Nuclear medicine software - nothing's perfect

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A discussion of clinical audits is sometimes perceived to be like watching paint dry. Hopefully this editorial will change some minds. Consider a hypothetical situation where a patient undergoes annual check-ups to monitor their condition using a nuclear medicine procedure. One year the procedure is performed at a different hospital, where it is found that that the result has fallen significantly. Does this really mean that their condition has deteriorated or could it be that the discrepancy is due to different methods used in the two hospitals? In reality several factors lead to discrepancies. One important factor leading to variation is the type of software used during processing. This variation is due to systematic difference in software implementation (different manufacturers, etc.) and software versions. This undesirable variation must be investigated and minimised by the nuclear medicine profession, in order to improve the quality of patient care. The role of audit in development of nuclear medicine care has been reported elsewhere [1,2].

The purpose of this editorial is to discuss the value of clinical software audits in nuclear medicine [3]. We will introduce the voluntary auditing work of the Nuclear Medicine Software Quality Group (NMSQG) which is a sub-committee of Nuclear Medicine Special Interest Group of the Institute of Physics and Engineering in Medicine, and their collaboration with the British Nuclear Medicine Society (BNMS). The group have identified various statistically and clinically significant issues in proprietary nuclear medicine software. Significant differences in the implementation of software, by different manufacturers have also been discovered, along with several surprising outlying centres. This editorial will frame the work of the NMSQG, by addressing the successful completion of a 12-year national audit cycle, into the calculation of glomerular filtration rate (GFR) with plasma sampling.

First of all, why audit? Under clinical governance, healthcare providers are held accountable for continuously improving and safeguarding the quality and high standards of services and patient care. Clinical audits play an important role in this process. The National Institute for Clinical Excellence (NICE) [4] define clinical audits as “a quality improvement process that seeks to improve patient care and outcomes”, through the continuous “systematic review of care” evaluated against defined criteria, such as national guidelines. Where national guidelines do not exist, the NMSQG study intercentre variability relative to audit data sets (clinical or generated data). After reading this paragraph, there is a strong probability that the reader is now looking around the room, for a freshly painted wall to stare at, but behind the formal definitions of auditing, lays an extremely valuable clinical tool.

Since the formation of the group, NMSQG have found many insightful and clinically relevant results. The following are examples of previous audits. The reader is invited to consider the clinical value and importance of the results.

Audits have investigated clinical software for planar radionuclide imaging. Software for relative lung function [5] was found to be accurate and reproducible. An audit of software for calculating relative renal function from DMSA scans [6] found that the technique was essentially reliable although improvements could be made by standardisation. A related audit of quantitative parameters in renography using real patient data [7] showed some consistency in measurement of relative function but considerable variation in mean transit time, requiring standardisation. A follow-up audit showed that even with phantom data it is not easy to know the ‘true’ answer in these audits [8].

NMSQG have also investigated cardiac based scintigraphy, one of nuclear medicine’s diagnostic workhorses. Statistically significant differences were found between proprietary software for determining left ventricular ejection fraction from multi gated acquisition scans [9]. The audit led to proposed corrections for this systematic variation [10]. On the other hand calculation of functional parameters in gated myocardial perfusion imaging was found to be reliable and showed limited national variability [11] which is a positive result.

The clinical value of single-photon emission computed tomography (SPECT) as a diagnostic tool is well established. The group has audited technical aspects of SPECT. One NMSQG audit investigated the quantitative characteristics of SPECT

reconstruction [12]. Significant differences in quantitative parameters were found between manufacturers and different versions of software from the same manufacturers. A further audit investigated how different manufacturers implement a common SPECT filter [13]. The audit found large variation in the implementation of the filter by different manufacturers. Corrections were proposed to replicate filter performance, between manufacturers. Both of these audits are obviously pertinent to the replication of SPECT image quality, between different brands of gamma cameras.

Some modern software packages tend to be ‘black box’, meaning that the user does not see the processing stage (programming code, etc.), but only the input and output data. An example of this is bespoke resolution recovery which is a new feature in modern software. Audits play an important role in understanding the basic variability between new software packages which is imperative in establishing high national standards of service and patient care, for these new emerging SPECT technologies. A recent audit studied half-count myocardial perfusion imaging using resolution recovery software, from different manufacturers [14]. Some centres found that they could use the software to obtain equivalent clinical results using half-counts whereas others were unable to do this, although there were no significant differences in acquisition parameters between the two groups.

It is hoped that the value of the presented NMSQG audits is recognised, for quantifying intercentre variability and establishing respective baselines. Most recently a 12-year national audit cycle has been completed for GFR measurement with plasma sampling. It involved a total of fifty nine centres from England, Scotland,

Wales and Northern Ireland. GFR is used clinically to quantify kidney function**.** Several technical considerations must be taken to allow for accurate GFR calculation [15]. An initial audit investigated the variability of the GFR calculation in 2001 [16]. The audit found widespread considerable variability due to varying methods of analysis. This led to the BNMS GFR guidelines [17] in 2004, which intended to standardise the procedure and so reduce variability. The repeat GFR audit [18] showed the successful widespread national adoption of these guidelines. This is the first national software audit cycle, involving national guidelines. Unlike for image processing, there is no CE marked proprietary software available, for GFR calculation. The audit will play an important role in the benchmarking of GFR software, developed in-house by departments. Examples of calculations, following the BNMS guidelines, are available as supplemental digital content with the recent audit publication. The data is also available from the group's website at http://nmsqg.org/. It is hoped the audit will contribute to the development of new GFR guidelines.

The audit found that seventy percent of GFR studies are performed on oncology patients, mainly to determine and individualise chemotherapy dosing. Inaccuracies in GFR calculation translate directly to suboptimsed chemotherapy dosing. GFR calculation is also used in the assessment of renal patients and potential live donors. This underlines the need for accurate and standardised national GFR calculation; hence harmonisation is welcomed. This successful audit cycle represents the core principles of clinical governance.

NMSQG would like to thank everyone in the nuclear medicine community, including the BNMS, for supporting us through participation in our audits. Without your support, we could not do our work. We endeavour to continue auditing to support the development of high standards of services and patient care. We are grateful to all our NMSQG members and regional audit coordinators, both past and present, for their time. We also welcome suggestions for future audits.

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