SMR 2616, Joint ICTP-IAEA Workshop on Determination of Uncertainties of Measurements in Medical Radiation Dosimetry, 9-13 June 2014, Trieste

Self-assessment: intended answers

Part 2:

1. In practice, it is recommended to use typical uncertainty values given in dosimetry code of practices.
   a. Yes
   b. No

You should determine your own achievable uncertainties, taking into account your measurement procedures and laboratory conditions. Your estimated uncertainties should be compared against those published in dosimetry codes of practice or best practice guidelines.

2. You operate a Secondary Standard calibration laboratory and have determined that the response of your activity calibrator for measurement of 18F deviates by 2.2(1) % over the activity range (200 MBq to 1 GBq) that you typically measure. You have determined that the linearity of the device is within the measurement standard deviation below 400 MBq but you wish to measure a source having an activity of 900 MBq. Do you:

   a. Add an uncertainty of 2.2 % to your final activity,

   b. Make a 2.2 % correction to the measured activity and add 0.1 % into the combined standard uncertainty,

   c. Add 0.1 % into the calculation of the combined standard uncertainty,

   d. Nothing needs to be done.

3. Besides the design of the instruments (i.e., what they are made of), give two differences between the operating characteristics of gamma well counters and activity calibrators.

   Total deposited energy vs energy per event, spectral information possible only with gamma well counters, high activity count rates (activity calibrator) vs low count rates (gamma well counters, dead time effect (gamma well counters vs linearity (activity calibrator)

4. Why is the calibration coefficient for an activity calibrator dependent on the specific radionuclide and measurement geometry?

   Self-absorption and other effects that change deposited energy spectrum, geometry also influences bremsstrahlung spectrum for beta emitters.

5. An uncertainty of 50% for a Diagnostic Reference Level (DRL) value, sounds

   a. Logical, although high

   b. Absolutely wrong

   d. I do not know

6. How many Regional Metrology Organisations (RMOs) are there worldwide? 5

   What is the RMO in your part of the world……………………………………………………………………………………

7. What are calibration and measurement capabilities (CMCs): A CMC is a calibration and measurement capability available to customers under normal conditions:
(a) as published in the BIPM key comparison database (KCDB) of the CIPM MRA; or
(b) as described in the laboratory's scope of accreditation granted by a signatory to the ILAC Arrangement."

8. In a CMC for ionizing radiation uncertainty claims are given. What coverage factor k is used?

a. 1

b. 2

c. 1.73

9. What types of calorimeters are in use for measurements in high-energy photon beams? Water and graphite calorimeters

10. What is the maximum photon energy suitable to measure with a Free Air Chamber in X-rays?

a. 600 keV
b. 150 keV
c. 400 keV

11. Estimate the uncertainty that accounts for the variations over time of a reference dosimeter, knowing that no measurements were done to check the stability, but a difference of 0.3% was found between the last 2 calibration coefficients.

Type B evaluation, Rectangular distribution, relative standard uncertainty= $0.3\%/\sqrt{3}$

12. A brachytherapy source is measured with a scintillator and a diode with different answers. What could be the cause of this difference, creating the greatest uncertainty?

(i) Temperature effects
(ii) Pressure effects
(iii) Energy response
(iv) Ion recombination
(v) Method of readout (light versus electrical signal)

13. An instrument is used to measure a radioactive source with a standard deviation of measurement of 1%. The total uncertainty is claimed to be 3%. Distinguish the difference between the precision and accuracy of the measurement

The precision is how close together the measurements are; thus the standard deviation (1%). Accuracy is how close it is to the true value (3%).

14. If the relative combined uncertainty is claimed to be 3%, what is the uncertainty for a:

a. coverage factor of 1: 3%.

b. coverage factor of 2: 6%

c. coverage factor of 3: 9%