The nuclear cardiology report: Problems, predictors, and improvement. A report from the ICANL database

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Background. **The quality of nuclear cardiology reports is essential for the effective communication of results of cardiac radionuclide imaging and has never been evaluated for compliance with the ICANL standards. This retrospective study was designed to evaluate required reporting elements and site characteristics to determine differences in the compliance of applicant nuclear cardiology laboratories with *The ICANL Standards*, and identify potential mechanisms for improvement.**

Methods and Results. **Site characteristics and the 18 elements of the ICANL nuclear cardiology reporting standard ranked by level of importance were evaluated in 1,301 labs applying for accreditation from 1/1/08 to 1/1/09. A majority of labs were non-compliant (57.2%) with ≥1 of the 18 elements, mean number of errors 2.13 ± 2.58. There were significant differences among applications with different accreditation decisions, first application and repeat applications, and region of the United States. Laboratories with multiple re-accreditations had significantly increased compliance. These findings were confirmed following analysis of the ranked importance of the non-compliant elements.**

Conclusions. **Nuclear cardiology reports have a high degree of non-compliance with the current ICANL standards. There were identifiable characteristics defining labs more likely to be non-compliant. Feedback from prior applications improves compliance with reporting standards on subsequent applications. (J Nucl Cardiol 2011)**

Key Words: SPECT • diagnostic and prognostic application • outcomes research

INTRODUCTION

The report from any testing facility to the requesting physician is the single most important part of the test as it communicates the result of the test to the patient's health care provider, allowing them to act on the result and provide meaningful care. The importance of this communication has been emphasized in both the cardiology and the radiology literature for more than a decade and has recently received increased emphasis in an effort to reduce repeat testing and control cost.[1-6] Myocardial perfusion imaging serves as the ''gatekeeper'' for an increasing number of invasive cardiology procedures that are performed as a result of the myocardial perfusion imaging study. Therefore, it is essential that the results are reported accurately and concisely to reduce the need for unnecessary and repetitive testing and decrease patient risk. To improve quality in nuclear cardiology, leaders in the field of nuclear cardiology, nuclear medicine and positron emission tomography (PET) formed the Intersocietal Commission for the Accreditation of Nuclear Medicine Laboratories (ICANL) in December 1997. ICANL is charged with promoting quality diagnostic nuclear medicine testing, utilizing a peer-review laboratory accreditation process. Well-defined standards of quality serve as the foundation of the program, to improve the quality of testing, and assure that the services provided by the accredited facilities meet minimum levels of care.

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The *ICANL Standards* are based upon published guidelines from the related professional organizations and are an extensive document defining the minimal requirements laboratories must meet in order to achieve accreditation. The *Standards* are electronically available at www.icanl.org.[7,8] Included in the accreditation process is the thorough evaluation of all aspects of laboratory operations inclusive of staff qualifications, policies and procedures, image quality, reporting and outcomes, and quality assessment.

One of the most significant aspects in the assessment of the laboratory is evaluation of the final imaging report. The report must clearly detail useful results to the referring physician and is required to contain standard data elements. The quality of the nuclear cardiology report has never been systematically evaluated across a large sample of nuclear cardiology laboratories in the United States.

This study was designed retrospectively with three aims: (1) identify the compliance of applicant nuclear cardiology laboratories with *The ICANL Standards*, based on the required reporting elements; (2) to examine characteristics of nuclear cardiology laboratories across the United States to determine whether there were differences in reporting compliance and identify potential mechanisms for improving the quality of the report across laboratories; and (3) to examine the non-compliant reporting elements ranked according to their relative importance in relation to the nuclear cardiology laboratory characteristics.

METHODS

From January 1, 2008 to January 1, 2009, 1,301 laboratories applying for ICANL accreditation were evaluated to determine compliance with the 18 data elements of the ICANL nuclear cardiology reporting standards. Site characteristics for each laboratory were also evaluated. Two trained independent reviewers (one physician and one nuclear medicine technologist) from a pool of 99 with expert knowledge of the ICANL standards performed the review. Each reviewer determined compliance of the reports with the ICANL standards. ICANL technical staff adjudicated any disagreement between the reviewers. The agreement between observers for assessing these types of data are very good as demonstrated by Coleman and colleagues in a recent study evaluating PET reporting (inter-rater reliability 0.835 [95% confidence interval, 0.815-0.853]).[9] Inter-reviewer agreement for the ICANL review process ranges between 76% and 93% with a mean of 86% during a recent internal assessment demonstrating good concordance with this method.

The ICANL Nuclear Cardiology Reporting Standards

The 18 required elements of the report that were evaluated include: (1) succinct impression; (2) the defect size, severity, location, and type described using standardized terminology (defect quantification); (3) wall motion findings if gated SPECT was performed; (4) the clinical indication for the study; (5) the final report completed within four days of the exam (timeliness)[10]; (6) did the laboratory use standardized nomenclature to describe the location of defects/findings. Additionally, did the report contain: (7) the report signed by an interpreting physician listed in the application; (8) the description of the procedure; (9) the date of the report; (10) the dose and route of administration of any non-radioactive materials (e.g., dipyridamole, adenosine) (non-radioactive dose and route); (11) the exact dose and identification of radiopharmaceutical given to the patient; (12) patient name, laboratory name, and address (demographic items); (13) whether stress findings were integrated into the imaging report or separate (separate reports); (14) the referring physician's name; (15) patient birth date or age; (16) patient gender; (17) the route of administration of radiopharmaceutical; and (18) typographical errors. Detailed descriptions of the elements are located in Table 7, appendix.

Given the potential for differences in perception regarding the relative importance of the 18 essential reporting elements a retrospective survey was conducted. Twelve experts familiar with the ICANL standards and laboratory accreditation process ranked each of the 18 reporting elements on a 1-5 scale (1 = very important, 5 = least important). The results were averaged and a mean score for each of the elements was calculated. Based on the scores, the 18 elements were placed into three importance categories: high (score < 2.0), moderate (score ≥ 2 and < 3), and low (score ≥ 3) importance. Based on these categories each laboratory was profiled according to the importance of the non-compliant reporting elements present in their reports. This resulted in eight possible profiles. The laboratories were then grouped according to the highest severity non-compliant reporting element present in their reports. The four groups are: group 1—all labs non-compliant with any reporting element of high importance; group 2—all labs with full compliance with all high importance reporting elements and non-compliance with any reporting element of moderate importance; group 3—all labs with full compliance with all high and moderate importance elements and non-compliance with any reporting element of low importance; and group 4—full compliance with the reporting standards.

Laboratory Characteristics

The individual laboratory characteristics that were examined were: final accreditation decision on the reviewed application, the cycle of accreditation application (first, second, third, or fourth application cycle); the geographic region of the United States where the laboratory was located (Northeast, Midwest, South, and West; see Table 8 in appendix)[11]; whether or not accreditation was required by the payer for reimbursement; the type of laboratory (private office, hospital, multispecialty practice, or a mobile unit); the annual volume of nuclear cardiology studies divided into quartiles; and the number of physicians and technologists working in the laboratory.

In regards to the accreditation decision on the applications reviewed, there were three potential decisions made after

review of an application in 2008: (1) grant accreditation if the laboratory is in full compliance with the ICANL standards. Accreditation expires after 3 years. (2) Provisional accreditation if only minor issues need to be corrected and are corrected within 1 year. Accreditation expires 3 years after submission of application. (3) Delayed accreditation until items of non-compliance are remedied. Accreditation is granted after remedied and expires 3 years after initial submission of application.

Planned Analyses

Data were analyzed using SPSS for Windows (version 14.0; Chicago, IL). Data were cleaned and examined for outliers, normality, and correlations. To determine compliance with the ICANL standards, site characteristics and the 18 elements of the ICANL nuclear cardiology reporting standards (continuous outcome variable) were evaluated in 1,301 laboratories applying for ICANL accreditation from January 1, 2008 to January 1, 2009. All laboratories used in these analyses conducted radionuclide myocardial perfusion imaging (RMPI) tests. For aim one, descriptive analyses were conducted on the site characteristics, the 18 standards of reporting, as well as the ranked importance categories. Cochran Q non-parametric tests were conducted to examine if the importance categories of the elements were significantly different from each other. Cochran Q was used because these categories were not orthogonal. For aim two, a series of analyses of variance (ANOVA) were conducted with number of requirements not met as the dependent variable. Logistic regression analyses were conducted with the dichotomous-dependent variable (all requirements met vs $\geq$1 not met). When there was a significant omnibus test (i.e., family-wise F test, $P < .05$), contrasts were conducted to determine which groups were significantly different. Bonferroni post hoc comparisons were used in the ANOVAs. Significant logistic regression analyses were followed with contrasts (first group as reference group), applying Bonferroni alpha corrections for each series of logistic regression contrast tests (e.g., 4 cycles of accreditation: $\alpha = .05/6 = .008$). For aim three, a series of χ^2 (chi-square) analyses were conducted among the four importance groups and the individual laboratory characteristics. When there was a significant omnibus test (i.e., family-wise χ^2, $P < .05$), contrasts were conducted to determine which groups were significantly different, applying Bonferroni alpha corrections (i.e., four compliance groups: $\alpha = .05/6 = .008$).

RESULTS

Aim 1: Elements of Reporting Standards

Descriptions of the site characteristics are presented in Table 1. A majority of the laboratories were non-compliant with reporting standards, with 57.2% reporting at least one element of non-compliance. The mean number of non-compliant elements per lab was 2.13 ± 2.58 (range 0-12, total possible 0-18). The top four non-compliant elements were: missing date of report (26.4%), separate stress and imaging reports (23.6%), missing the route of administration of radiopharmaceutical (22.8%), and no mention of the defect size, severity, type, and location using standardized terminology (defect quantification) (19.8%). Those elements with the lowest rate of non-compliance (or highest compliance rate) were: demographic items (1.3%), succinct impression (4.5%), and typographical errors (5.3%).

Table 1. Site characteristics (N = 1,301)

Characteristic	n (%)
Cycle of accreditation	
First	900 (69.2)
Second	270 (20.8)
Third	101 (7.8)
Fourth	30 (2.3)
Region (census definition)	
Northeast	357 (27.4)
Midwest	261 (20.1)
South	574 (44.1)
West	109 (8.4)
Required by payer	
Not required	720 (55.3)
Required	581 (44.7)
Laboratory type	
Private office	1060 (81.5)
Hospital	109 (8.4)
Multispecialty-independent	113 (8.7)
Mobile unit	19 (1.5)
Volume of RMPI tests (quartiles)	
1st quartile (0-25th)	519.0 ± 185.4
2nd quartile (26-50th)	1056.2 ± 148.7
3rd quartile (51-75th)	1809.5 ± 311.7
4th quartile (76-100th)	4396.4 ± 2447.6
Number of physicians (M ± SD)	4.19 ± 4.47
Number of technologists (M ± SD)	2.87 ± 2.69
Accreditation decision	
Granted	284 (21.8)
Provisional	180 (13.8)
Delayed	837 (64.3)

RMPI, Radionuclide myocardial perfusion imaging.

The importance scores calculated for each reporting element resulted in six elements in the high importance category: succinct impression, defect quantification, wall motion findings, indication, timeliness, and nomenclature or standardization. The moderate importance category consisted of five elements: signature, description of procedure, date of report, non-radioactive dose and route of administration, and exact dose of the radiopharmaceutical. The remaining seven low

importance reporting elements were: demographic items, separate reports, referring physician, age/birth date, gender, route of administration of the radiopharmaceutical and typographical errors. Data for all 18 elements including the mean importance score and the high, moderate, or low importance category designation are reported in Table 2.

Summing the number of labs that were non-compliant with the elements by level of importance resulted in 715 high importance, 1,042 moderate importance, and 1,020 low importance non-compliant elements for a total of 2,777 non-compliant reporting elements in the 1,301 laboratories (Table 2). Figure 1 illustrates the distribution of laboratories and the number of non-compliant elements across the ranked importance of reporting elements. There were significant differences among the three importance groups in the proportion of labs with at least one error in each of the three importance groups (Cochran Q [2] = 35.111, $P < .001$), with significant differences between the high (36%) and moderate importance groups (43%) (Cochran Q [1] = 28.251, $P < .001$), and between the high and low importance groups (41%) (Cochran Q [1] = 17.308, $P < .001$). There was no difference between the moderate and the low importance groups.

The compliance profile description of the laboratories (the distribution of non-compliant reporting elements grouped by importance) is shown in Table 3. The four groups based on severity of non-compliant elements equate to frequencies, in descending order: 559

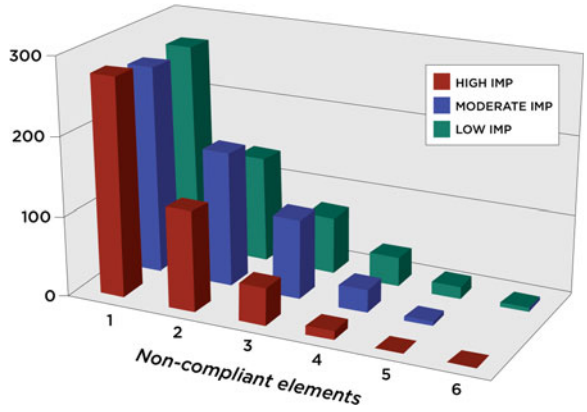

Figure 1. Frequency of laboratories with number of non-compliant reporting elements by ranked importance group. There were significant differences between high importance (IMP) (36%) and moderate (43%) and low (41%) importance groups ($P < .001$).

Table 2. ICANL reporting elements listed in descending order of importance

Required component	Requirement not met n (%)	Mean importance score	Importance category
1. Succinct impression	59 (4.5)	1.0	1
2. Defect quantification	253 (19.4)	1.25	1
3. Wall motion findings	77 (5.9)	1.42	1
4. Indication	170 (13.1)	1.75	1
5. Timeliness	85 (6.5)	1.83	1
6. Nomenclature or standardization	71 (5.5)	1.83	1
7. Signature	205 (15.8)	2.0	2
8. Description of procedure	158 (12.1)	2.17	2
9. Date of report	343 (26.4)	2.5	2
10. Non-radioactive dose and route	125 (9.6)	2.5	2
11. Exact dose	211 (16.2)	2.75	2
12. Demographic items	17 (1.3)	3.0	3
13. Separate reports	307 (23.6)	3.0	3
14. Referring physician	115 (8.8)	3.17	3
15. Age/birth date	108 (8.3)	3.17	3
16. Gender	108 (8.3)	3.3	3
17. Route of administration of the RP	296 (22.8)	3.7	3
18. Typographical errors	69 (5.3)	3.9	3

Note Mean importance score: 1-5 scale (1 = very important, 5 = least important).
Importance category: 1 = high importance, 2 = moderate importance, 3 = low importance.
RP, Radiopharmaceutical.

Table 3. Distribution of laboratories by importance score and severity grouping

Importance score profile	Number of non-compliant laboratories n (%)	Severity group	Severity group totals (%)
1. High only	65 (5)	1	462 (35.5)
2. High and moderate	60 (4.6)	1	
3. High and low	65 (5)	1	
4. High, moderate, and low	272 (20.9)	1	
5. Moderate only	80 (6.1)	2	231 (17.7)
6. Moderate and low	151 (11.6)	2	
7. Low only	49 (3.8)	3	49 (3.8)
8. All compliant	559 (43)	4	559 (43.0)

laboratories in compliance with all the reporting standards (group 4), 462 laboratories had non-compliant elements of high importance (group 1), 231 had compliance with the high importance elements but non-compliance with any moderate importance element (group 2), and 49 were compliant with high and moderate importance elements and were non-compliant with any low importance element (group 3).

Aim 2: Examining Lab Characteristics

Examining site characteristic differences on the number of non-compliant elements (range 0-18), there were significant differences in non-compliance with reporting standards with respect to accreditation decision ($P < .001$), accreditation cycle ($P < .001$), region of the U.S. ($P < .001$), managed care requirement for accreditation ($P < .001$), type of laboratory ($P = .001$), and number of RMPI studies conducted annually ($P = .002$). Table 4 compares the laboratory characteristics for means, standard deviations, and significance between groups. Specifically, there was greater non-compliance with reporting standards across the decision process with delayed having the greatest non-compliance. Cycle 1 had more non-compliant elements compared to cycle 3. The South and West had greater non-compliance compared to the Northeast and Midwest. The Northeast was significantly more compliant than the other three regions, and the West was significantly more non-compliant compared to the other three regions. Laboratories in states that did not have a managed care requirement for accreditation for reimbursement had greater non-compliance compared to laboratories in states with the requirement. Additionally, mobile units had significantly higher non-compliance than a private office, hospital, and multispecialty clinics. There were no significant differences between private office, hospital, or multi-specialty clinics; or between multi-specialty clinics and mobile units. The 1st quartile (0-25th percentile) in volume of RMPI tests conducted had significantly greater non-compliance than the third quartile (26-75th percentile) and the fourth quartile (76-100th percentile) in volume. There were no other statistically significant differences between quartiles (seen in Table 4). The number of physicians or technologists in the laboratory had no effect on compliance with reporting standards.

Using logistic regressions, we examined probabilities or likelihood for non-compliance among site characteristics. As in the ANOVAs, there were significant differences among accreditation decision, cycle, and region of the United States (see Table 5 for odds ratios and confidence intervals for contrast tests). Specifically, there were higher odds of non-compliance in accreditation decision between a provisional or delayed decision compared to the originally granted decision. Cycle 1 was 2.7 times more likely to be non-compliant compared to those in cycle 3. There were higher odds for non-compliance for laboratories in the Midwest, South, or West, compared to the Northeast. The omnibus likelihood tests for managed care requirement, type of laboratory, or volume of studies conducted were not significant and therefore follow-up contrasts were not examined.

Aim 3: Examining Reporting Element Severity Rating with Lab Characteristics

The lab characteristics that were examined were the same as in Aim 2 (accreditation decision, accreditation cycle, region of the U.S., managed care requirement, and type of laboratory, volume of studies, number of technologists, and number of physicians). The omnibus Pearson χ^2 was significant for accreditation decision, accreditation cycle, region of the U.S., managed care

Table 4. Laboratory characteristic differences (N = 1,301)

Characteristic	Non-compliant elements (mean ± SD)	*P* value
Accreditation decision		$P < .001$
Grant	0 ± .06	All comparisons, $P < .001$
Provisional	1.21 ± 1.6	
Delay	3.06 ± 2.7	
Accreditation cycle		$P < .001$
Initial	2.31 ± 2.67	1st and 2nd, $P = .337$
2nd	1.97 ± 2.49	1st and 3rd, $P < .001$
3rd	1.18 ± 1.83	1st and 4th, $P = .330$
4th	1.40 ± 2.04	2nd and 3rd, $P = .048$
		2nd and 4th, $P = 1.00$
		3rd and 4th, $P = 1.00$
Region of country		$P < .001$
Northeast	1.62 ± 2.18	NE and MW, $P = 1.00$
Midwest	1.69 ± 2.14	NE and S, $P < .001$
South	2.44 ± 2.76	NE and W, $P < .001$
West	3.30 ± 3.16	MW and S, $P < .001$
		MW and W, $P < .001$
		S and W, $P = .007$
Managed care		$P < .001$
Required	1.78 ± 2.2	
Not required	2.42 ± 2.8	
Type of laboratory		$P = .001$
Hospital	1.58 ± 2.27	Private and hosp, $P = .175$
Private office	2.14 ± 2.59	Private and multi, $P = 1.000$
Multi-specialty	2.25 ± 2.45	Private and mob, $P < .003$
Mobile	4.21 ± 3.44	Hosp and multi, $P = .314$
		Hosp and mob, $P < .001$
		Multi and mob, $P = .013$
Volume of studies		$P = .002$
1st quartile (0-25th)	2.76 ± 2.76	1 and 2, $P = .792$
2nd quartile (26-50th)	2.44 ± 2.62	1 and 3, $P = .003$
3rd quartile (51-75th)	2.00 ± 2.54	1 and 4, $P = .021$
4th quartile (76-100th)	2.13 ± 2.56	All others NS

Note Family-wise $\alpha = .05$. Follow-up comparisons with Bonferroni α correction, $P < .008$.
NE, Northeast; *MW*, Midwest; *S*, South; *W*, West; *multi*, multispecialty; *mob*, mobile; *hosp*, hospital; *private*, private office; *NS*, non-significant.

requirement, and type of laboratory ($P < .001$ to .009), but not for quartiles of RMPI volume. Follow-up contrasts were then conducted for all the significant variables to determine between groups differences for all pair-wise comparisons of the four severity groups. Examining each significant lab characteristic demonstrated no significantly proportional differences between groups 1 and 2 and 1 and 3 across all lab characteristic variables. Groups 1 and 4 were significantly different in proportions across all variables ($P > .001$ to .002), with a lab more likely to be in group 4 (complete compliance) compared to group 1. The detailed analysis of significant differences is presented in Table 6; non-significant group comparisons are not presented. Specifically, with regard to accreditation decision, for a decision to grant there was a greater probability of having less severe errors. For a provisional decision there was a greater probability of having higher severity non-compliant elements compared to having errors of lower importance elements and this trend continued for a delayed decision.

Table 5. Significant group differences for nuclear cardiology reporting compliance (odds ratios)

Characteristic	*P* value	Odds ratio	Confidence interval (95%)
Accreditation decision: provisional	<.001	.006	.001–.041
Accreditation decision: delayed	<.001	.001	<.001–.006
Cycle 1 and 2	.716	.923	.600–1.421
Cycle 1 and 3	<.001	2.741	1.591–4.721
Cycle 1 and 4	.128	2.162	.800–5.839
Region NE and MW	.003	.444	.258–.763
Region NE and South	.037	.564	.329–.966
Region NE and West	.021	.398	.181–.872

Note Contrasts with reference group as group 1—1st group of categories (i.e., Granted, Cycle 1, Northeast).
NE, Northeast; *MW,* Midwest.

With regard to accreditation cycle, for cycles 3 and 4 there was a greater probability of being in group 4 than 1 and this trend continued in cycle 2. For labs located in the Midwest and Northeast, there was a higher probability to be in group 4 than group 1. The opposite was true for the West with a higher probability of group 1 than 4. In regards to having a managed care requirement, there was a greater likelihood of being in group 4 compared to group 1. When examining lab type, mobile labs had a greater probability of being in group 1 than groups 4 and 3 compared to group 2. Hospital-based laboratories had a greater probability of being in group 4 compared to group 1. Multi-specialty and private offices had a greater probability of being in group 4 compared to groups 1 and 2 compared to group 3.

Analyses of variance were conducted to examine differences between severity groups and number of physicians and technologists working in the laboratories. There was a significant difference across the groups for number of technologists (F [3, 1261] = 33.750, $P = .003$), but number of physicians was not significant. Examining Bonferroni contrasts for number of technologists across groups, there were significant differences between groups 1 and 4 ($P = .009$), and 2 and 4 ($P = .019$). There were more technologists in group 4 ($M = 3.18 \pm 2.87$) compared to groups 1 ($M = 2.64 \pm 2.43$) and 2 ($M = 2.56 \pm 2.29$).

DISCUSSION

The compliance of nuclear cardiology laboratories with the ICANL reporting standards has important areas that can be improved. For those laboratories participating in the ICANL accreditation process in 2008, a majority of laboratories across the nation are non-compliant with reporting standards (57.2%). Site characteristics that were associated with non-compliance were: accreditation decision, accreditation cycle, region of the U.S., type of laboratory, and volume of RMPI tests conducted. However, these results also suggest improvement over time within sites.

The relative importance of the required reporting elements allows a more in-depth assessment regarding the quality of the reporting process. There were a smaller proportion of laboratories with high severity non-compliant elements in comparison with moderate and low severity non-compliant elements when all the non-compliant elements were evaluated (see Figure 1). When laboratories were evaluated by the highest severity level of a non-compliant reporting element, however, this pattern changed. The group of laboratories with the highest severity non-compliant elements was the second largest after laboratories compliant with all elements of the standard (35.5% vs 43%) (see Table 3). The significant findings with the differences in the lab characteristics maintained even after inclusion of the severity of the non-compliant elements. Specifically, there was an association not only with the number of non-compliant elements, but also higher levels of severity in delayed labs, compared to provisional and for both delayed and provisional compared to granted. This pattern diminished as laboratories participated in sequential accreditation cycles. Regional variation was also noted with higher severity non-compliant elements being more prevalent in the West than in the other regions. The mobile lab setting is challenging with an increased proportion of non-compliant reporting elements in the high severity group compared to other settings. In contrast, the hospital setting has a significantly greater compliance with the elements when evaluated by severity. Notably, the number of studies the lab performs or the number of interpreting physicians did not effect the distribution of the severity of non-compliant elements.

Table 6. Significant severity group differences for lab characteristics (N = 1,301)

Characteristic/proportion by severity group	Proportions (%)		*P* values
Accreditation decision			<.001
Groups 4 and 1	54.8	45.2	<.001
Granted	99.6	0.4	
Provisional	62.7	37.3	
Delayed	31.0	69.0	
Groups 2 and 3	82.5	17.5	.003
Provisional	63.3	36.7	
Delayed	84.8	15.2	
Groups 2 and 4	29.2	70.8	<.001
Granted	0	100	
Provisional	16.8	83.2	
Delayed	53.8	46.2	
Groups 3 and 4	8.1	91.9	<.001
Granted	0	100	
Provisional	10.5	89.5	
Delayed	17.3	82.7	
Accreditation cycle			.007
Groups 4 and 1	54.8	45.2	<.001
Cycle 1	49.0	51.0	
Cycle 2	58.5	41.5	
Cycle 3	73.2	26.8	
Cycle 4	66.7	33.3	
Region of country			<.001
Groups 4 and 1	54.8	45.2	<.001
Northeast	65.4,	34.6	
Midwest	59.7	40.3	
South	48.9	51.1	
West	37.7	62.3	
Managed care			.009
Groups 4 and 1	54.8	45.2	<.001
Not required	50.5	49.5	
Required	60.2	39.8	
Type of laboratory			<.001
Groups 4 and 1	54.8	45.2	<.001
Private office	54.6	45.4	
Hospital	66.3	33.7	
Multi-specialty	51.8	48.2	
Mobile unit	16.7	83.3	
Groups 2 and 3	82.5	17.5	<.001
Private office	86.0	14.0	
Hospital	55.0	45.0	
Multi-specialty	76.7	23.3	
Mobile unit	0	100	

Table 6 continued

Characteristic/proportion by severity group	Proportions (%)	*P* values
Volume of studies		.122
Contrasts not performed		

Note Family-wise $\alpha = .005$. Follow-up comparisons with Bonferroni α correction <.008. Comparisons not presented in the table were not significant.
Group 1—non-compliant with high importance reporting element.
Group 2—compliant with high importance elements, non-compliant with moderate importance reporting element.
Group 3—compliant with high and moderate importance elements, non-compliant with low importance reporting element.
Group 4—compliant with all reporting elements.

Coleman and colleagues reported similar findings for PET studies validating the need for significant efforts aimed at improving the quality of reporting for nuclear medicine studies.[9] The findings from this study are helpful in focusing future educational and quality reporting initiatives through identification of specific elements of the reports that are problematic for laboratories. Understanding regional variability and other factors that assess the quality of the report can further focus educational activities targeted at specific regions, laboratory types, particularly mobile laboratories, or size of the laboratory. It is not clear why regional variability exists, except that most physicians tend to practice near areas of training and thus may duplicate the errors that were incorporated into their training programs. Evaluating the required components with the greatest non-compliance allows training and development to focus on the necessity and reasoning behind inclusion of these elements in the report. The date of the report is required to assess compliance with the standard for timely final report generation. A number of labs utilize separate reports for the stress and imaging portions of the test, and not integrating these leaves the referring physician with the dilemma of what to do if the results of the two portions of the test are discordant, a question that should be answered by the expert interpreting the study with access to all the data. The route of administration of isotope is necessary to adequately describe how the study was performed and ensure quality images were obtained. Defect quantification, describing both defect size and severity using standard nomenclature are important to allow a referring physician the information necessary to guide them in deciding on and counseling the patient regarding the integration of the test results with the plan of care, becomes a very important focus for process improvement. Ensuring an indication is present also becomes important, particularly as it allows determination of Appropriate Use Criteria. Furthermore, companies developing electronic health records and nuclear cardiology reporting software can use the results to ensure compliance with the standards as reports are generated at the point of care, including emphasis on those elements of highest importance. This can be accomplished through the development of report templates, serving as reminders of what is necessary to include in the report.

The data demonstrate that the ICANL accreditation process works. The process identifies the non-compliant reporting standard elements and makes an accreditation decision based on this along with compliance with other elements of the standards. This process resulted in laboratories with a larger number of reporting errors were more likely to have delayed decisions, with provisional laboratories having fewer errors and those with granted status had no errors. By setting standards of policies and procedures, based on guideline documents developed by the professional societies, ICANL is an instrument driving the improvement process. ICANL accreditation helps advance the quality improvement process by promoting uniform performance among laboratories with very different characteristics, e.g., study volume, laboratory type, and geographic location. Accreditation is a learning process for the laboratories. As the laboratories apply in sequential cycles, there is an increase in the compliance of the report with the standards, demonstrating the feedback from the review is incorporated in the laboratories daily process completing the quality cycle. Interestingly, this improvement usually requires two application cycles to reach full compliance. The reason for this was not evaluated by this study, however, possible reasons include changing long standing processes requires time and multiple interventions that include motivation, belief in the change, and accountability, described in several behavior change theories.[12] Furthermore, this study did not evaluate the effect of the accreditation process on compliance with other sections of the standards not specific to the report quality.

With regard to the type of lab and its compliance with the reporting standards, in this study, mobile labs were found to be the most non-compliant. The reasons for this are unclear, probably multi-factorial and were unable to be analyzed with the available data.

Interestingly, there were no differences between any of the other lab settings studied, including hospitals, private office, and multi-specialty sites. This would support the concept that involvement, supervision, and responsibility for the entire nuclear cardiology process promotes compliance with the ICANL standards in all of these settings.

In addition to the learning curve through accreditation, these findings also demonstrated that laboratories responded to managed care initiatives focused on requiring accreditation for reimbursement. This requirement had a positive effect on the compliance of the laboratory with ICANL reporting standards. This is an important finding as the effects of the Medicare Improvements for Patients and Providers Act start to affect the accreditation process beginning in 2012.[13] Required accreditation should improve compliance with the reporting elements of the ICANL standard and through the re-accreditation process lead to increasing compliance with repeat cycles.

The study is limited by the fact that the reviews were conducted by a diverse group of physician and technologist peer reviewers. The potential for inter-rater variability was attempted to be mitigated by required training of all the reviewers on an annual basis. Furthermore, ICANL staff and board reviews were used to resolve those reviews with disparate findings. A second limitation of the accreditation process is that it is a voluntary activity for most laboratories, except those required to participate in the accreditation process as part of managed care contracting. This may bias the population of laboratories that were included in the study.

In conclusion, compliance with the reporting standards of ICANL has many factors affecting success. Participation in the process leads to continued improvement in compliance with the standards. There are multiple opportunities to affect improvement in compliance with the standards; these include focusing on need-specific educational opportunities for particular regions, type, and size of laboratories, and on certain elements that are more frequently omitted from the report or are of greater importance.

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APPENDIX

See Tables 7 and 8.

Table 7. ICANL reporting elements definitions

1. Succinct impression	Report must contain an accurate succinct impression (e.g., normal or abnormal) that clearly communicates the results of the study
2. Defect quantification	Quantification of myocardial perfusion defects in terms of location, size, severity and type
3. Wall motion findings	Description of overall left ventricular function and regional abnormalities
4. Indication	Clinical indication and pertinent history leading to the performance of the examination
5. Timeliness	An interpretation must be available within two working days of the examination and the final report must be transmitted to the referring healthcare provider within four working days.
6. Nomenclature or standardization	Use of appropriate reporting terminology and 17-segment model
7. Signature	Signature of the interpreting physician
8. Description of procedure	Description of the procedure including type of examination, imaging protocol, imaging sequence and type of stress
9. Date of report	Date the final report is reviewed, signed and dated by the interpreting physician
10. Non-radioactive dose and route	Amount and route of administration of pharmacologic stress agent or other pharmaceuticals (e.g., aminophylline, PYP)
11. Exact dose	Exact dose of the administered radiopharmaceutical with one decimal point (i.e., XX.X mCi)
12. Demographic items	Demographic items such as facility identification and phone number

Table 7 continued

13. Separate reports	Lack of integration of imaging findings and stress data (exercise or pharmacologic) into the final imaging report
14. Referring physician	Requesting health care provider's name
15. Age/birth date	Patient's age or date of birth
16. Gender	Patient's gender
17. Route of administration	Route or method of administration of the radiopharmaceutical (i.e., intravenous)
18. Typographical errors	Typing mistakes or errors

Table 8. United States census defined regions

Northeast region
Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, Pennsylvania, Vermont
Midwest region
Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, Wisconsin
South region
Alabama, Arkansas, Delaware, District of Columbia, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, West Virginia
West region
Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, Wyoming

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