Sacré-Cœur Hospital research centre in Montréal, Canada, has created a diagnostic model of OA using a variety of tests other than SIC[20]. The model has been validated in the working population in Europe and has been transformed into an online calculator by Calculate by QxMD (https://qxcalc.app.link/occ-asthma-hmw)[21].

In places where SIC is not available or routinely performed, this model can guide doctors in secondary care centres (specialists: pulmonologists or occupational medicine doctors) to decide whether they can start treatment or perform further diagnostic tests for workers suspected of having occupational asthma. To be used in Indonesia, a collaboration has been established to test the validation of the model in the Indonesian working population.

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