Musings on the Written Scintigraphy Report

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INTRODUCTION

The scintigraphy report is the final step in the scan process and is a principal component of our roles as nuclear medicine physicians. The report reflects the competence, training, experience, and attitude of the physician interpreting the scan. It is often the only form of interaction between us and the referring doctors (1). The scintigraphy report also serves as a legal document. With the rising numbers of medicolegal cases involving imaging studies, a clear and definitive scintigraphy report becomes even more desirable (2-7). In the present Philippine set up, the primary function of nuclear medicine physicians is interpreting scans and writing reports. After the acquisition and processing protocols are established the technologists are the ones mainly responsible for the creation of the scan itself. Since the scintigraphy report is our sole responsibility then it is only logical that we write it as well as we can.

There is a perceived lack of literature on how scintigraphy reports should be written (8,9). The vast majority of nuclear medicine text books do not have a section on writing reports, a situation akin to a journalism text having no mention of grammar and composition (1). Few journal articles are available, and these are mainly found in the radiology publications. Most of these consist of editorials and letters to the editors, and therefore give the impression that they are personal preferences of opinionated writers. (10-14). Often, the authors do not give any reason for those preferences and some of the various recommendations downright contradict each other.

This article is being written not only to express the personal preferences of another opinionated writer but also to address the need for something more specific to nuclear medicine report writing. The limited literature on report writing was likewise reviewed, and I am presenting the various recommended options with regards to the components of a report, grammar and writing style, and what the trends are in report writing.

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CONTENT AND STRUCTURE

Some features and characteristics have been identified that improve the usefulness of imaging reports. These include the use of standard terminology, consistent content, and a structured format (15, 16). Many reports of imaging studies in a number of American hospitals were found to be often vague, with wide differences in content and terminology, even though the survey was limited only to procedures involving a few selected diseases and anatomical locations (17).

A set of standard contents and structure for scintigraphy reports is proposed below. Table 1 shows a compilation of items that should be included in a comprehensive report as suggested by various imaging modality specialty organizations (18, 19).

Administrative information and patient identification

Obviously the patient's identification data (e.g. name, hospital number) and examination done should be clearly and easily identified (20). Hospital policies and information systems setups generally dictate the patient identification data that need to be included, but having a universal hospital identification number will greatly help in indexing and retrieval of correlative information. Ideally the date of transcription or interpretation should be stated separately from the date of scintigraphy acquisition. These administrative details are crucial for quality management, particularly for auditing scintigraphy reports.

Clinical history

The indication for performing the scintigraphy procedure must be clear and appropriate. A statement on clinical history and indication may not be necessary in all cases but it can help direct the flow of the findings and interpretation. It will also place the scan findings within

Table 1. Comprehensive Scintigraphic Report Structure

1. Administrative information and Patient identification
2. Clinical History
3. Imaging Technique
4. Comparison with previous scans
5. Findings or Observations
6. Interpretation or Impression
7. Recommendations
8. Signature

the proper clinical context. I am not fond of scan reports with detailed clinical information though, especially if these have no diagnostic or correlative impact. Likewise, starting a report with "a 42-year-old female was referred for bone scintigraphy" is redundant as these data are already printed at the top of the report.

From experience, most scintigraphy requests do not even state the diagnosis, let alone what information the referring physician wants to get from the scan. Some authors advise that if a pertinent history is not provided by the requesting physician, it should be stated as so in the report (20 – 22). This advice may be construed as a bit aggressive, but can be useful come malpractice suit time. Some local hospitals have adapted this practice already. The ACR practice guidelines on communicating diagnostic imaging findings suggest including the ICD-9 diagnostic code as well (23).

Imaging technique

There is some disagreement about the need for the inclusion of technical or procedural details in radiology reports (20). Clinicians may find a lengthy description of the scintigraphy procedure used distracting. The imaging technique is directed mainly to other nuclear medicine physicians who might be reviewing the scan, either as a referral or for comparison to subsequent scans. With this in mind, a short description of the technique used is appropriate, particularly if this has a bearing on the interpretation and comparison with latter studies. An accurate statement on the interval between radiopharmaceutical injection and image acquisition can help explain possible losses in quality or normal variations (e.g. technetium washout in thyroid scanning). Doses of pharmaceutical interventions (e.g. furosemide, dipyridamole, and captopril) certainly should be included in the report. The physiologic response to the intervention is also appropriate to include in the report. A lack of effect or abnormality in the scan may be due to an inadequate dose of the intervention.

The protocols used for calculating glomerular filtration rate, or the quantitation software for cardiac studies, must be stated since these affect the results directly.

Comparison

A comparison must be made with previous scintigrams when available. The standard of care is that reasonable efforts must be exerted to obtain previous procedures (24, 25). As they say, hindsight is 20/20 vision, so findings occasionally change when a previous study is available. Lesions that have been missed, either in the previous or the present study, can be caught and described in the latter scans. Clinical impressions also often become clearer when comparison is done (26).

It is less clear whether a scintigram should be compared only with the latest study or with all previous studies (27). The logical thing to do is to include as many previous studies as will matter. Exercise your judgment. For instance, consider the case of multiple bone scans done for metastasis screening where therapy was done between the previous and the present scan. Comparison only with the most recent scan is appropriate. Cases of traumatic bone lesions, on the other hand, take a long time to resolve. Bone scans in those cases may have to be compared with multiple previous studies done over the years.

Even when there have been multiple studies on a single patient, I prefer to create a self-standing scintigraphy report, meaning each report should be complete by itself. This becomes important when the previous scans go missing or the patient switches doctors.

In radiology, where it is not unusual to perform a half dozen chest x-rays on a single patient over the period of a few days, the entire report often just consists of a short comparison with the previous x-ray. This is understandable given the work load, and may have the practical advantage of being less cumbersome to read. In a way, a large number of x-rays done over a short period of time can be considered as one continuous study.

Logically, the current scan findings should be described first, followed by comparisons. Repetition of the scan findings will be avoided. Besides, it may be disconcerting to read a comparison being made when the description has not yet been stated (21).

Findings or Observations

The observations should be described clearly but concisely. When there are multiple abnormalities, the most important lesions should be described first. Both pertinent abnormalities and incidental findings should be included, preferably putting them on separate paragraphs (12, 28). The level of detail of the scan descriptions depends on the clinical situation (29).

Should we avoid jargon as suggested by some? There is medical jargon, and then there is nuclear medicine jargon. Medical jargon that is generally expected to be known by all physicians is not only suitable but is preferred in order to provide precise descriptions. Technical terms were developed by professionals to be able to communicate succinctly, clearly and accurately with each other. However, nuclear medicine jargon should be kept to a minimum. The proportion of referring physicians who are comfortable with reading "photon-deficient," "reverse redistribution," or "super scan pattern" in our scintigraphy reports is probably less than we think, especially if these terms are placed in the interpretation section.

We have encountered numerous thyroid scans without lobar measurements, renal scans without relative function measurements, or stress myocardial perfusion scans without a statement on induced ischemia. Table 2 shows a listing of findings expected to be included in the report in some of the more common procedures being done in nuclear medicine. The list presupposes that the usual abnormalities and pertinent incidental findings have been routinely included.

Interpretation or Impression

If the scintigraphy report is the culmination of the scan process, then the interpretation or impression is the culmination of the scan report. It is arguably the most important portion of the scintigraphy report, and according to one survey, the only part read by most referring physicians (30). There should definitely be an interpretative statement separate from the scan descriptions.

There is some debate on what to call the final part of the report. Some prefer impression (21), noting that it is an excellent gauge of the clinical judgment of the radiologist. Based on the usual or dictionary definitions of the various terms, Orisson makes a compelling argument for using the term "interpretation" (31). He argues that "impression" should be avoided not only because it suggests knowledge that is vague, subjective, and unreliable, but also because the word focuses attention on the perceiver rather than the subject matter. "Summary" means a shortened form of what has already been presented and suggests a repetition of the earlier section. The final part of the report is there to provide an interpretation; therefore "summary" should not be used. "Diagnosis" is descriptive of the report's final part, however, protocol may argue against its use. It should be the referring physician who arrives at a diagnosis, after incorporating the report with other clinical and laboratory data. Other terms found unsuitable were "conclusion," "opinion," "judgment," and "analysis." According to Orisson, "interpretation" and "reading" denote the primary importance of the findings, and are the preferred terms.

Another issue on report structure is where should we put the interpretation? There are those who recommend that the interpretation be placed at the start of the report (10), as is commonly done in pathology reports here in the Philippines. This may be due to studies showing that more than 50% of clinicians read the interpretation section only (30), and only 38% of referring clinicians read the report in full (8). The latter study also showed that 32% of clinicians preferred the summary at the beginning, while only 29% preferred it at the end. Using inductive logic, one would expect the report to start from a description of imaging findings and progress to an interpretation at the end. Regardless what sequence is used, the most important elements should come first in each section (10).

Should we incorporate the clinical and other

Table 2. Items to include in scintigraphy report of commonly performed organ imaging procedures

Brain	Defects and foci of increased uptake Regional radiopharmaceutical distribution
Thyroid	Size and location Defects and foci of increased uptake Overall estimate of function Presence of metastases (in case of thyroid cancer)
Bone	Abnormal osteoblastic and osteolytic lesions Overall tracer uptake
Heart (perfusion)	Perfusion defects (size, severity, location, reversibility) Cardiac volumes and ejection fraction A statement on presence of ischemia if stress-rest or rest-redistribution was performed A statement on myocardial viability, if appropriate
Lungs	Defect (size and bronchopulmonary segment location) Correlation between regional perfusion / ventilation Chest x-ray correlation
Kidneys (dynamic)	Radiopharmaceutical clearance rate Relative renal function Perfusion, parenchymal function, obstruction Quantitative renogram parameters Defects
Kidneys (cortical)	Presence of scars or infection Relative renal function
Hepatobiliary	Organ sizes and relative uptake Timing of gall bladder uptake Presence of gastric reflux
Gastrointestinal bleeding	Time of procedure Abnormal tracer localization and motion

laboratory findings into our scan interpretation? Scintigrams done on research basis are read differently from clinical studies since the interpreting physicians are usually blinded to the data that may bias the scan reading. In practice, we want to be as well-informed as possible about the patient so that correlation can be performed at a high level. Impressions provide a good gauge of the interpreting physicians' clinical judgment and thought process. (21). Therefore, it is wise to include other clinical and laboratory information in the report, as appropriate, for interpretative correlation and to give context to some of the findings (32 – 34). Care should be taken though that the interpretation be appropriate for an imaging procedure. "Graves' disease" and "nodular toxic goiter" are terms that should probably not be seen in a scintigraphy interpretation.

The interpretation should address or answer the clinical questions for which the scintigraphy was requested. Even if the study was normal a short statement on the clinical question, for example, "no signs of bone metastasis," is desirable in order to reassure the clinician that the interpreting physician is aware of and considered the clinical issue. In fact, an interpretation of "normal bone scan" should probably be avoided as these patients have usually undergone surgery, and arguably do not have normal anatomies to begin with. If one breast has been removed, can we really call the scan normal?

Recommendations

Correlative skills across diagnostic specialties have become necessary with the rapid advances in the imaging and interventional modalities during the past several years – skills that the referring physician may not necessarily have. When appropriate, the interpreting physician can therefore recommend follow-up or additional studies to clarify and confirm the impression, or to improve patient management (35 – 37). Because of the increased systems complexity of modern medicine, there is a need for good interdisciplinary collaboration using evidence-based practices (10, 20, 38).

We should, however, consider the downsides of including recommendations in the scintigraphy report. Obvious recommendations may be resented by the clinician, some of whom may not even agree with the recommendation itself. Fine needle aspiration biopsy for non-functioning thyroid nodules? Some clinicians may opt for surgery, considering the less than optimal accuracy of fine needle biopsy and the generally poor response of the nodule to medical therapy. Another issue to keep in mind is that some clinicians may feel compelled to request the suggested additional tests because of the medicolegal implications of not performing the tests (21, 35).

A common situation seen is the suggestion for a bone scan to be repeated after several months when the presence of metastasis is not clear. Because of the urgency of the situation it is probably better to recommend other imaging modalities.

Recommending "clinical correlation" should not be routinely written in the report. It goes without saying that the attending physician should correlate the results of ancillary procedures to the other clinical information he or she may have. I occasionally use the phrase "please correlate clinically" only when there is an utter lack of clinical information; the written request does not contain a diagnosis, or the information being sought, and the patient or relatives do not have any idea what the medical condition is. You may have come across bone scan requests for metastasis evaluation, and the referring clinician is not even sure if the patient has cancer, let alone a specific type and location of malignancy. Which brings us to the question: "When the attending physician is on a fishing expedition, should we allow ourselves to be used as bait?"

Signature

Whether signed by pen or electronically, the report must have a signature. Having to sign gives us an opportunity to review the final report. However, studies show that interpreting physicians rarely re-review reports when signing after the transcription process (39).

STYLE GUIDE

The scintigraphy report is the primary means by which we communicate with the referring physician. The ideal scintigraphy report gives the referring physician a good picture of the relevant abnormalities and suggests a diagnosis or next appropriate management step. It is also a formal medicolegal document, and as such, may be used as evidence in court. The scintigraphy report must therefore be accurate and comprehensive in content, while still being concise, clear, and pertinent in style. Current training programs place appropriate emphasis on content, but style often receives little attention (21, 40).

Format

As mentioned previously, the scintigraphy report represents the last stage in scan creation. It incorporates the official findings and interpretation of the procedure performed. Aside from these, the scintigraphy report also is aimed at providing specific diagnostic information that the referring physician may be looking for (41). Conceptually it should resolve any specific issue for which the scan was requested.

In general, what do clinicians expect or want from the scintigraphy report? Studies have shown repeatedly that the most important things expected from the report are that it be accurate and prompt, clear and unequivocal. The principal qualities useful to the clinician were clarity, brevity, and clinical correlation. Advice on planning of future investigations was especially valued by general practitioners (30). GPs wanted radiology reports to indicate more clearly the meaning of radiological terminology, the likelihood of disease, the clinical relevance of the findings, and/or the need for further investigations (34).

One survey indicated that an itemized format is preferred by the majority of radiologists and referring physicians (42). The itemized format becomes practical when the reporting system is computerized. With the proper software, the interpreting physician can generate complete reports by filling out a checklist. Among the most important cited advantages of the itemized report are appearance, completeness, legibility, and the structured format. It is also much easier to perform computerized auditing of itemized reports compared to those written in traditional prose. A small proportion of interpreting and referring physicians in the survey still preferred the prose format, citing reasons such as "maintenance of context" and "narrative flow." Another study indicated that free text and structured reporting were equally efficient in information transfer, although clinicians strongly preferred a structured format (43).

The issue of whether or not to number the findings or diagnoses again shows the lack of agreement as to how our reports should look like. Some authors advise to do so (1), while others recommend not to number diagnoses but to just place them in separate lines (21). Either way, it would be a good idea to rank them according to importance.

Grammar

The scintigraphy report is the sole responsibility of the interpreting nuclear physician. Gross syntactical, typographical and spelling errors in the report will therefore reflect poorly on the interpreting physician's level of attention to detail and other personal attributes. Completely avoiding these errors can be difficult in practice because nuclear physicians will need to be conversant not only with the entire anatomical and physiological lexicon, but also with various subspecialty jargons (44).

There are subtle sentence construction issues in the scintigraphy report that are often overlooked. They may not be as important as, say, errors in laterality, but looking out for these result in a more professional scan report. For instance, the sentence "The rest images show partial improvement of the defects, which completed after 24 hours" means that the defects became complete but I'm sure the intent of the writer is the complete opposite. As a side note, we should avoid writing "24 hours" unless we mean it. Writing "the following day" is more accurate and is preferred.

Anatomical description often involves multiple qualifiers. Adjectives and other modifiers should be stated first, followed by the anatomical part. For example, the proper sequence of terms is "proximal right humerus" not "right proximal humerus" because there is a bone named the "right humerus" but no bone named the "proximal humerus." "Proximal" is the modifier while "right humerus" is the body part.

Colloquialisms should be used with care. Radiologists have learned to steer clear of the phrase "in contrast" since this can cause confusion when contrast agents are used. "On the other hand" should also be avoided; for instance, "on the other hand, the left foot shows increased tracer uptake" may strike some as quaint and amusing.

Removing tautological phrases (redundancies) like small-sized, oval-shaped, past history, close proximity, and upsloping accumulation, results in a tighter and more polished report. In the same way, oxymorons (contradictory phrases) like "horizontal downslope" (a commonly-used stress ECG term) are to be avoided.

Coakley presented their institutional style guidelines in radiology reporting that could serve as a good reference for developing a version for scintigraphy (40). Readers are also advised to check references that are specific to medical grammar (44).

Tense

Using the present tense or the past tense is a matter of preference as this is unlikely to impact on patient management. Most radiology authors recommend that the description of the procedure be stated in the past tense, and the scan image description written in the present tense, often without any explanation (1, 9, 20, 21, 35). This recommendation seems to stem from the common practice abroad of interpreting physicians dictating what they are seeing, thus use of the present tense. It is likewise recommended that the past tense is used for procedures that require real-time image analysis, like fluoroscopy. Grammarians may raise the issue of tense consistency within paragraphs, although this is probably arguable and a minor matter.

While a number of articles on radiology report writing are available, the nuclear medicine literature is very sparse on this subject. Among the few available are those written by eminent nuclear cardiologist Franz Th. Wackers (45). His nuclear cardiology report templates were written in the past tense. Why the discrepancy with recommendations by radiologists? We can surmise personal preference as the major reason for this choice. However, an important reason for using the past tense is to emphasize that the findings represent the condition of the patient at the time the scintigraphy was performed. Nuclear medicine imaging is much more sensitive than most radiology procedures to time-based factors such as intake of medications – e.g. compare thyroid scintigraphy and ultrasound; bone scintigraphy and skeletal x-ray surveys. Therefore, there is some justification for highlighting the fact that the findings being reported reflect the patient's status during the scan acquisition, not findings being read off the scan film. A minor advantage of using the past tense is the consistency (the entire report is in the past

tense) and easier syntax construction when comparing with previous scans.

Voice

Almost without exception, published articles on imaging report writing recommend using the active voice, often without explaining why (1, 20, 21). The active voice is supposedly more natural, dynamic, energetic and precise, and less wordy than the passive voice. It is the natural voice in which most people speak and write (46).

While this may be true in most literature, the scintigraphy report may actually be better written in the passive voice. Bjelland studied 20 top writers in non-scientific literature and found that 75% of the sentences in their works were written in the active voice. However, in scientific writing, he found that there was a heavy reliance on passive constructions, resulting in an overwhelming number of what he referred to as "inverted sentences" (47).

The passive voice is frequently used in technical and scientific writing because the form is impersonal and objective. The action is felt to be more important than the agent or the performer of the action, or if the receiver or the action needs to be emphasized more than the doer of the action (48 – 50). Laboratory reports, scientific or technical writing often require the passive voice when the object (the process or principle being described) is more important than the subject. The interpreting physician ought to be in the background. This is the reason why the active phrase "I see a . . . in the scan" is much less commonly used than the passive "The scan shows . . . "

C. Edward Good noted wryly that while some authors are recommending the use of the active voice – e.g. "The active voice is preferred," "The passive voice should be avoided," – the statements used were written, ironically, in the passive voice (51).

Trimming the hedges

The running joke is that the hedge is the official plant of the imaging specialties (21, 52). "Hedging" involves the use of qualifications that allow for unknown contingencies, withdrawal from commitment, or a means for escape or retreat in case our statements are incorrect (46). Phrases used to hedge include: "suspicious for," "equivocal," "non-specific," "consistent with," and "appears to be." For the referring clinician expecting a clear and definitive report, hedges represent defensive posturing and lead to frustration and annoyance.

However, the admonishment of some against hedging, and exhortations to always commit to a diagnosis, is easier said than done. Hedging is necessary since not many scintigraphic findings give definite diagnoses. For instance, the bone scan is well-known to be very sensitive but not specific for metastasis. Therefore, making a definite diagnosis of metastasis or lack of it in all cases is ignoring the suboptimal accuracy of the technique and may lead to either inadequate or unnecessary treatment. The known uncertainty of lung V/Q scintigraphy was acknowledged with the Biello and PIOPED criteria classifying findings into low, intermediate and high probability for pulmonary embolism, rather than positive or negative for the disease (53). Accepted guidelines like those criteria save the interpreting physician from having to go through the nuclear medicine equivalent of hemming and hawing by recognizing the limited accuracy of our techniques. Ideally, all organ procedures should have some sort of interpretation guidelines like the criteria for lung scintigraphy.

Unnecessary hedging is another matter altogether. Minimizing the use of trite phrases like "metastasis cannot be ruled out" will help establish our credibility as partners in patient care. If you need to hedge indicate your confidence level by using qualifiers such as "possible" and "probable." A quality standard for nuclear cardiology recommends that at least 90% of reports from an institution must definitely state a normal or abnormal result (54).

The ultimate hedge, and unfortunately commonly seen, is not putting an interpretation in the report. How often have we seen a scintigraphy report consisting of descriptions of tracer localization, but with no separate statement on the interpretation? This situation is most often seen in bone scintigraphy where lesions are listed but no clear statement on whether these are metastases. Or in many cases, the interpretation simply repeats the description. If we are not sure of the interpretation, then we say so, but we must interpret the findings.

Stating the certainty of the interpreting physician is increasingly performed because it can be incorporated in clinical decision making (17, 55). The concept of incorporating the diagnostic probability of disease,

together with the confidence level of the assessor, has been proposed previously for clinical use (56). The resulting model, referred to as metadiagnosis, may be adopted less rigorously in our scintigraphic reporting. These attempts at adding a dimension of confidence level simply recognize the inherent uncertainty in diagnosis, instead of artificially forcing findings into "positive" or "negative".

A more common, alternative approach is to use Bayesian probability analysis for determining the likelihood of disease (57). In this model, the pre-test probability of the disease is combined with the results of the test. Instead of using the confidence level of the physician regarding the diagnosis, the sensitivity and specificity of the test is incorporated to calculate post-test probability for the disease. Bayesian probability analysis has been used successfully in myocardial perfusion scintigraphy for coronary artery disease diagnosis (58).

Scintigraphic Hierarchy of Terms

The scan findings should be interpreted to the highest level possible, using terminology appropriate to that level (35). A scintigraphic hierarchy of terms (59) is a useful concept to adopt (Table 3).

Description of tracer kinetics comprises the lowest level in the hierarchy and should properly be limited to the Observations section of the report. Examples of description of tracer kinetics include "diffusely increased tracer activity," "focal defect," "rapid tracer elimination," "tracer retention." These phrases have no place in the interpretation and, in my opinion, the word tracer should not appear at all in the final portion of the report.

The second level in the hierarchy is the physiological process (and anatomical constructs) corresponding to the tracer kinetics. For example, the physiological process "osteoblastic activity" requires some interpretive skills and is a step higher than a simple description of tracer kinetics. This is because increased tracer localization in a bone scan are not necessarily osteoblastic lesions but may be due to things like urine in the bladder, soft tissue inflammation, or contamination artifacts.

If the diagnosis is indeterminate, then the physiological process may suffice in the Interpretation section. For instance, in a woman with breast cancer, the predictive value of a solitary skull lesion may be so low that committing to an interpretation of bone metastasis either way may be a disservice to the referring physician or the patient. It would be more helpful to the clinician to call the lesion osteoblastic and recommend further investigation.

When the nuclear medicine physician is confident of the findings and what they mean then a statement of the disease state, the highest level of terminology, should be made in the Interpretation section. Can disease states be placed in the Observations section? Certainly, and many do it particularly in bone scan reports with multiple metastases because it may help clarify the message. But using the inductive reasoning logic flow approach, it is generally better to make a statement of the disease in the Interpretation section.

By keeping the scintigraphic hierarchy of terms in mind we are able to avoid some common erroneous report constructions. One example is describing reduced thallium uptake in the inferior segments of the left ventricle as "hypoperfusion" in the Observations section of the

Table 3. Scintigraphic Hierarchy of Terms

Hierarchy level	Example scan phrases	Appropriate section in report
1. Tracer Kinetics	"Increased tracer activity"	Description
2. Physiological Processes	"Osteoblastic lesion"	Interpretation
3. Disease States	"Bone metastasis"	

report, but making a final interpretation of attenuation artifact. Another example is "non-visualized thyroid gland," a level one phrase, which must not be used in the Interpretation section. Awareness of the hierarchy of terms likewise guides us in writing reports that follow inductive logic sequences, the thought processes of which can be followed by the reader.

While we attempt to use the highest level of terminology, "over-reading" must be avoided. Over-reading is used here to mean making statements in the report that have insufficient medical basis (as opposed to its context in the United States, that of another interpreting physician making a second report of the same scan). It is, in a way, the opposite of hedging. We want to be as helpful to the clinician as we can, without putting ourselves in jeopardy. The benchmark to use is to imagine yourself in a witness stand during a malpractice suit. Can your report stand up in court under questioning by the plaintiff's lawyer (60)? An interpretation of "stenosis of the distal portion of the second obtuse marginal branch of LCX" may be stretching the limits of the myocardial perfusion SPECT scan technology a little bit, and is more appropriate in an angiography report. It is important that our interpretation be limited to what can be justified by the scintigraphic findings assisted by clinical information (59). There are those who justify over-reading by incorporating known statistical probability of conditions (the cardiac reading above was adapted from an actual scintigraphy report, albeit slightly exaggerated for humorous effect). But this approach can be likened to reading a thyroid scan, and then making an interpretation that the patient is female. One will be correct 80 – 90% of the time, an accuracy rate approaching those of the best nuclear imaging procedures, even though conceptually the process approaches absurdity.

SCINTIGRAPHIC REPORT OF THE FUTURE

It is said that a radiology report from the 1920s looks uncannily similar to one from the 1990s (61, 62). Technological advances during the past few decades however have provided new tools for the interpreting physician. What will imaging reports of the 21st century be like?

Standardized terminology

A standardized lexicon will certainly help referring physicians better understand the contents of reports. We should agree first among ourselves what the terms mean, then inform the referring physicians what we mean. Attempts have been made already for the imaging specialties to come up with common terminology (63). The PSNM should probably take steps to make our own list that is practical in the Philippine setting.

Structured reporting

Structured reporting involves creating standardized information from templates into a natural-sounding language report using consistent terminology and organization (64). The template may be accessed via checklists or menus, and replaces the traditional dictation and transcription processes (15).

Aside from providing the initial structure, computerization has many advantages, including: rapid generation of an attractive, organized and legible report; bypass of the transcription process; and immediate verification and modification of the text if necessary. Results can likewise be delivered immediately via fax, electronic mail or through the hospital network.

Future systems are envisioned to have a check list or menu-driven interface that will force structuring of reports. Computer software then generates a natural language output (65, 66). A report generator for nuclear medicine using a graphical user interface has been reported some years back that allows physicians to point-and-click their way through anatomical diagrams to create a complete scintigraphy report (67). Decision support modules could be integrated into a computerized system, allowing the interpreting physician rapid access to practice guidelines and other clinical information that may help in providing recommendations. A module for x-ray mammography has already been created (68, 69).

The potential disadvantages of a computer-generated reporting system, such as the requirement of a rudimentary level of computer literacy and typing skills, are minor and probably not an issue for twenty-first century nuclear medicine physicians (42).

Multimedia content

Aside from helping provide structure, computer systems have tools such as graphics and links to information sources that can result to a completely different form

for reports (70). Beyond acting like a super-typewriter, computerization can add unique value to the traditional paper-based scintigraphy report. Multimedia applications come to mind. Graphics, including representative portions of the scan, can easily be incorporated in the report. Annotated radiology films have been attempted by others, with good response from the clinicians. Instead of simply typing out a report of metastasis in a bone scan, and including a copy of the bone scan print out on another page, we can conceivably insert a close-up of the lesion itself within the report.

The drop in prices of recording media will allow us to distribute electronic forms of the scintigraphy report at a low cost. We already provide copies of the images on CD-ROMs for high-value procedures like myocardial perfusion scans. Animated graphics (e.g. gated SPECT images) that are impossible to render on regular paper, are easily done electronically. The next step is to create an electronic version of the scintigraphy report, with connections to an annotated copy of the scintigram. Clickable text links are paradigms that are already familiar to Internet-savvy physicians or patients. The electronic scintigraphy report can easily be created to have links that activate when they sense an Internet connection. Recommendations can point to evidence-based medicine literature sources. Suggestions for further diagnostic and therapeutic procedures can likewise be linked, say, to the hospital website so that patients would know where to proceed.

Though "high-tech" sounding, these forms of the "Scintigraphy Reports of the Future" are reasonably easy to carry out at low cost, using existing, off-the-shelf technology. They may not be suitable for all nuclear medicine tests, but certainly they should be considered for our more complicated and expensive procedures.

In summary, the quality of scintigraphy reports can be improved by employing standardized content, terminology and structure. Various options regarding writing style have been presented but in all cases, we should strive to produce scintigraphy reports that are clear, comprehensive and unequivocal.

REFERENCES

1. Wilcox J. The written radiology report. Applied Radiology 2006 July; 33-37.
2. Leppo JA. A thallium scan goes to court. J Nucl Med 1992;33:120-126.
3. Berlin L, Berlin JW. Malpractice and radiologists in Cook County, IL: Trends in 20 years of litigation. Am J Roentgenol.1995;165:781-788.
4. Cascade P and Berlin L. American College of Radiology Standard for Communication. Am J Roentgenol 1999;173,1438-1442.
5. Berlin L. Alliterative errors. Am J Roentgenol 2000;174:925–931.
6. Berlin L. Communicating Findings of Radiologic Examinations: Whither Goest the Radiologist's Duty? Am J Roentgenol 2002;178:809–815.
7. Berlin L. Radiology reports. Am J Roentgenol 1997;169:943-946.
8. Clinger NJ, Hunter TB, Hillman BJ. Radiology reporting: Attitudes of referring physicians. Radiology 1988;169:825-826.
9. Taylor J. Writing radiology reports in chiropractic. JCCA 1990;34(1):30-34.
10. Friedman PJ. Radiologic Reporting: Structure. Am J Roentgenol 1983;140:171-173.
11. Hunter TB. Radiographic reports: structure and review. Am J Roentgenol 1984;142:647–648
12. Revak CS. Dictation of radiologic reports. Am J Roentgenol 1983;141: 210
13. Hall FM. Radiologic terminology. Am J Roentgenol 1986;146:425
14. Lautin EM. Writing, Signing, and Reading the Radiology Report: Who Is Responsible and When? Am J Roentgenol 2001;177:246-247.
15. Rubin D. Informatics Methods to Enable Patient-centered Radiology. Acad Radiol 2009;16:524–534.
16. Sistrom C and Langlotz C. A framework for improving radiology reporting. J Am Coll Radiol 2005;2(2):159-67.
17. Sobel JL, Pearson ML, Gross K, *et al*. Information content and clarity of radiologists' reports for chest radiography. Acad Radiol 1996;3:709-717.
18. Douglas P, Hendel R, Cummings J, *et al* (Writing Committee Members). ACCF/ACR/AHA/ASE/ASNC/HRS/NASCI/RSNA/SAIP/SCAI/SCCT/SCMR 2008 Health Policy Statement on Structured Reporting in Cardiovascular Imaging. Circulation 2009;119:187-200.
19. Kahn C, Langlotz C, Burnside E, *et al*. Towards Best Practices in Radiology Reporting. http://medical.nema.org/Dicom/minutes/Committee/2009/2009-04-21/Reports/RSNA%20Structured%20Reporting%20-%20PREPRINT.pdf. Accessed October 17, 2009.
20. Stolberg H. Radiology reporting handbook. Can Assoc Radiol J 2002;53(2):63-72.
21. Hall FM. Language of the radiology report: primer for residents and wayward radiologists. Am J Roentgenol 2000;175:1239-1242.
22. Hall FM. Clinical history, radiographic reporting, and defensive radiologic practice. Radiology 1989;170:575-6.
23. ACR Practice Guideline for Communication of Diagnostic Imaging Findings. American College of Radiology. Revised 2005 (Resolution 11).
24. Berlin L. Comparing new radiographs with those obtained previously. Am J Roentgenol 1999;172:3-6.
25. Hunter TB, Boyle RR Jr. The value of reading the previous radiology report. Am J Roentgenol 1988;150:697-698.
26. Berlin L. Reporting the "Missed" Radiologic Diagnosis: Medicolegal and Ethical Considerations. Radiology 1994;192:183-187.
27. Berlin L. Must new radiographs be compared with all previous radiographs, or only with the most recently obtained radiographs? Am J Roentgenol 2000;174:611-615.
28. Martin LFW. Opinion: is this your report? J Can Assoc Radiol 1982;33:255-256.
29. McLoughlin R, So C, Gray R, Brandt R. Radiology Reports: How Much Descriptive Detail Is Enough? Am J Roentgenol 1995;165:803-806.
30. Lafortune M, Breton G, Baudouin JL. The radiological report: what is useful for the referring physician? Can Assoc Radiol J 1988;39(2):140-143.
31. Orisson W, Nord T, Kinard R, Juhl J. The language of certainty: Proper terminology for the ending of the radiology report. Am J

Roentgenol 1985;145:1093-1095.
32. Leslie A, Jones AJ and Goddard PR. The influence of clinical information on the reporting of CT by radiologists. Br J Radiol 2000;73:1052-1055.
33. Doubilet, P. and Herman, PG. Interpretation of radiographs: effect of clinical history. Am J Roentgenol 1981;137:1055-1058.
34. Espeland A and Baerheim A. General practitioners' views on radiology reports of plain radiography for back pain. Scandinavian Journal of Primary Health Care 2007;25(1):15-19.
35. Ridley LJ. Guide to the radiology report. Australasian Radiology 2002;46:366-369.
36. Berlin L. Pitfalls of the vague radiology report. Am J Roentgenol 2000;174:1511-1518.
37. Berlin L. Relying on the radiologist. Am J Roentgenol 2002;179:43-46.
38. The Evidence-Based Radiology Working Group. Evidence-based radiology: a new approach to the practice of radiology. Radiology 2001;220:566-75.
39. Lautin E. and Berlin L. Writing, Signing, and Reading the Radiology Report: Who Is Responsible and When? (letter and reply) Am J Roentgenol 2001;197:246-247.
40. Coakley F, Liberman L, and Panicek D. Style Guidelines for Radiology Reporting: A Manner of Speaking. Am J Roentgenol 2003;180:327-328.
41. Batten G. B. The requirements of the clinician from the radiologist and vice versa. British Journal of Radiology 1930;3:259-267.
42. Naik SS, Hanbidge A and Wilson SR. Examining Radiologist and Clinician Preferences Regarding Style and Content. AJR 2001;176:591-598.
43. Sistrom C and Honeyman-Buck J. Free Text Versus Structured Format: Information Transfer Efficiency of Radiology Reports. Am J Roentgenol 2005;185:804-812.
44. Ribes R and Ros P. Radiological English. Springer-Verlag, Berlin and Heidelberg; 2007.
45. Wackers F, Bruni W, and Zaret B. editors. Nuclear Cardiology, The basics: How to set up and maintain a laboratory. Humana Press, New Jersey; 2nd edition 2008.
46. Matthews JR and Matthews RW. Successful scientific writing. Cambridge University Press, New York;2008:142-143.
47. Bjelland H. Writing Better Technical Articles. BlueRidge Summit, PA: TABBooks; 2000.
48. Svobodova Z, Katzorke H, Jaekel U, *et al.* Writing in English: A Practical Handbook for Scientific and Technical Writers. European Commission Leonardo da Vinci programme; First edition 2000:56-57.
49. Walton R. Advanced English CAE Grammar Practice. Pearson Education Ltd; 2nd ed 1999.
50. Passive and active voice. University of West Florida Writing Lab handout. http://uwf.edu/writelab/handouts/passiveactive (accessed October 10, 2009).
51. Good CE. A grammar book for you and I – oops, me! All the grammar you need to succeed in life. Capital Books, Inc. Herndon, Virginia. 2002.
52. Hall FM and Movson JS. The radiologic hedge. (letter) AJR 1990;154:903-904.
53. Webber M, Gomes A, Roe D, *et al.* Comparison of Biello, McNeil, and PIOPED criteria for the diagnosis of pulmonary emboli on lung scan. Am J Roentgenol 1990;154:975-981.
54. Douglas P, Iskandrian A, Krumholz H, et al. Achieving Quality in Cardiovascular Imaging: Proceedings From the American College of Cardiology–Duke University Medical Center Think Tank on Quality in Cardiovascular Imaging. . Am Coll Cardiol 2006;48:2141-2151.
55. Guyatt G, Rennie D, editors. The Evidence-based medicine working group. Users' guides to the medical literature. A manual for evidence-based clinical practice. Chicago: JAMA and Archives, American Medical Association Press; 2001.
56. Diamond GA, Forrester JS. Metadiagnosis. An epistemologic model of clinical judgment. Am J Med 1983;75(1):129-137.
57. Diamond GA, Forrester JS: Analysis of probability as an aid in the clinical diagnosis of coronary artery disease. N Engl J Med 1979;300:1350-1358.
58. Detrano R, Yiannikas J, Salcedo EE, *et al.* Bayesian probability analysis: a prospective demonstration of its clinical utility in diagnosing coronary disease. Circulation 1984;69:541-547.
59. Friedman PJ. Radiologic Reporting: The hierarchy of terms. AJR 1983;140:402-403.
60. Olson W. Straight talk in medical reports. http://overlawyered.com/2009/09/straight-talk-in-medical-reports. Accessed October 7, 2009.
61. Reiner BI, Knight N, Siegel EL. Radiology reporting, past, present, and future: the radiologist's perspective. J Am Coll Radiol. 2007;4(5):313-319.
62. Raymond A. Gagliardi. The Evolution of the X-ray Report. Am J Roentgenol 1995;164:501-502.
63. Langlotz CP, Caldwell SA. The completeness of existing lexicons for representing radiology report information. J Digit Imaging. 2002;15 Suppl 1:201-205.
64. Liu D, Zucherman M, Tulloss WB Jr. Six characteristics of effective structured reporting and the inevitable integration with speech recognition. J Digit Imaging 2006;19:98-104.
65. Langlotz C and Meining L. Enhancing the Expressiveness and Usability of Structured Image Reporting Systems (proceedings of the American Medical Informatics Association) http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2243902/pdf/procamiasymp00003-0502.pdf (accessed October 17, 2009).
66. Langlotz CP. Automatic Structuring of Radiology Reports: Harbinger of a Second Information Revolution in Radiology. Radiology 2002;224:5-7.
67. Sanger J. Graphic User Interface-Based Nuclear Medicine Reporting System. J Nucl Med 1993;34:515-522.
68. Burnside E, Rubin D, Shachter R. A Bayesian network for mammography. Proc AMIA Symp 2000;106-110.
69. Burnside ES, Rubin DL, Fine JP, Shachter RD, Sisney GA, Leung WK. ayesian network to predict breast cancer risk of mammographic microcalcifications and reduce number of benign biopsy results: initial experience. Radiology 2006;240:666-673.
70. Dreyer K, Hirschorn D, Thrall J, Mehta A. PAC S: a guide to the digital revolution. 2006 second edition. Springer. New York, USA.t