HOWARD HUGHES MEDICAL INSTITUTE DOSE ASSESSMENT SURVEY

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Abstract—**Biomedical science researchers often express frustration that health physics practices vary widely between individual institutions. A survey examining both internal and external dose assessment practices was devised and mailed to fifty institutions supporting biomedical science research. The results indicate that health physics dose assessment practices and policies are highly variable. Factors which may contribute to the degree of variation are discussed.**
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INTRODUCTION

RESEARCHERS USING radioisotopes for biomedical research often work at several research or academic institutions in the course of their career. These individuals often have expressed frustration at the variability of health physics requirements that exist between various facilities. The Environment, Health and Safety staff of the University of California, San Diego, designed a survey tool to determine licensee demographics and dose assessment practices at the collaborating research institutions of the Howard Hughes Medical Institute.[§]

MATERIALS AND METHODS

The "Health Physics Survey" and a cover letter describing the survey's purpose were mailed to the directors of environmental health and safety at fifty HHMI host institutions. The survey tool requested information regarding the number of radiation users, dosimeter issuance criteria, number of individuals enrolled in bioassay programs and enrollment criteria, and instrumentation used. Table 1 summarizes the "Health Physics Survey."

Upon return, the results of the individual surveys were summarized and tabulated. An executive summary was composed and distributed at the HHMI Environmental, Health and Safety Conference in April 1995.[‖]

RESULTS

Thirty-seven HHMI host institutions returned surveys. Tables 2 and 3 summarize a portion of the survey. Due to publication length guidelines, the results are not reported in their entirety.

General demographics

The number of radiation workers at a single institution varied between approximately 250–6,000. Nine institutions had 500 workers or less. Eight institutions indicated between 501 and 1,500 radiation workers; seven had between 1,501 and 2,500. Seven institutions reported between 2,501 and 3,500 radiation workers, while six expressed more than 3,501.

External dose assessment

The dosimeter issuance criteria varied greatly between licensees. The percentage of total radiation workers assigned whole body dosimeters varies widely between institutions, from 6% to 100%. Table 2 lists the percentages of radiation workers and radioisotope users assigned dosimeters at the various facilities. All institutions report using combinations of thermoluminescent materials and film for whole body and extremity dose assessment.

Considering the use of beta emitting radioisotopes separately, several decision strategies were present. Some institutions considered only the kinetic energy of the radioisotopes' beta emissions and indicated the beta kinetic energy at which dosimeters are issued as 170, 200, 500, or 600 keV or "high energy" depending upon the individual institution. Several institutions considered only the quantities of radioactivity and reported the criteria for dosimeter assignment as using greater than 37, 370, or 1,110 MBq (1, 10, or 30 mCi) depending upon the institution, not the radioisotope. Sometimes, a combination of emission energy of the radioisotope and radioactivity levels used determined dosimeter policy. Facilities reported their dosimeter issuance criteria as

[§] The Howard Hughes Medical Institute (HHMI) is a scientific and philanthropic organization whose principal purpose is the direct conduct of biomedical research. Its laboratories are located throughout the United States at academic medical centers, universities, and other research institutions, under collaborative research agreements.

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‖ Available from Howard Hughes Medical Institute, Office of Laboratory Safety, Chevy Chase, MD 20815-6789

Table 1. "Health Physics Survey" summary.

General Demographics
How many Principal Investigators using radioactive material are at your facility?
How many Radioisotope Use Authorizations are assigned?
How many laboratories using radioactive materials are there?
Do you have a medical center or hospital facility?
How many total radiation workers are employed at your facility?
Number of radiation workers at medical center? At campus?
External Dose Assessment
What types of dosimeters are in use at your institution?
How many radiation workers have dosimeters? Whole body? Extremity?
What criteria determine who wears a whole body dosimeter(s)?
What criteria determine who wears a extremity dosimeter(s)?
Are finger dosimeters required for cardiac cath. physicians, nurses, or techs?
Are finger dosimeters required for neurosurgery physicians, nurses, or techs?
Are finger dosimeters required for nuclear medicine physicians, nurses, or techs?
Are operating room, oncology, or iodine therapy nurses issued dosimeters?
Are custodians, security guards, maintenance workers, etc. issued dosimeters?
What type of dosimeter(s) are issued to workers who have declared pregnancy?
Do employees wear different dosimeters when working at multiple sites on one license?
What is the percentage of dosimeters returned on time?
What measures do you use to facilitate timely dosimeter returns?
At what frequency do you change dosimeters? Monthly? Quarterly? Other?
What criteria are used to determine frequency?
Does your regulatory agency (NRC or State) dictate who should wear dosimeters?
If you use a commercial dosimetry service, which one?
Does your vendor provide an "on-line" ordering system via modem?
Please assess the quality of the commercial dosimetry service you use.
How do you total annual doses for workers employed at more than one licensed facility?
What incidents, if any, have contributed to significant external doses?
Internal Dose Assessment
What criteria determine who is enrolled in a bioassay surveillance program?
Are workers using ^{32}P enrolled in a bioassay surveillance program?
Are workers using ^{125}I and/or ^{131}I enrolled in a bioassay surveillance program?
Are workers using other radioisotopes enrolled in a bioassay surveillance program? Isotopes?
Are nuclear pharmacists enrolled in a bioassay surveillance program?
Describe other individuals who may be subject to routine bioassay surveillance?
Describe the bioassay guidelines for both acute and chronic potential exposures.
How do you demonstrate "lack of intake" by workers using quantities > one ALI[a]?
Detection Equipment and Procedures
What make and model of detection equipment do you use for thyroid bioassays?
Is thyroid counting done in the field or in a designated room?
What make and model of detection equipment do you use for urine bioassays?
Please state strengths/weaknesses regarding bioassay equipment described.
Who performs the required bioassays? HP staff? Researcher? Other?
Engineering Controls
What procedures do you require to be performed in a fume hood?
What face velocity do you feel is optimum for these procedures?
What incidents, if any, have resulted in significant internal doses to personnel?
Do you use a computerized internal dose assessment calculation program? Program name?
Are there restrictions for a DPW[b] using radioisotopes or radiographic/fluoro units?
10 CFR 20[c] (1/1/94)
Has your facility switched over to 10 CFR 20 (1/1/94) requirements yet?
What advice can you offer to make the transition smoother for others?
What staff training have you done to facilitate the transition to 10 CFR 20 (1/1/94)?

[a] Annual Limit on Intake.
[b] Declared pregnant worker.
[c] Title 10, Code of Federal Regulations, Part 20.

follows: emission energy greater than 100 keV and activity greater than 740 Mbq (20 mCi); or, energy greater than 200 keV and activity greater than 37, 185, 370, or 1,110 MBq (1, 5, 10, or 30 mCi), depending upon the institution. A few facilities base dosimeter requirements on the potential of receiving 10% of the occupational dose limit with no issuance of specific criteria. Four institutions issued dosimeters to all radiation workers, while two facilities assigned dosimeters to all radi-

Table 2. Percentage of radiation workers and radioisotope users issued dosimeters at each institution.

Percentage of workers/users issued dosimeters	Number of institutions
75%–100%	17
50%–74%	9
25%–49%	3
1%–24%	4
not specified	4

Table 3. Responses to questions concerning criteria for enrollment in an institutional bioassay surveillance program. Replies are grouped according to radioisotope.

^{3}H
Single use limit
any form: 370, 925, 1850, 3700, 37,000 MBq (10, 25, 50, or 100 mCi or 1.0 Ci) if used in a fume hood
thymidine, organic compounds, nucleic acid precursors: 37, 296 MBq (1, 8 mCi)
Single order, any form: 370, 3,700 MBq (10, 100 mCi)
Monthly use limit, any form: 370 MBq (10 mCi), > 1 ALI (2,960 MBq) (80 mCi)
Quarterly use limit, any form: 1,850, 3,700 MBq (50, 100 mCi)
Semi-annual use limit, any form: 3,700 MBq (100 mCi)
Annual use limit: 296 MBq (8 mCi)
If accidents occur or wide-spread contamination is found
All radioactive waste workers are bioassayed
^{32}P
Single use limit, any form: 22, 37, 56, 370, 740, 1850, 3700 MBq (0.6, 1, 1.5, 10, 20, 50, 100 mCi)
Monthly use limit, any form: 37, 185 MBq (1, 5 mCi), 10 ALIs
Bimonthly use limit, any form: 296 MBq (8 mCi)
Quarterly use limit, any form: 925 MBq (25 mCi)
If accidents occur or wide-spread contamination is found
All radioactive waste workers are bioassayed
^{125}I
Single use limit
any form: 37 MBq (1 mCi)
volatile forms: 0.37, 1.5, 3.7, 9.3, 37, 185, 370 MBq (0.01, 0.04, 0.1, 0.25, 1, 5, 10 mCi) or all
bound form: 370, 3700 MBq (10, 100 mCi)
Weekly use limit, all forms: 37 MBq (1 mCi)
Quarterly use limit, all forms: 3.7, 37 MBq (0.1, 1 mCi)
All iodinations independent of radioisotope quantity
If accidents occur or wide-spread contamination is found
All radioactive waste workers are bioassayed
^{35}S
Single use limit, any form: 185, 370, 3,700 MBq (5, 10, 100 mCi)
Weekly use limit, any form: 1,850–3,700 MBq (50–100 mCi) (for study purposes)
Monthly use limit, any form: 10 ALIs
Quarterly use limit, any form: 925 MBq (25 mCi)
^{14}C
Single use limit, any form: 111, 3,700 MBq (3, 100 mCi)
Monthly use limit, any form: 10 ALIs
Quarterly use limit, any form: 1,295 MBq (35 mCi)
^{45}Ca
Single use limit, any form: 111 MBq (3 mCi)
Monthly use limit, any form: 10 ALIs
^{51}Cr
Single use limit, any form: 148 MBq (4 mCi)
Additional responses
Radioisotope users are bioassayed whenever there are accidents or wide spread contamination
Radioisotope users are bioassayed if they use greater than 10 ALI's during one month
Radioisotope users are bioassayed if they use greater than 1 ALI of all radioisotopes in dispersible form
All radioactive waste workers are routinely bioassayed
Whole body counts are performed routinely on accelerator workers

ation workers except those individuals using tritium exclusively.

In issuing dosimeters to photon emitting radioisotope users, quantities of radioisotope in use generally determined whether whole body dosimeters were assigned. The radioactivity quantities that resulted in the issuance of a whole body dosimeter were 18.5, 37, 185, 740 MBq (0.5, 1.0, 5.0, 20 mCi) or any quantity depending upon the licensee. As in the use of beta emitting radioisotopes, a few facilities based dosimeter issuance on radioisotope type and quantity that may potentially result in 10% of the occupational dose limit. Overall, dosimeter issuance criteria varied greatly and there was no distinct pattern or policy present when monitoring radioisotope laboratory workers. Many facilities, however, have specific policies for issuing dosimeters based on potential doses to support personnel.

The survey included questions regarding facility policies for support personnel such as security guards, custodians, and maintenance staff entering radioisotope use areas. The assignment of whole body dosimeters for support staff of this nature also varied widely among the 37 institutions. Five licensees issue whole body dosimeters to security guards, 13 facilities monitor custodial staff, and 15 track whole body doses to maintenance personnel. Some facilities issue dosimeters to all support personnel, while others badge none. One institution monitors animal technicians, two monitor shipping/receiving staff, and one monitors dishwashers.

Once distributed, radiation workers must return dosimeters for reading and processing. Licensees generally reported fair to good dosimeter return rates of 70–99%. Licensees use various incentives to encourage timely badge returns. Nine facilities levy fines, two record audit deficiencies, and one withholds radioisotope orders. Twenty-four institutions send reminders such as letters, memos, and telephone calls. Four institutions reporting a dosimeter return rate of 95% or better have health and safety staff visit laboratories to retrieve dosimeters.

Internal dose assessment

The variation in internal dose assessment practices was so great that a general summary is not possible. Table 3 tabulates the survey results obtained. Some institutions based bioassay surveillance requirements only on the quantity of radioisotope used, independent of form. Other facilities regarded radioisotope form as an important criterion to define bioassay needs. A few institutions defined bioassay enrollment criteria as the radioisotope quantity present in a single use or a single order. Many licensees based bioassay surveillance on the quantity of radioisotope in use over a designated time span. The designated time span over which radioisotope quantity totals were integrated was 1 week, 1 month, 2 months, 3 months, 6 months, or 1 year, depending upon the facility. Where institutions defined identical time spans over which to integrate radioisotope quantities, the level designated to initiate bioassay monitoring for a specific radioisotope varied considerably. Few institutions defined bioassay criteria as a percentage of the Annual Limit on Intake (ALI).

DISCUSSION

Clearly, for facilities doing similar research, there exists wide variability in health physics practices. The

basis of any dose assessment policy must necessarily include many underlying assumptions regarding potential radiation hazards. Health physics personnel have varying degrees of confidence in defining and defending these assumptions.

The health physics staffs' educational level, degree of experience, and familiarity with research laboratory processes may influence institutional radiation safety policies. In addition, technical and administrative capabilities may constrain the policies and practices of the licensee.

The institution's license requirements and regulatory history may define present health physics programs. In clinical facilities, following established standards of practice, the health physics policies will be well established. However, in a research environment where new procedures are developed, established health physics practices may not exist. Therefore, radiation safety programs may be institutionally specific, perhaps explaining the breadth of dose assessment strategies observed. Given the existing variations in health physics practices, confusion among researchers moving between similar institutions is understandable.

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