7c

Issues in Tomographic Clinical Studies

B. F. Hutton (London)

Tomographic studies are undoubtedly the main-stay of Nuclear Medicine and the explosion of dual modality systems has not only enhanced the clinical value of emission tomography but opens further avenues for development. In order to identify the key issues in current practice it is useful to first define the current clinical expectations of tomographic systems and use this as a basis for identifying areas of need. For procedures to be clinically acceptable they need to be effective (diagnostic), efficient (cost-effective) and practical. Increasingly the objectives are to not only to identify and localise areas of abnormal uptake but to quantify extent and severity and to monitor change. On the whole the extraction of information from increasingly large datasets continues to be a difficult task for the reporting medical specialist, made harder by the artefacts and uncertainties present in the data. There tend to be competing demands for improved quality versus increased throughput, often driven by the commercial sales pitch rather than by scientific enquiry. There is need for versatility, yet optimisation for specific applications. There is need for simplified practical procedures but equally an extended armoury of analysis tools.

Given these often competing requirements there are many general issues that can be identified and discussed:

- Should system design aim for higher sensitivity for the purpose of improving quality, for reducing radiation dose or for increasing patient throughput?
- Is resolution improvement more important than sensitivity gain?
- Should reconstruction be considered an integral part of a tomographic system for the purposes of assessing quality?
- How can quality be assessed in a practical setting?
- What quantitative accuracy is necessary (activity concentration, volume, functional parameters)?
- What software tools are needed and how are these evaluated?

Focusing on some more specific issues, what artefacts continue to be problematic in clinical studies? Despite years of effort to develop correction techniques for attenuation, scatter and partial volume effects these all to some extent continue to be problematic for both PET and SPECT studies. There is clear recognition that the impact of errors is greater in PET than in SPECT (e.g. noise propagation). Yet the commercial solutions are not universal and have in many cases attracted unfavourable criticism. Companies have tended to be slow to adopt correction techniques or to offer the necessary flexibility; solutions become more competitive than practical or cost-effective. The clear example is in cardiac attenuation correction where multiple solutions have been suggested and even the most costly use of CT introduces its own set of limitations. Were a simple data-driven approach feasible it might gain widespread acceptance. Similarly there has been considerable effort to reduce partial volume effects and elegant solutions exist making use of registered anatomical data; these techniques should be more readily implemented on dual modality systems. Suppliers are faced with similar dilemmas to the end user in deciding what approaches to adopt from academia, where increasingly sophisticated algorithms are being developed. There is however clear evidence that these approaches are contributing to the improvements in overall system performance evident in both PET and SPECT.

It is clear that clinical practice continues to require analytical tools that extend beyond the standard simplified analysis typically offered. For example, reliable and effective registration software is rarely available despite its clear need to complement dual modailty systems. Similarly image segmentation is a technique that has only been developed in specialised applications, while the libraries of more general algorithms have not been adapted for use in the field. Defining the functional boundary of an active tumour remains a daunting task despite the sophistication of technology in the 21st century! It is similarly amazing that possibly the most topical subject in current physics sessions is the correction of patient motion. Various studies continue to be difficult to interpret and the establishment of databases that support cross-platform normal and diseased populations are in their infancy (with some excepti-

ons). The development of cross-platform tools to achieve this in a nuclear medicine setting continues to be challenging.

In summary there continue to be multiple issues related to the technology and analysis of nuclear medicine studies. Practitioners need to be aware of the various choices and limitations in system performance in order to provide informed advice during study interpretation. There is little doubt that the technology is improving and with this the diagnostic capabilities. As a result nuclear medicine continues to make a valuable contribution to patient management.