TABLE 1. THYROID STUDIES IN TWO CHILDREN WITH THYROID HEMIAGENESIS

Thyroid function	Case 1	Case 2
T_3 ng/dl (80–210)*	291	160
T_4 μg/dl (5–12)	10.5	11.4
TSH μU/ml (0–6)	2.3	2.5
Thyroid uptake %		
Tc-99m 20′ (0.3–3.0)	3.2	4.43
131-I, 24 hr (6–30)	ND	45
Post-T_3 suppression	ND	0.8
Thyroid scan	Rt. lobe visualized	Rt. lobe visualized
TRH stimulation	Normal response	ND
TSH stimulation	Failure of left lobe to visualize	ND

* ( ) normal values. ND = not determined.

evated T_3 in Case 1 and increased Tc-99m and RAI uptake values in Case 2.

The following steps are necessary to establish a diagnosis of thyroid hemiagenesis: Thyroid imaging with Tc-99m or iodine-123 will show that the mass is functional. Although a "hockey-stick" appearance has been described (*1*), it is not always present. A consistent finding is nonvisualization of the opposite lobe. Next, a TRH test or a T_3 suppression test should be performed. Lack of a normal TSH response to TRH, or nonsuppressibility of the RAI uptake to T_3 administration, would be compatible with an autonomously functioning thyroid adenoma. If the responses to these tests are normal, a TSH stimulation test should be considered. In thyroid hemiagenesis, TSH administration fails to stimulate uptake outside the previously visualized thryoid tissue.

Our patients were clinically and biochemically euthyroid and had no detectable thyroid antibodies. The enlargements presented no cosmetic problems. Consequently we decided to follow them without therapy. The primary risk these patients face is that of unnecessary surgery. It is important to consider thyroid hemiagenesis whenever one encounters a thyroid mass, for hemiagenesis imaging will show that the mass is functional, essentially eliminating concern for a malignancy. The further studies outlined above will differentiate an autonomously functioning thyroid adenoma from hemiagenesis. Treatment with thyroid hormone will produce regression in these hyperplastic masses if this is considered desirable.

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REFERENCES

1. MELNICK JC, STEMKOWSKI PE: Thyroid hemiagenesis (hockey stick sign): A review of the world literature and a report of four cases. *J Clin Endocrinol Metab* 52:247–251, 1981
2. HOPWOOD N, CARROLL RG, KENNY FM, et al: Functioning thyroid masses in childhood and adolescence. Clinical, surgical, and pathological correlations. *J Ped* 89:710–718, 1976

Interpretation of the NEMA Protocols for Scintillation Camera Performance

The National Electrical Manufacturers Association (NEMA) originally introduced standards for the measurement and specification of scintillation-camera performance in 1980 (*1,2*). These standards were developed by a consortium of scintillation-camera manufacturers and were intended as guidelines to be followed by manufacturers so that purchasers and users could expect some degree of conformity of the specifications for cameras from different manufacturers. Although they were not intended to be used as such, a number of users have adopted these standards for purposes of acceptance testing and ongoing quality control (*3–10*).

Our own interest was stimulated by a need to establish a method by which we could reliably determine the integral and differential uniformity of a scintillation camera under different conditions of improper operation (*11*). However, when we investigated the various documents relating to the NEMA standards (*1,2*) and the more familiar abbreviated publication "Standards for performance measurements of scintillation cameras . . . and what they can mean for you," we discovered some statements and ambiguities that could make application of the standards difficult.

The most important ambiguity is that relating to differential uniformity. It is intended that this parameter shall be a measure of the "worst-case rate of change" of counts in a flood-field image over a limited pixel range in either the horizontal or vertical direction. The wording in some of the documents does not make clear whether the number of pixels included in the range over which the measurement is to be made should be five or six. Some documents also allude to the largest deviation of counts in this pixel range. The largest deviation of counts will not necessarily give the "worst-case rate of change."

Clarification is contained in Appendix A of the full NEMA standards (*1*). Paragraph NU 1.A1.02.D (*5*) states categorically that the pixel range shall be six and that this is intended to correspond (in a 64 × 64 matrix) to the radius of a photomultiplier tube in a 37-tube scintillation camera. Further, one must search for the largest gradient or percentage change of counts over this range of pixels. A deviation of ΔN counts will be more significant in a region of low counts than the same deviation in a region where the surrounding counts are more dense.

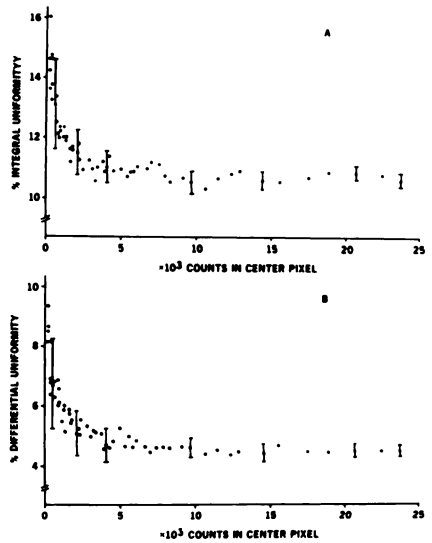

FIG. 1. Graphs of integral and differential uniformity against center-pixel count content. All cameras investigated yielded similar results. Only when center-pixel count content exceeds about 8000 can measured uniformity be expected to be minimal.

The NEMA standards also advocate that a minimum of 4000 counts be accumulated in the center pixel for uniformity measurements. We investigated the reproducibility of uniformity measurements at increasing count densities and have found that one can achieve consistent estimates of the best uniformity achievable only when the counts in the center pixel exceed 8000 (Fig. 1). Measurements made with several different scintillation cameras all resulted in curves similar to those shown in Fig 1. Note that the uniformity values decrease as the count density increases and, though it represents a somewhat arbitrary cut-off, a value of 8000 counts in the center pixel will give uniformity values that represent the best performance of the camera. This may require that as many as 30-40 million total counts need to be collected in the flood-field image and, though this may well be regarded as excessive for routine quality control (*12*), it is a small price to pay when an acceptance test is being made or as a less frequent, but more rigorous, periodic quality-control test giving a numerical result. Flood-field images of 30 million counts have also been recommended for SPECT calibration (*13*,*14*).

NEMA standards are gradually being used by manufacturers for the specification of scintillation-camera performance. However, they are by no means fully implemented and it would therefore be advisable for users to ascertain under what measurement conditions performance specifications for their camera were obtained. For example, in addition to differential uniformity discussed above, other questions arise: were all, or only some, specifications obtained with uniformity-correction circuitry in action? Or were specifications of maximum count rate actually obtained without repeaking the analyzer window as required by the NEMA protocol? Because some manufacturers use their own protocols for final acceptance testing of their product before shipment, it is possible that acceptance testing at the user site using the NEMA protocols may result in measurements at variance with the manufacturer's specifications.

In conclusion, those using the NEMA standards to quantitate scintillation-camera performance are strongly urged to examine closely the full document (NU 1-80) on performance measurements and to be aware of pitfalls when comparing results with those of others. Differential uniformity should be calculated over a six-pixel range and the maximum differential uniformity determined and reported. Accuracy and reproducibility of the uniformity measurement become assured only at a minimum pixel count density of 8000 counts per pixel.

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REFERENCES

1. National Electrical Manufacturers Association: Standards Publication Nu 1-80. Performance Measurements of Scintillation Cameras, Washington DC, NEMA, 1980
2. MUEHLLEHNER G, WAKE RH, SANO R: Standards for performance measurements in scintillation cameras. *J Nucl Med* 22:72-77, 1981
3. Quality Assurance in Nuclear Medicine, World Health Organization, Geneva, 1982
4. American Association of Physicists in Medicine: Scintillation Camera Acceptance Testing and Performance Evaluation. AAPM Report No 6, American Institute of Physics, New York, 1980
5. HASEGAWA BH, KIRCH DL: The measure of a camera—pathways for future understanding. *J Nucl Med* 22:78-81, 1981
6. HIDALGO JU: Re: Standards for performance measurements in scintillation cameras. *J Nucl Med* 22:833, 1981
7. FINNEY C, HORN B, LUK K: The use of the NEMA standard for in-field acceptance testing of scintillation cameras. In *Nuclear Medicine and Biology, Proceedings of the Third World Congress of Nuclear Medicine*, Vol 4, Pergamon Press Paris, 1982, pp 2909-2911
8. RAIKUR UR, SONI PS, SAROJINI C, et al: New Quality Assurance Measures for Scintillation Cameras in Indian Environment. In *Proceedings World Congress on Medical Physics and Biomedical Engineering*, MPBE, Hamburg, 1982, No. 21.13 (abst)
9. NOSIL J, ROJEK H: Scintillation camera uniformity as a function of gamma ray energy. In *Proceedings World Congress on Medical Physics and Biomedical Engineering*, MPBE, Hamburg, 1982, no. 21.19 (abst)
10. SMITH AH: Proceedings of HPA Conference on Quality Assurance of Nuclear Medicine Instrumentation, London, Feb, 1983 (in press)
11. BUSEMANN-SOKOLE E, CRADDUCK TD: Effect of camera uniformity on ejection fraction measurements. *J Nucl Med* 24: 1983 (abst)
12. ROLLO FD: Quality assurance in nuclear medicine. In *Nuclear Medicine Physics, Instrumentation, and Agents.* Rollo FD, Ed. St. Louis, CV Mosby Co., 1977, pp 322-360
13. TODD-POKROPEK A: Quality control, detection and display. In *Radionuclide Imaging.* Kuhl DE, Ed. Paris, Pergamon Press, 1982, pp 27-76
14. ROGERS WL, CLINTHORNE NH, HARKNESS BA, et al: Field-flood requirements for emission computed tomography with an anger camera. *J Nucl Med* 23:162-168, 1982

The London Liver Phantom

Various organ phantoms have been developed for specific purposes; e.g., the thyroid phantom was useful with rectilinear scanners, and the brain and liver phantoms developed by the College of American Pathologists are very suitable for interlaboratory comparison studies and self-evaluation of laboratory technique. For assessment of clinical performance and instrumentation quality control, accurate simulation of an organ demands that the phantom be three dimensional and provide the advantages of realism and the facility to exercise practical techniques.

The London liver phantom (*1*) is useful in several areas: (a) to study the dependence of tumor resolution on lesion size and depth within the liver with variable tumor sizes and positions, using the variant of the phantom; (b) as a routine total performance quality control test phantom with tumors fixed in specified position within the liver (Fig. 1.); (c) for the study of fixed tumor sizes and positions in an interlaboratory comparison program, such as that undertaken by the Department of Health and Social Security (DHSS) (*2*) in the United Kingdom in 1976-1977, planned by WHO (*3*) in 1980 and is now in the process of analysis, and the program currently being undertaken in the United Kingdom by the DHSS as an extension of the work of Elliott, Short, Potter, and Barnes (*4*); and (d) to study ECT performance.

The purpose of this communication is to acquaint the nuclear medicine community with this liver phantom so that it can be made more readily available.* A *standard version*, which has been distributed by IAEA to several recognized nuclear medicine facilities in Latin America and Southeast Asia, is illustrated in Fig. 1. It contains three simulated tumors of various sizes and locations as follows: 2 cm on the anterior surface of the left lobe; 3 cm at the center of the posterior surface of the right lobe; and 2 cm on the