Quality control for nuclear medical instruments

by E.U. Buddemeyer*

Quality control is to a nuclear medicine practitioner as tenure is to a university professor in that neither the quality control nor the tenure is conspicuous except by its absence. Thus, when the performance of nuclear medicine instruments is under adequate control, nothing remarkable occurs. The lack of proper instrument quality control (QC) procedures, however, is likely to become apparent in the form of an untoward event, such as when the technician is obliged to report to the physician: "We can't scan Mr Jones today because something is wrong with the scanner." If, as is often the case in the absence of regular QC, the instrument malfunction was not discovered until the attempt to scan Mr Jones proved to be a failure, then not only has there been a waste of time, effort and money but Mr Jones will also have already received a radiation dose for which there can be no commensurate medical reward. There are thus both economic losses and health risks associated with inadequate QC practices. On the other hand, a programme to provide 'zero defect' quality control would be impossibly expensive and time-consuming if, indeed, it could be accomplished at all. Accordingly, the Agency assembled in 1979 a multinational advisory group of experts who drafted a set of QC schedules for nuclear medical instruments. The new schedules were designed to offer reasonable quality control and, at the same time, to be practicable in the conditions likely to be found in developing countries. After initial experience with these schedules in Latin America, they were introduced into the Asia and Pacific region at a week-long seminar** held at the Siriraj Hospital in Bangkok, Thailand.

In addition to presenting the techniques of QC, the seminar was also intended to illustrate the economic value of such testing. It was pointed out, for example, that an instrument which fails to operate correctly at installation has a high likelihood of never doing so. Initial QC acceptance testing thus can serve to prevent costly mistakes in instrument selection. Should the instrument pass the acceptance tests, then these first results are useful as a reference against which any future degradation of performance can be measured.

Regular checking and documentation of performance is particularly important in developing countries where instruments are sometimes exposed to conditions for which they were not designed. The manufacturer probably would not have anticipated, for instance, that a hospital administrator in a tropical country, not seeing any reason why an inanimate gamma camera should be kept 'comfortable' when it is idle, might insist that the air conditioning be turned off at night to save electricity*. The resultant wide excursions in temperature could crack the fragile crystal of the camera – a *very* expensive item to replace. Also, morning cooling of the hot, humid night air causes condensation that can be devastating to high-voltage power supplies as well as to electronic components. These and other environmental problems (dust, line voltage variations, etc.) tend to shorten the life expectancy of nuclear medical instruments in developing countries, especially those in tropical zones. QC procedures cannot by themselves prevent instrument malfunctions but – when regularly applied – will reveal any trends towards degradation of performance. Once recognized, these trends often point to specific adjustments that can be made to slow or reverse the degradation before the instrument becomes frankly non-functional, thus avoiding down-time and expensive repairs.

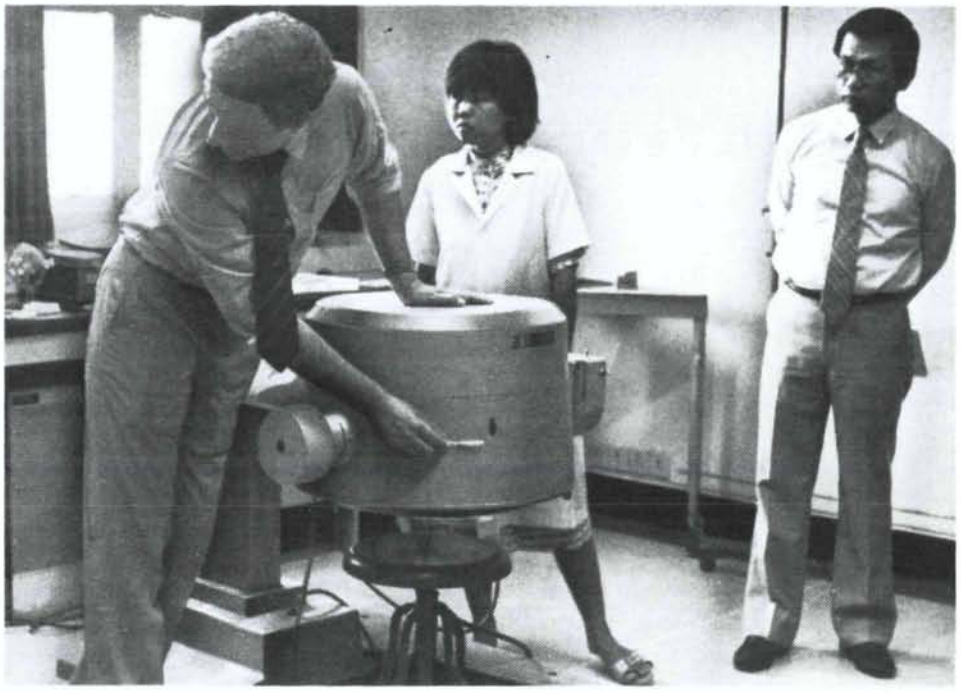
The QC schedules and their rationale were presented in lecture sessions during the first three days of the seminar. The suggested Agency schedules include thorough and rigourous acceptance and reference tests together with simpler, routine tests to be done daily, weekly, quarterly or half-yearly, according to the likelihood of failure of the tested function and the complexity of the QC procedure. Test schedules were described for the following categories of instruments employed in nuclear medicine:

- Ionization chambers used for the measurement of the quantity of activity (Bq or Ci) in a dose intended for administration to a patient;
- Simple crystal scintillation counting systems for relative activity measurements *in vitro* (e.g. radioimmunoassay counting) or *in vivo* (e.g. uptake of radioiodine by the thyroid);
- The two classes of imaging devices (i.e. rectilinear scanners and gamma cameras) used to portray the distribution of a radiopharmaceutical within the body.

* Mr Buddemeyer is in the Medical Applications Section of the Agency's Division of Life Sciences.

** Seminar on quality assurance in the use of nuclear medical instruments, organized by the IAEA and held in Bangkok, Thailand, 19 to 23 July 1982. The seminar was attended by 43 participants representing 11 countries from the Asia and Pacific region.

* This policy was found to be the practice at a significant number of institutions responding to an Agency survey.



By using a small source of 99m-Tc, an Agency expert demonstrates leakage-testing of shielding of a gamma camera during a workshop at the seminar in Bangkok.

Several presentations at the seminar concerned the design, function, and testing of data and image-processing computers that are widely distributed in nuclear medical facilities in the developed countries. These computers are now being introduced into clinics in the developing countries as well, although more slowly and in limited numbers. Seminar participants presented at the seminar six proferred papers reflecting their experience in QC.

One paper described a technique for obtaining gamma camera QC data analogous to that specified in the US National Electrical Manufacturers Association (NEMA) standards, but without requiring a multichannel analyser or a dedicated computer – ancillary testing equipment – that is unavailable in most clinics in developing countries.

The last two days of the seminar were devoted largely to workshop sessions, in which the recommended QC tests were demonstrated on the instruments at the Siriraj Hospital using test sources and phantoms supplied by the Agency. For this purpose the participants were divided into groups of 14 to 15, each group working through three half-day workshops: one on dose calibrators and scintillation counters, a second on rectilinear scanners, and a third on gamma cameras. The workshop experience proved valuable to participants because, among other things, it demonstrated that ingenious use of local materials can often be effective, as when one of the Agency experts was able to repair a faulty photorecorder using only adhesive tape and a black marking pen. On the negative side, even though a computer was available, it was not possible to demonstrate the NEMA gamma camera QC procedures; simpler testing procedures were therefore substituted.

The Bangkok seminar was the first phase of the Agency's QC programme for nuclear medical instruments in the Asia and Pacific region. It was intended to implant an appreciation of the value of QC, as well as to instruct participants in the use of QC techniques that they can disseminate in their own clinics. In future, the Agency plans to sponsor in the region a series of smaller, national QC workshops providing more highly tailored instruction and greater opportunity for 'hands on' experience. To prepare for these national workshops (beginning in early 1983), a second meeting of the advisory group will be convened in Vienna. Using feedback from both Latin America and from the seminar in Bangkok, the Agency experts will assess their 1979 recommendations, and incorporate changes suggested by field experience.