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ALBERTA OCCUPATIONAL MEDICINE NEWSLETTER

EDITOR'S COMMENTS

In this first issue of 1994 are two original papers from quite different areas of occupational health. The first article I hope will assist physicians in providing medical examinations for workers going to tropical or sub-tropical job assignments where malaria is present. Rather than using an "agent-host-vector" framework that is traditional for communicable diseases, Dr. McLeod has approached risk assessment using a chemical toxicity framework: hazard identification, exposure assessment, dose-response and individual susceptibility, and risk estimation. She then provides some guidance in determining medical fitness-to-work, in particular, for situations in which job placement in a malaria zone is absolutely or relatively contraindicated. Her article provides a novel perspective of medical fitness and communicable disease. (Readers can expect more articles in the Newsletter that explore the principles of fitness-to-work.)

The second article addresses both a clinical and epidemiologic problem in occupational health: given a job title or description, how do we determine what are the possible chemical exposures when specific worksite information may not be available? Dr. Yoshida describes the historical development of occupational exposure databases, some of their current and future applications, and the changing role of the occupational hygienist in health protection. (Again, readers can expect more articles in the future that describe the activities and roles of occupational health professionals.)

Kenneth Corbet, M.D., F.R.C.P.C.
Editor

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ASSESSMENT OF FITNESS-TO-WORK: MALARIA RISK

Laura J. McLeod M.D., C.C.F.P.*

Many occupations involve overseas postings to tropical and sub-tropical countries where malaria is a significant risk. Some examples are community development workers, missionaries, armed forces personnel, and oil industry workers on exploration and drilling assignments in developing countries. It is important that pre-placement fitness-to-work assessments for such postings include malarial risk assessment. This paper will present a risk assessment framework for malaria, and then will discuss the evaluation of fitness-to-work in this context.

RISK ASSESSMENT FOR MALARIA

Hazard Identification:

Malaria is a disease caused by four species of the parasite *Plasmodium*, transmitted to humans via the bite of an infected *Anopheles* mosquito. *P. falciparum* infection causes fever, chills, profuse sweating and headache, and is commonly chloroquine-resistant. It can progress rapidly to shock, coma, and death, so it is essential that all cases be treated promptly. Case fatality rates in non-immune adults and untreated children exceed 10%. The other *Plasmodium* species, *vivax, ovale* and *malariae* have lower fatality rates, but cause cyclic episodes of fever and chills which can relapse for up to 2, 5, and 50 years respectively.

Exposure Assessment:

Malaria exposure is determined by geographical, temporal (seasonal and diurnal) and behavioral factors. Most tropical and sub-tropical countries have malaria, with exposure varying from one location to another. Exposure in urban areas is generally low, but higher in rural areas, especially near fresh water where the anophiline mosquitoes breed. High altitude decreases exposure, but the specific limiting altitude varies: in Sri Lanka malaria does not occur above 1000 meters, but in Kenya it occurs up to 2500 meters. Location also affects drug resistance. Only Central America and parts of the Middle East still have chloroquine-sensitive *falciparum* malaria. Resistance has also developed to mefloquine, the

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main replacement for chloroquine, along the Thai-Burmese and Thai-Cambodian borders.

In the tropics, malaria is usually present year-round, but in many sub-tropical locations it is seasonal, with increasing risk during, or just after, the rainy season. *Vivax* malaria peaks in the spring and *falciparum* in the late summer to fall. *Anopheles* mosquitoes only feed between dusk and dawn, so the time of day greatly affects exposure. Protecting oneself by remaining inside screened or air-conditioned dwellings at night, using insect repellents, wearing protective clothing, spraying with insecticides, and sleeping within bed netting decreases exposure to the mosquito vector.

Dose-response Assessment:

Examining the dose-response relationship in a population is an important part of the risk assessment of a health hazard. Ideally, one would want to know the likelihood of being bitten by an infectious mosquito, in different locations and time periods, and how many of these bites it would take to result in clinical symptoms in an unprotected population, compared to a protected population.

Only some of this information is available in the literature. In parts of sub-Saharan Africa, everyone is bitten by an infectious mosquito every day, while in other areas it may take 30-60 days before everyone is bitten. Not everyone who is bitten by a malaria-carrying mosquito succumbs to malaria. In a semi-immune population, of every 500 individuals bitten by an infected mosquito, 200 will develop parasite infection, of whom half will develop symptoms. Of those 100, 2 will become severely ill, and 1 of the 2 will die. Comparable proportions for overseas workers are not known. Most Canadian workers have no immunity and therefore have much higher rates of severe disease once exposed.

Individual Susceptibility:

Genetic, developmental, nutritional, disease, and behavioral factors should be considered. A number of inherited factors confer increased resistance to malaria. Most of these involve red cell polymorphism and metabolism: α and β thalassemia, hemoglobins S, E and C, Melanesian ovalocytosis, G6PD deficiency and Duffy antigen negativity. For example, Hemoglobin S (Hb-S) heterozygotes are less susceptible to severe malaria. The entry of the parasite into the red cell causes sickling, which results in the destruction of the cell by the spleen. The selective pressure created by this resistance to malaria has maintained a carriage rate of Hb-S in 10-30% of the population in sub-Saharan Africa, despite Hb-S homozygotes having sickle cell anemia.

Pregnant women have an increased incidence of malaria complications, such as cerebral malaria, renal failure and hemolysis. Malaria increases adverse pregnancy outcomes, including spontaneous abortion, intrauterine growth retardation, prematurity, stillbirths and neonatal deaths. Infants under six months of age rapidly develop severe disease and die, and in highly endemic areas the malarial death rate can be 10/1000 per year for children in the 1 to 4 age group. Adults are less susceptible to malaria, but the elderly are more susceptible than younger adults.

Contrary to expectation, malnutrition appears to have a protective effect against malaria. Correction of protein-calorie malnutrition can trigger cerebral malaria, and treating iron and riboflavin deficiencies has worsened the clinical status of malaria-infected children.

Anti-malarial drugs can be contraindicated in certain medical conditions, such as drug allergies, epilepsy, psychiatric diseases, cardiac conduction defects, and β blocker use. Being unable to take required anti-malarial drugs increases susceptibility to both acquiring the infection and dying from it. People who have pre-existing cardiac, renal or pulmonary disease will have their condition worsened by malaria, resulting in increased morbidity and mortality.

Immune status also affects susceptibility. Immunocompromised persons are at greatly increased risk of death if they contract malaria. Alternatively, people who spend their lives in endemic areas develop a partial immunity. This is maintained only by constant exposure to malaria, and is lost if a person emigrates to a non-endemic area. This is particularly relevant for persons from endemic areas now living in Canada, who return to their homelands for a visit, not realizing they are as susceptible as other 'naive' Canadians. People returning to their homelands have low rates of chemoprophylaxis and high rates of malaria.

Taking regular chemoprophylaxis, for the appropriate time period, decreases susceptibility to malaria. This time period includes both the time spent in malarial areas and four weeks afterwards. Chemoprophylaxis does not prevent the parasite from entering the host, but creates an environment within the host that is hostile to the parasite. Even if infection is not completely suppressed, the severity of breakthrough infections is decreased; patients who were not taking prophylaxis are approximately 10 times as likely to have severe malaria as those patients on prophylaxis. Seeking medical care promptly if any signs or symptoms of malaria occur also decreases susceptibility. Treatment of malaria requires more aggressive use of medications than does chemoprophylaxis, usually requiring admission to an intensive care unit if the malaria is severe. Persons who are treated appropriately soon after symptoms occur are less likely to suffer severe consequences than those who delay seeking treatment.

Risk Estimation:

Rough estimates of malaria risk can be based on reported malaria rates in situations similar to those of the overseas worker. Several studies have reported malaria rates in returning travellers and overseas workers. In 1990, the incidence in Peace Corps volunteers in Africa ranged from 65 cases/100 per year in Guinea to none in Botswana. Malaria attack rates were 80/100,000 per year in travellers in Kenya and Tanzania in 1986-7, on chloroquine or not, and 1200/100,000 per year in Nigeria and Ghana. European mortality rates from imported malaria (deaths/100,000 per month were: 43 in travellers from West Africa, 27 from East Africa, 1.4 from India and 0.16 from South America. The risk increased with increased length of stay.

In returning U.S. travellers, 81% of *falciparum* malaria cases were acquired in sub-Saharan Africa, 7% in Asia, 6% in the Caribbean and South America, and 6% in the rest of the world, despite the fact that only 90,000 Americans go to sub-Saharan Africa per year, while 900,000 go to malarial areas of Asia and South America. This is because travellers to the former region tend to spend most of their time in rural areas, whereas those to the latter regions are more often visiting urban or resort locations of lower risk. Overall, the risk to travellers of contracting and dying from malaria appears to be generally low, except for areas of Africa. However, most of the subjects in these studies are short term travellers, and most are on chemoprophylaxis. With the exception of Peace Corps volunteers, few studies have been done on long term overseas workers.

FITNESS-TO-WORK WITH RESPECT TO MALARIA RISK

Fitness-to-work is a medical opinion that an individual can undertake a specific job without danger to self or others. It is based on an evaluation of a worker's *capacity* to perform the specific requirements of the job, plus an assessment of the *risk* of medical problems that would interfere with the worker's ability to perform the job. In the context of malaria, both the risk of acquiring the disease by the worker and the risk to others if the worker holds a critical job function (such as a medic or pilot) must be considered. Malaria is not transmitted by person-to-person contact.

There are several legal and ethical considerations in performing fitness-to-work assessments. First is the principle of informed consent - the worker must understand the nature, purpose, and possible consequences of the assessment, particularly that if a medical contraindication exists, the job placement may be denied. Confidentiality of medical information is another important issue, and the examining physician needs to be sure that no health information is released to the employer without the consent of the worker.

An opinion of medical fitness should be phrased as "fit", "fit with modifications or restrictions", or "unfit". The physician must be aware of the malaria risk present in the location and during the period of foreign assignment; the nature of the work, and in particular any "critical" roles for which the patient is responsible; malaria susceptibility factors as determined by medical history and examination; and the availability of appropriate medical care should malaria-like symptoms arise. To ensure consistency and impartiality, placement-specific guidelines should be established in advance of medical examinations.

If there is virtually no chance that the worker could contract malaria, he or she can be declared "fit" with regards to malaria risk. If the probability is low, the worker can be declared fit with counselling regarding the risk of malaria, methods of protection (behaviors, topical repellants), and chemoprophylaxis. Current guidelines for chemoprophylaxis for every region of malarial risk can be obtained from Centers for Disease Control in Atlanta, and from Health Canada. Physicians should remember, however, that chemoprophylaxis cannot be regarded as being 100% effective.

If the risk of malaria is high, then the fitness decision is more complicated. If chemoprophylaxis and personal protective measures can decrease the malaria risk , then the worker can be treated as in the above "fit with recommendations" scenario. Difficulties arise when workers are unwilling or unable to take chemoprophylaxis. The issue of individual autonomy versus impact on the employer's operation and/or risk posed to others workers must then be addressed, especially if the individual holds a "critical" job. For high risk postings, the workers' willingness or ability to comply with protective measures is an essential part of deciding that they are fit, but this is often difficult to assess in advance.

A special case is that of pregnant workers. Pregnancy increases the consequences of malaria from severe to even more severe, so even a low probability of disease may be too high. Chemoprophylaxis in pregnancy is difficult, because a number of the medications used are contraindicated in pregnancy, or their safety is not yet known. If a pregnant worker is going to a chloroquine-sensitive area, chemoprophylaxis is not a problem, since chloroquine has no apparent deleterious effects in pregnancy. However, the pregnant worker going to areas of chloroquine-resistant *falciparum* malaria should be advised to delay travel until after the pregnancy. Workers should also be strongly advised not to take infants to those areas, as infants are prone to the more severe consequences of malaria.

CONCLUDING REMARKS

In the future, vaccines against malaria may be available, which would make the fitness-to-work assessment easier, because workers going to jobs with high malaria probability could be considered fit once vaccinated. However, malaria vaccines are likely to offer only partial protection, so physicians assessing fitness-to-work will still need to be able to evaluate malaria risk and counsel workers about protective measures.

(References available on request).

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OCCUPATIONAL EXPOSURE DATABASE DEVELOPMENT

A New Role of Occupational Hygienists

Ken Yoshida, Ph.D., R.O.H., C.S.S.*

INTRODUCTION

Recent advances in industrial technology are reflected by the quality of sampling equipment commonly used in current worksite investigations. Instrumentation has undergone remarkable technological change from predominantly manual operation to microprocessor-assisted automated mode and analog-to-digital processing in data acquisition systems. The profession of industrial hygiene (or occupational hygiene in Canada), however, has gained little understanding among worksite supervisors and human resources managers.

In Alberta, an ad hoc committee on

the licensing of professional occupational hygienists has been formed to define the categories of licensing and a professional code of ethics. Prior to the discussion of the ethical issues facing the profession, attempts were made to place the following questions in perspective:

1) What will be the trends in industry and industrial technology?
2) What will be the advances in the occupational hygiene field?
3) How will all these factors affect hygienists and their work?

As management has become more sensitive to worksite health and safety issues than it was twenty years ago, the role of the occupational hygienist is also dramatically changing. Role changes and subsequent professional challenges for occupational hygienists in the 1990's were summarized in a recent publication by the American Conference of Governmental Industrial Hygienists (ACGIH). Occupational hygienists will have a more significant role in the planning stages of occupational health programs and will be involved in the management decision-making process rather than the traditional role of monitoring of employee exposure.

Recently, with ever-changing health and environmental regulations and limited budgets available for maintaining complex programs, occupational hygienists will need to be more aware of legal ramifications.

This article will provide practical information on the background of occupational exposure databases (OEDB), the rationale for developing a database for occupational health and safety practitioners in North America, an examination of professional capability of occupational hygienists in developing such a database in Alberta, and a description of currently available databases and resources in the province.

RATIONALE OF DATABASE DEVELOPMENT

In occupational health practice, workplace exposure assessments (WEAs) are performed to identify, evaluate, and control employee exposure to hazardous substances. These assessments assist occupational health practitioners in making decisions and taking responsive action by estimating the magnitude, frequency, duration, and route of exposure. The components include:

1) the compilation of the initial characterization (qualitative rather than quantitative);
2) the definition of the homogeneous exposure groups (HEGs);
3) the assessment of work place exposure (WEA);
4) an appropriate monitoring program (AMP);
5) the implementation of the hierarchy of controls (HCy);
6) the verification of the work place controls (WCy);
7) the determination of the frequency of periodic reviews.

The need for a national worksite exposure database system was created because:

1) the database supports the WEA activities that are needed to accomplish risk assessment and risk management goals, and
2) it also supports WEA research, epidemiological investigations and surveillance, and policy and program design and evaluation.

In 1985, the United States EPA Office of Research and Development completed a Phase I study leading to TEAM (Total Exposure Assessment Methodology) with the aim of documenting personal exposure to target chemicals at worksites and urban living environments. The TEAM study also included indoor air quality among other major industries. In 1989 in the United Kingdom, the HSE National Exposure Database (NEDB) was proposed. With the need for epidemiological research, attempts at developing an exposure database were already made in 1986 in the United States by the occupational medicine community. More organized arguments for a OEDB in epidemiological research were presented to occupational hygienists in 1991.

In late 1993, ACGIH held an international conference on OEDB with the purpose of maximizing the usefulness of OEDB for risk assessment and management by:

1) reviewing the state of the art in OEDB through the examination of currently available databases, their contents, organization, strengths and limitations;
2) discussing how the use of existing databases can be optimized, and
3) stimulating the development of consensus recommendations for the future collection, abstraction, coding, storage and access, and analysis of exposure data in such databases.

Presentations were made in the areas of government agency databases, experience in the private sector, and legal and regulatory aspects. A workshop focused on:

1) key data needs for OEDB,
2) coding systems and approaches,
3) serving multiple needs with exposure databases,
4) practical guidelines,
5) future needs and co-ordination.

From a total of thirty-three general session papers, three originated from Canada.

ROLE OF OCCUPATIONAL HYGIENISTS

It has become standard practice among well-established occupational health and safety services in large corporations or government agencies to maintain and operate various sizes of PC-assisted programs related to employee health status including potential exposure scenarios. Commercial software has already been developed as part of the Workplace Hazardous Materials Information System (WHMIS) package. Users may develop their own database by entering readily available worksite data into these programs for processing, but this can be expensive and time-consuming.

An occupational hygienist in Canada might examine the following criteria when the use of such a database is required for risk assessment-management of a particular employee or job function:

1) What exposure parameters are involved? The hygienist may seek accurate information on suspected

substances, industries or job function.
2) Is an individual exposure case considered within a homogeneous exposure group?
3) What are the sampling and analysis methodologies? The distinction between OSHA standard practice and the NIOSH standard method of analysis is critical.
4) Do the cases involve multiple exposure assessment?
5) Is it cost-effective to use the database?

For practical purposes, the hygienist may create an employee exposure database as an extract of ACGIH TLVs documentation which describes typical exposure cases as a base of TLV for a particular substance. An alternative and more cost-effective route is to use currently available public domain databases. They are:

1) OSHA-IMIS database: The U.S. federal agency maintains exposure data in its integrated management information system database. Case study reports and intervention by OSHA have been documented and entered in NIOSHTIC and are available under CCINFO by the Canadian Centre for Occupational Health and Safety. Further detailed exposure cases beyond TLVs are contained in the NIOSHTIC. Up to now, NIOSHTIC is a part of CCINFO and only available by CD-ROM accesses (see references 1 and 2).

2) MSHA database: A similar package is available from another U.S. federal agency in charge of mining health and safety. The database contains a considerable amount of research data and some controversial issues in mining health-safety. Documentation is progressing far beyond OSHA endeavors.

3) Pesticide Exposure database: Both government and industrial institutions sponsored a variety of pesticide exposure studies when new formulations were introduced to markets. Documenting exposure in a database began during the 80's. The database being developed contains both U.S. and Canadian study results since the two countries administer pesticide use under the Pest Control Product Act (PCPA). In mid 1992, large scale documentation of pesticide exposure data was completed by a commercial publisher.

4) NIOSH-NCI database: Currently under development, typical information includes documentation of health hazard evaluation data by NIOSH under collaboration with the National Cancer Institute. At present, extensive exposure data can be accessed from NIOSHTIC.

5) Chemical Manufacturers Association database: Only a recent attempt to document the member activities was reported. Most of its data is still confidential.

6) U.S. EPA database: The federal agency collects exposure data under the authority of Toxic Substances and Control Act to support occupational population exposure assessments.

7) European database: Existing databases developed and reported at the ACGIH conference include those from the United Kingdom and Denmark. Access to these databases may be restricted to members of the EEC. In a recent workshop in Europe, development of pesticide handlers exposure database (PHED) was proposed. There is, however, considerable lack of confidence in the databases currently available in the European community. Also proposed was a European-U.S.-Canadian database (EURO_POEM).

Although a proposed databank for national occupational exposure (NOED) was presented recently in the United States, regulatory and budgetary obstacles will likely delay further development of such a large scale multi-purpose database. American hygienists will most likely further organize their activities toward the targeted time frame for practical use (estimated at three years or more). In the meantime, Alberta OH practitioners and physicians handling OH-related cases are encouraged to access databases through Library Services, Alberta Labour in Edmonton (see reference 6) and the Library Services of the University of Alberta and the University of Calgary. For further details, additional resource centers and databases are listed below.

References

1) Software Packages In Occupational Health and Safety
2nd Edition 1993, P92-5E
Canadian Centre for Occupational Health and Safety (CCOHS)
250 Main Street East
Hamilton, Ontario L8N 1H6
Telephone: (905)-572-2981; Fax: (902)-572-2206

2) CCINFO Disc Core Series
CCOHS, by annual subscription
Telephone: 1-(800)-668-4284 or (905)-570-8094

3) IRPTC (International Register of Potentially Toxic Chemicals)
Health and Welfare Canada
IRPTC-Canada
Rm 212, Environmental Health Centre
Tunney's Pasture, Ottawa, Ontario K1A 0L2

4) National Toxicology Program Chemical Database
National Institute of Environmental Health
Vol.3, Standards and Regulations, Worker Exposure Hazard Ratings; 1992
Vol.4, Medical Hazards and Symptoms of Exposure; 1992.

5) CAS Databases and CASurveyor, 1993
CAS, American Chemical Society
Accounting Department 60693
2540 Lentangy River Road
P. O. Box 3012
Columbus, Ohio 43210-0012 U.S.A.
Telephone: 1-(800)-753-4227; Fax: (614)-447-3751

6) Alberta Labour, Library Services
3rd Floor, 10808 - 99th Avenue
Edmonton, Alberta T5K 0G5
Telephone: (403) 427-8533; Fax: (403) 422-5070

(Further references available on request).

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UPCOMING CONFERENCES

Sixth Conference of the International Society of Environmental Epidemiology and Fourth Conference of the International Society for Exposure Analysis
Sheraton Imperial Hotel, Research Triangle Park, North Carolina, U.S.A.

September 18-21, 1994

Contact:
Phylliss Woody, Registrar
UNC School of Public Health
Office of Continuing Education
Tel: (919) 966-4032
Fax: (919) 966-5692

Occupational and Environmental Medical Association of Canada Annual Scientific Conference
Montreal, Quebec

September 19-21, 1994

Contact:
Association des medecins du travail du Quebec
1100, Beaumont avenue
Office 505
Ville Mont-Royal, Que.
H3P 3E5
Tel: (514) 344-1662
Fax: (514) 737-6431

Tenth International Symposium: Epidemiology in Occupational Health
Milan - Como, Italy

September 21-23, 1994

Contact:
ISEOH '94
Centro di Cultura Scientifica "A. Volta"
Villa Olmo - Via Cantoni 1
22100 Como - Italy
Tel: +39 31 5772213
Fax: +39 31 573395

Work with Display Units: Fourth International Scientific Conference
Aula Magna, University of Milan

October 2-5, 1994

Contact:
AES Congressi S.r.l.
Via Scheiwiller, 1 20139 MILANO, Italy
Tel: +39 (2) 55210523 - 57403891 - 5457203
Fax: +39 (2) 57400473

14th International Conference on the Prevention of Occupational Risks in the Construction Industry
Madrid

October 24-26, 1994

Contact:
AECOM - CNC
C/ Serrano no. 40
28001 MADRID
ESPANA
Fax: (341) 575 55 13