CONSISTENCY OF EXTERNAL DOSIMETRY IN EPIDEMIOLOGIC STUDIES OF NUCLEAR WORKERS

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ABSTRACT

Efforts are underway to pool data from epidemiologic studies of nuclear workers to obtain more precise estimates of radiation risk than would be possible from any single study. The International Agency for Research on Cancer (IARC) is coordinating combined analyses of data from studies in the United States, Canada, and the United Kingdom. In the U.S., the Department of Energy (DOE) has established the Comprehensive Epidemiologic Data Resource (CEDR) to provide investigators an opportunity to analyze data from several DOE laboratories. IARC investigators, in collaboration with those conducting the individual studies, have developed a dosimetry protocol for the international combined analyses.

INTRODUCTION

In the pooling of radiation exposure data, there is significant concern regarding consistency of personnel exposure records between the different epidemiologic studies. Dosimetry working groups have been formed to evaluate this issue for pooled studies for the International Agency for Research on Cancer (IARC) and U.S. Department of Energy (DOE) Comprehensive Epidemiologic Data Resource (CEDR). A protocol has been developed for the IARC study by representatives of the United States, United Kingdom and Canadian studies. Recently, a dosimetry working group has been formed to provide recommendations to CEDR regarding retrospective and prospective radiation dose records. The IARC protocol addresses concerns related to the consistency of recorded dose as obtained from personnel exposure records, and requires evaluation of historical dosimetry practices by dosimetrists for each of the contributing studies.

EPIDEMIOLOGIC EVALUATIONS

Several epidemiologic studies of workers who have been exposed occupationally to external radiation are being conducted in the United States, the United Kingdom, and Canada. U.S. studies include workers at the Hanford site[1], at Oak Ridge National Laboratory[2], and Rocky Flats Nuclear Weapons Plant[3]; the U.K. studies include workers at the Atomic Energy Authority[4], the Atomic Weapons Establishment[5], and at the Sellafield Plant[6], and the Canadian study is of workers at Atomic Energy of Canada Limited[7]. Analyses of data from these studies have included tests for an

association of cumulative radiation dose and mortality from many specific diseases, and have also included the estimation of excess risk per unit of dose.

Recently, pooled analyses of data from the three U.S. studies have been conducted[8] and pooled analysis of the international studies are underway[9]. A major objective of these pooled analyses is to obtain more precise risk estimates than could be obtained from any single study, and to compare these estimates with risk estimates obtained through extrapolation from studies of the Japanese A-bomb survivors and other groups exposed at high doses. To accomplish this objective, it is important to evaluate the consistency of dose estimates across studies and across time. In addition, because risk estimates from high dose studies are generally based on organ doses, it is important to understand the relationship between recorded whole body doses obtained from personnel dosimeters and doses to various organs.

CONSISTENCY OF RECORDED DOSE

Consistency of recorded dose between epidemiologic studies is essential to the technical integrity of the pooled evaluations. There are several potential causes, administrative and technical, of inconsistency between different facilities or through time for a given facility. These causes of potential inconsistencies should be evaluated as an integral part of the epidemiologic evaluation. Typically, there is a need for documentation of the physical meaning of the recorded dose, particularly for facilities which began operation in the 1940s and 1950s. Potential causes of inconsistency should be evaluated for systematic differences, which affect the entire dosimetry system, and for differences in administrative practices, which are generally of most significance for recorded doses near the detection level of the dosimetry system.

Potential causes of systematic differences include the dosimetry technology, calibration methodology, dose algorithms, environmental dose correction and the physical definition of the calculated dose (i.e., exposure, absorbed dose in air, deep dose, etc.). Technical, administrative and compliance considerations are involved in the determination of practices adopted by facilities to record personnel dose. Facility specific technical and administrative practices may have significant effects on the recorded lifetime personnel dose for each individual. Prior to pooling data between facilities, an evaluation of the potential causes of inconsistency in recorded dose is necessary to ensure credibility of the analyses.

DOSIMETRY ASPECTS OF IARC PROTOCOL

A protocol for "Combined Analyses of Cancer Mortality Among Nuclear Industry Workers" was published by IARC in 1989[9]. This protocol includes a discussion of dosimetry data and the consistency of dose estimates, makes specific recommendations regarding documentation of dosimetry data, and specifies the dosimetry variables that are to be included in the IARC data sets. Results of the U.S. dosimetry working group evaluation were considered along with evaluations conducted in the U.K. and Canada in the development of the dosimetry portion of the IARC protocol. The IARC protocol contains several recommendations for dosimetry data. These include the following:

- Documentation of procedures and practices used to record dose
- Report external whole body dose as currently recorded
- Report external whole body dose components (i.e., penetrating photon and beta, neutron and tritium)
- Flag records with monitoring for internal depositions
- Flag records with confirmed plutonium, uranium or other nuclide internal depositions
- Comparison of recorded dose to deep dose
- Determination of organ dose as feasible

Prior to inclusion in the IARC study, a representative for each participating study completed a questionnaire on specifics of dosimeter design, dose assessment, monitoring and recording practices, radiation fields to which workers were exposed, etc. This information was used by IARC and the dosimetry subcommittee to conduct a preliminary evaluation of consistency of dose estimates used in different studies, and whether the reported doses can be converted to "deep dose", and to doses to various organs. More detailed documentation by the respective studies is encouraged. Recently, documentation of historical personnel dosimetry practices was published for Hanford[10]. This document describes dosimeters, calibration and dose recording practices for hanford facilities from 1944 through 1989.

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ACKNOWLEDGEMENT

This work was funded by the U.S. Department of Energy under Contract DE-AC06-76RLO 1830.