J of Nuclear Medicine Technology, first published online December 22, 2017 as doi:10.2967/jnmt.117.202234

Impact of Nuclear Laboratory Personnel Credentials & Continuing Education on Nuclear Cardiology Laboratory Quality Operations

Saurabh Malhotra, MD, MPH, FASNC[a]; Diana M. Sobieraj, PharmD[b]; April Mann, MBA, CNMT, NCT, RT(N)[c]; Matthew W. Parker, MD[d];

[a]University at Buffalo, Buffalo, NY, [b]University of Connecticut School of Pharmacy, Storrs, CT, [c]Hartford Hospital Division of Cardiology, Hartford, CT and [d]University of Massachusetts Medical Center, Division of Cardiovascular Medicine, Worcester, MA,

Funding Source

This work was supported by an investigator-initiated research grant to the authors from the Intersocietal Accreditation Commission, Ellicott City, MD. The content is solely the responsibility of the authors and does not necessarily represent the official views of the IAC or the IAC Research Committee.

Conflicts of Interest:

Authors Malhotra, Sobieraj, Mann and Parker have no conflicts of interest related to this manuscript.

Short Title: Personnel Credentials and Nuclear Laboratory Quality

Word Count (including references and tables): 4412

Address for Correspondence

Matthew W Parker, MD
University of Massachusetts Memorial Medical Center
55 N Lake Avenue
Worcester, MA 01605
(508) 654-1652
Matthew.Parker@umassmemorial.org

First Author

Saurabh Malhotra, MD, MPH, FASNC
University at Buffalo
875 Ellicott Street
CTRC Suite 7030
Buffalo, NY 14203

Abstract

Background/Objectives: The specific credentials and continuing education (CME/CE) of nuclear cardiology laboratory medical and technical personnel are important factors in the delivery of quality imaging services that have not been systematically evaluated, especially in relation to accreditation.

Methods: Nuclear cardiology accreditation application data from the Intersocietal Accreditation Commission (IAC) was used to characterize facilities performing myocardial perfusion imaging (MPI) by setting, size, previous accreditation and credentials of the medical and technical personnel. Credentials and CME/CE were compared against initial accreditation decisions (grant or delay) using multivariable logistic regression.

Results: Complete data were available for 1913 nuclear cardiology laboratories from 2011-2014. Laboratories with initial grant accreditation decisions had a greater prevalence of Certification Board in Nuclear Cardiology (CBNC) certified medical directors and specialty credentialed technical directors. Certification and credentials of the medical and technical directors, respectively, personnel CME/CE compliance, and assistance of a consultant with the application were positively associated with accreditation decisions.

Conclusion: Nuclear cardiology laboratories directed by CBNC-certified physicians and NCT- or PET-credentialed technologists were less likely to receive delay decisions for MPI. CME/CE compliance of both the medical and technical directors was associated with accreditation decision. Medical and technical directors' years of experience were not associated with granted accreditation decision.

Key Words

Nuclear Cardiology – Accreditation – Board Certification – Certified Technologists

Introduction

The credentials and continuing education of professionals performing nuclear cardiology are key components of quality imaging services(1,2) emphasized in the Intersocietal Accreditation Commission-Nuclear/PET (IAC) accreditation process(3). Specifically, the 2012 IAC Standards(3) required that the medical director must be certified by the Certification Board in Nuclear Cardiology(4) (CBNC) or have equivalent training(5) and experience as detailed in the Standards. Other medical staff must meet similar criteria. These criteria allow physicians with adequate experience to staff or direct an accredited nuclear cardiology laboratory without being certified by the CBNC. Technical directors may qualify for their position on the basis of state licensure or the Certified Nuclear Medicine Technologist (CNMT) or Registered Technologist in Nuclear Imaging (RT[N]) credentials. They may present additional credentials as well, including more specialized training in nuclear imaging (such as the PET or NCT credentials from the Nuclear Medicine Technology Certification Board for which the CNMT or RT credentials are a pre-requisite(6)) or parallel credentials in related imaging modalities (the Registered Technologist in Radiographic Imaging, Computed Tomography, or Magnetic Resonance credentials(7)). The impact of these different credentials on laboratory accreditation and quality has not been studied. Accreditation from IAC Nuclear/PET also requires that each physician and technologist submit 15 hours of continuing medical education/continuing education (CME/CE) relevant to the practice of nuclear cardiology in the three years prior to accreditation(3). In one analysis, inadequate CME/CE was the most common reason for delayed accreditation(2), causing delay in 30% of applications. It is less clear whether inadequate CME/CE is associated with other deficiencies, for example in imaging protocols, quality improvement processes, or reporting. We endeavored to use the IAC Nuclear/PET applications database to investigate nuclear cardiology practice patterns with respect to credentials of the medical and technical directors and staffs, as well as CME/CE of both, in relation to peer-reviewed assessments of laboratory quality.

Methods

This was a cross-sectional study evaluating data submitted for IAC Nuclear/PET radionuclide myocardial perfusion imaging (MPI) accreditation in the United States from 2011 to 2014. A single accreditation application could be a nuclear cardiology laboratory at one or multiple sites organized and staffed by a single group of physicians and technologists. IAC Nuclear/PET accreditation is granted for a three-year period and facilities must re-apply by the same process to maintain accreditation. Among the laboratories applying for accreditation from 2011 to 2014, only those with complete data on the descriptive characteristics of interest as well as credential and continuing education information for medical and technical personnel were included for analysis.

Options for training and credentials of medical and technical directors of IAC Nuclear/PET nuclear cardiology laboratories are presented in Table 1. Specialty of the medical director was categorized as “cardiology” if they were board certified by the American Board of Internal Medicine in Cardiovascular Diseases and as “other” if they were board certified in radiology, nuclear medicine, or trained before 1995 and qualified through the experience pathway. We created categories for technical directors with specialized credentials such as NCT or PET in addition to CNMT or RT(N) for comparison to those with CNMT or RT(N) without NCT or PET. Separately, we categorized technical directors as those with a credential in an additional modality such as RT(R), RT(CT), or RT(MR) in addition a nuclear medicine credential in distinction to those with only nuclear medicine-specific credentials. Other physicians and technologists may participate in nuclear cardiology laboratories but without the responsibilities of a director; the IAC Nuclear/PET Standards define the acceptable credentials for such staff and CME/CE requirements for them but do not stipulate experience criteria (3). Note that all laboratories must have a medical and a technical director but do not necessarily have additional staff.

Descriptive characteristics were compared between labs with initial grant versus delayed decisions for MPI accreditation, using Chi-square for categorical data and t-tests or Mann Whitney tests, based on distribution, for continuous data. The primary analysis focused on determining the predictors of a granted MPI accreditation decision while secondary analyses focused on determining the predictors of reporting deficiencies and protocol deficiencies, separately. Multivariate logistic regression models were built for each dependent variable to evaluate the association of lab characteristics and directors’ credentials and training with the individual dependent variable, with adjustment for each of the following variables: number of sites per applicant, annual MPI procedure volume per 1000, number of previous accreditation cycles, consultant assistance with application, facility type (hospital versus non-hospital), whether the lab was also performing general nuclear medicine and/or PET oncology/neurology, medical director specialty (cardiology versus other), medical director volume of studies interpreted (as quartiles), medical director CBNC status, medical director CE compliance, number of medical staff, having at least 50% of medical staff with CBNC certification, number of CE compliant medical staff, technical director credentialing pathway (with or without NCT and/or PET), technical director compliance with CE, number of technical staff, and number of technical staff compliant with CE. An exploratory model investigated the possible association between average volume of studies interpreted per physician in each lab and grant MPI decision. This variable was substituted for the volume of studies interpreted by the medical director that was in the original model. Results of the multivariate models are presented as adjusted odds ratios (AOR) with accompanying 95% confidence intervals (CI). A p-value of <0.05 was considered statistically significant. Analyses were conducted using IBM SPSS Statistics for Windows, Version 22 (Armonk, NY, USA).

The Hartford Hospital Institutional Review Board reviewed the investigational plan prior to any analysis and determined this study was not “human subjects” research.

Results

A total of 1913 labs were included in the analysis (Table 2). The majority (87.9%) of IAC-Nuclear/PET applicants were non-hospital facilities and 9.1% perform general nuclear medicine, oncology, or neurologic procedures in addition to nuclear cardiology procedures. Most (77.3%) applications were for a single site laboratory and the largest proportion (45.4%) were located in the South US Census region.

The majority (69.6%) of medical directors were board certified or board eligible (BC/BE) in Cardiovascular Diseases by the American Board of Internal Medicine. The remaining medical directors were qualified under the experience pathway with training in cardiology prior to 1995 and with over 10 years practice experience (15.0%); BC/BE in nuclear medicine (10.8%); BC/BE radiologists (2.9%); or BC/BE in another specialty (2.1%). Fifty-eight percent of medical directors were certified by the CBNC.

Nearly half (45%) of technical directors held more than one registered credential relevant to nuclear imaging, with CNMT (85.8%) and RT(N) (44.8%) the most prevalent. A minority of the technical directors (8.9%) additionally held either the NCT or PET credentials and 284 (14.8%) held a parallel imaging credential in such as RT(R), RT(CT), or RT(MR) in addition to the CNMT or RT(N) nuclear imaging credential.

Medical directors reported adequate CME relevant to nuclear cardiology in 74.8% of applications; 74.5% of medical staff were compliant in CME. Technical directors reported adequate CE in 80.4% of applications; 81.1% of technical staff were compliant with the CE requirement. Nearly half (49.7%) of laboratories in which both the medical director and the technical director were compliant with the CME/CE requirements received initial granted accreditation decisions, compared with 24.5% of applicants in which either or both the medical director and/or the technical director were not compliant with the CME/CE requirements ($p<0.001$, Table **3**).

Upon multivariate adjustment, several variables were associated with increased odds of granted MPI accreditation decision, including presence of a medical director with CBNC status, presence of a technical director with NCT and/or PET, CME/CE compliance of the medical and technical directors and increasing number of medical staff with CME/CE compliance, and assistance of a consultant with the application (Table **4**). The only variable which negatively impacted the odds of a granted MPI decision was the number of medical staff. Years of experience of either the medical or the technical director were not associated with accreditation decision.

The exploratory analysis of average annual volume of studies interpreted per physician did not change the magnitude or direction of the associations in the primary analyses.

Variables that were independently associated with a lower prevalence of protocol deficiency were consultant assistance, medical director CME compliance, technical director CE compliance and increasing the number of medical staff with CE compliance. Factors associated with which increased protocol deficiency included laboratories that also do GNM and/or PET neurology/oncology, medical directors with volume of interpreted studies over 900, and an increasing number of medical staff (Table 5).

Variables that were independently associated with a lower prevalence of report deficiency were consultant assistance, medical director with CBNC status, medical director CE compliance, technical director CE compliance and technical director with NCT or PET. The only variable that was associated with increased reporting deficiency was the number of sites (Table 5).

Discussion

This analysis of 1913 nuclear cardiology laboratories demonstrated that the majority of facilities seeking IAC Nuclear/PET accreditation for MPI are directed by cardiologists certified by the CBNC and predominantly by registered technologists, many of whom hold multiple imaging credentials. Nuclear cardiology laboratories directed by CBNC-certified physicians and NCT- or PET-credentialed technologists were less likely to receive delay decisions for MPI. Moreover, CBNC status of medical directors was associated with increased odds of granted accreditation and reduced odds of deficiency in protocols and reporting while medical specialty and volume of experience of the medical director were not. Together, these findings suggesting that professionals with advanced training specific to nuclear cardiology are more likely to perform nuclear cardiology in the detailed-oriented fashion that leads to granted IAC Nuclear/PET accreditation. These findings are not altogether surprising but represent an important validation of specific training credentials in addition to general training in cardiology or radiation imaging technology. Additionally, directors and staff who are in compliance with IAC Nuclear/PET Standards for CME/CE were less likely to have deficiencies in protocols and reporting, an association that suggests CME/CE activity can improve laboratory operations above and beyond meeting a statutory requirement for quantity of ongoing education.

In the overall accreditation decision as well as in the domains of protocols and reporting, the training and continuing education of the technical director and technical staff have a similar impact as those of the medical director and medical staff. This finding validates the common observation that technologists, responsible for patient preparation, imaging acquisition including instrument quality control, and data entry on reports(*8*), are equally important for quality imaging laboratory operations as is the interpreting physician. CME/CE compliance of both the medical and technical directors, but not the years of experience of either, was significantly associated with granted accreditation decisions. This distinction emphasizes the importance of up-to-date knowledge of technologies and practice standards for the successful organization and operation of a nuclear cardiology laboratory, independent of duration of experience.

Facilities performing non-cardiac imaging tended to have more deficiencies in protocols for cardiac (MPI) imaging, which may be explained by the high percentage of cardiologists responsible for the imaging and interpretation observed in this sample of nuclear imaging laboratories. The process of applying for accreditation for a large number of protocols also introduces more opportunities for errors and missing or outdated materials. Similarly, we hypothesize that the trend toward more deficiencies in reporting in facilities with multiple sites and larger medical staffs to be related to both to increased complexity of the application materials and also more opportunities for variability across sites and between interpreting physicians.

Less clear is the finding that medical directors who interpret the highest quartile of study volumes were associated with increased protocol deficiencies. This may be a statistical “false negative finding,” especially as greater volume has been associated with greater quality across a range of procedures including coronary artery bypass grafting and acute myocardial infarction care(*9*). However, we are not aware of any studies relating nuclear imaging interpretative quality (i.e., diagnostic accuracy) to volume(*10*). One study of echocardiography interpretation demonstrated increased frequency of interpretation errors when higher numbers of reports were signed per hour(*11*), but annual laboratory volume data do not allow us to test whether speed is a factor in our sample.

A key limitation of this analysis is that accreditation is voluntary for hospital-based nuclear cardiology laboratories and required for non-hospital based facilities, resulting in a biased sample. This bias may be compounded by the fact that accreditation of imaging facilities is also available through the American College of Radiology and laboratories seeking accreditation from one or the other body may be systematically different(*12*). Review of laboratory materials for accreditation is performed by a diverse group of physicians, technologists, and IAC Nuclear/PET specialists, although all reviewers undergo the same initial and periodically updated training. Leadership and staff within laboratories may change independently of substantive changes in laboratory operations during an accreditation cycle, which may also bias our results.

The assistance of a consultant in preparing the application for accreditation was strongly associated with initial accreditation as opposed to delay decisions, which underscores the way the accreditation process relies heavily on a “snapshot” of materials presented to IAC Nuclear/PET and its reviewers(*13*). Laboratory staff may change during the course of an IAC Nuclear/PET accreditation period due to personnel changes or laboratory mergers and staff changes may mean that laboratory operations as described on the application materials may not reflect the work of the current leadership in every laboratory.

These structural quality data are distinct from outcomes such as diagnostic accuracy and improved patient care(*14*) and further studies will be required to explore the impact of advanced training credentials on patient outcomes. As with all observational research, only variables which were included in the analysis could be those adjusted for in the analysis. We cannot discount other confounders that may be influencing the results.

The American College of Cardiology Core Cardiovascular Training Statement was recently updated(*15*) and the new training standards had not been incorporated into the IAC Nuclear/PET Standards as of the time of this study.

In conclusion, CBNC status of medical directors and specialized credentials of technical directors are associated with increased odds of granted accreditation and reduced odds of deficiency in protocols and reporting among nuclear cardiology laboratories seeking IAC Nuclear/PET accreditation. These findings substantiate that specific training credentials in addition to general training in cardiology or nuclear imaging technology are associated with improved quality of cardiovascular imaging. More research is required to link these structural quality measures with patient outcomes.

Acknowledgements

The authors acknowledge Mary Beth Farrell, CNMT, for assistance with data management.

References

1. Cerqueira MD, Arrighi JA, Geiser EA. Physician certification in cardiovascular imaging: rationale, process, and benefits. *JACC Cardiovasc Imaging*. 2008;1:801-808.

2. Heller GV, Katanick SL, Sloper T, Garcia M. Accreditation for cardiovascular imaging: setting quality standards for patient care. *JACC Cardiovasc Imaging*. 2008;1:390-397.

3. *The IAC Standards and Guidelines for Nuclear/PET Accreditation*. 2016. Available at: https://www.intersocietal.org/nuclear/standards/IACNuclearPETStandards2016.pdf. Accessed October 19, 2017.

4. Wackers FJ, Bateman TM. Blueprint of the certification examination in nuclear cardiology. Certification Council of Nuclear Cardiology. *J Nucl Cardiol*. 1997;4:164–168.

5. Cerqueira MD, Berman DS, Di Carli MF, Schelbert HR, Wackers FJT, Williams KA. Task force 5: training in nuclear cardiology endorsed by the American Society of Nuclear Cardiology. *J Am Coll Cardiol*. 2008;51:368–374.

6. Certification Exams. *wwwnmtcborg*. Available at: https://www.nmtcb.org/certification-exams.php. Accessed December 1, 2016.

7. Initial ARRT Certification and Registration. *wwwarrtorg*. Available at: https://www.arrt.org/Certification. Accessed December 1, 2016.

8. *Nuclear Medicine Technologist Scope of Practice and Performance Standards*. Society of Nuclear Medicine and Molecular Imaging Technologist Section; 2013. Available at: http://snmmi.files.cms-plus.com/NMT_Scope_of_Practice_Clinical_Performance_Standards_FINAL_6-2013.pdf.

9. Halm EA, Lee C, Chassin MR. *Interpreting the Volume-Outcome Relationship in the Context of Health Care Quality*. Washington, D.C.: National Academies Press; 2000.

10. Eskandari M, Kramer CM, Hecht HS, Jaber WA, Marwick TH. Evidence Base for Quality Control

Activities in Cardiovascular Imaging. *JACC Cardiovasc Imaging*.2016;9:294–305.

11. Spencer KT, Arling B, Sevenster M, DeCara JM, Lang RM, Ward RP, O'Connor AM, Patel AR. Identifying errors and inconsistencies in real time while using facilitated echocardiographic reporting. *J Am Soc Echocardiogr*.2015;28:88–92.e1.

12. Wackers FT. ICANL and ACR nuclear medicine accreditation: a comparison. *J Nucl Med*. 2000;41:26N–8N.

13. Douglas PS, Chen J, Gillam L, et al. Achieving Quality in Cardiovascular Imaging II: proceedings from the Second American College of Cardiology -- Duke University Medical Center Think Tank on Quality in Cardiovascular Imaging. *JACC Cardiovasc Imaging*. 2009;2(2):231-240.

14. Donabedian A. *Evaluating the quality of medical care. 1966.*; 2005:691–729.

15. Dilsizian V, Arrighi JA, Cohen RS, Miller TD, Solomon AJ, Udelson JE. COCATS 4 Task Force 6: Training in Nuclear Cardiology. *J Am Coll Cardiol*. 2015;65:1800-1809.

Table 1. IAC-Nuclear/PET Requirements for Medical and Technical Directors of Nuclear Cardiology Laboratories

Medical Directors must meet at least one of the following criteria:
- Board certified after 1995 (or Board eligible but within two years of finishing training) in cardiology and completion of a minimum of a four-month formal training program in nuclear cardiology. - Board certified in cardiology before 1995 and training equivalent to Level 2 training or at least one year of nuclear cardiology practice experience with interpretation of at least 800 studies. - Certification in nuclear cardiology by the Certification Board of Nuclear Cardiology. - Board certified (or Board eligible but within two years of finishing training) in nuclear medicine. - Board certified (or Board eligible but within two years of finishing training) in radiology with at least four months of nuclear cardiology training. - Board certified (or Board eligible but within two years of finishing training) in radiology with special competence in nuclear medicine. - Board certified (or Board eligible but within two years of finishing training) in radiology and at least one year (full-time equivalent) of nuclear cardiology practice experience with interpretation of at least 800 studies. - Board certified (or Board eligible but within two years of finishing training) in radiology with at least four months of nuclear medicine training with interpretation of at least 800 nuclear medicine procedures. - Board certified (or Board eligible but within two years of finishing training) in any other relevant medical specialty and at least one year of nuclear cardiology practice experience with independent interpretation of at least 800 nuclear cardiology and/or PET procedures. - If trained before 1995, 10 years of nuclear cardiology, nuclear medicine, and/or PET practice experience with independent interpretation of at least 800 studies within the past 10 years
Technical Directors must meet one of the following criteria:
- Certified Nuclear Medicine Technologist (CNMT, NCT, or PET) - Registered Technologist (Nuclear) RT(N) - A state license to practice as a nuclear medicine technologist if the technical director was appointed prior to January 2010

Adapted from the IAC Standards and Guidelines for Nuclear/PET Accreditation (3).

Table 2. Characteristics of Nuclear Cardiology Laboratories Applying for IAC-Nuclear/PET Accreditation, 2011-2014

	All labs (n=1913)	Grant MPI accreditation decision n=779	Delay MPI accreditation decision n=1134	p-value
Facility Characteristics				
Region				0.002
Northeast	478 (25.0)	203 (26.1)	275 (24.3)	
Midwest	329 (17.2)	160 (20.5)	169 (14.9)	
South	869 (45.4)	318 (40.8)	551 (48.6)	
West	237 (12.4)	98 (12.6)	139 (12.3)	
Hospital based lab, n (%)	232 (12.1)	98 (12.6)	134 (11.8)	0.62
Number of sites, mean (SD‡)	1.72 (3.21)	1.79 (3.68)	1.68 (2.84)	0.21
General Nuclear Medicine and/or PET†, n (%)	175 (9.1)	60 (7.7)	115 (14.8)	0.07
MPI* volume, mean (SD)	1457.58 (1638.33)	1549.5 (1769.28)	1394.5 (1539.58)	0.06
Number of application cycles, mean (SD)	2.82 (1.01)	2.87 (1.02)	2.78 (1.01)	0.12
Consultant used, n (%)	318 (16.6)	166 (21.3)	152 (13.4)	<0.001

Abbreviations: *MPI= myocardial perfusion imaging; †PET= positron emission tomography; ‡SD=standard deviation

Table 3. Characteristics of Nuclear Cardiology Laboratory Staffs (Physician and Technologist) Applying for IAC-Nuclear/PET Accreditation, 2011-2014

	All labs (n=1913)	Grant MPI accreditation decision n=779	Delay MPI accreditation decision n=1134	p-value
Physician Characteristics				
Medical Director years of experience, mean (SD[§])	17.47 (8.34)	17.34 (8.36)	17.55 (8.32)	0.67
Medical director annual number of studies interpreted, mean (SD)	804.20 (1273.8)	746.46 (1273.48)	843.87 (1273.07)	0.06
Medical director with CBNC*, n (%)	1107 (57.9)	491 (63.0)	616 (54.3)	<0.001
Medical director is cardiologist, n (%)	1330 (69.5)	564 (72.4)	766 (67.5)	0.02
Medical Director Compliant with CME[‡], n (%)	1432 (74.9)	664 (85.2)	768 (67.7)	<0.001
MPI[#] volume per MD, mean (SD)	475.79 (409.07)	468.94 (416.16)	485.75 (398.57)	0.92
Number of medical staff, mean (SD)	3.18 (5.04)	3.39 (5.49)	3.03 (4.71)	0.05
Number of CBNC staff, mean (SD)	1.37 (2.50)	1.58 (2.85)	1.22 (2.22)	<0.001
Number of medical staff CME compliant, mean (SD)	2.36 (4.10)	2.83 (4.73)	2.05 (3.58)	<0.001
Technologist Characteristics				
Technical director years of experience, mean (SD)	19.21 (10.12)	19.95 (10.20)	18.71 (10.03)	0.35

Number of technologists, mean (SD)	2.55 (2.85)	2.64 (2.83)	2.49 (2.87)	0.43
Number of technical staff, mean (SD)	1.55 (2.85)	1.64 (2.84)	1.49 (2.87)	0.43
Technical Director Compliant with CME, n (%)	1538 (80.4)	702 (90.1)	836 (73.7)	<0.001
Number of technical staff CE† compliant, mean (SD)	1.26 (2.45)	1.43 (2.57)	1.14 (2.36)	0.01
Technical Director with PET? or NCT¶ plus CNMT§ or RT(N)†, n (%)	166 (8.7)	82 (10.5)	84 (7.40)	0.02
Technical director with (RT[R] ‡, RT[CT]** or RT[MR])* plus CNMT or RT(N), n (%)	284 (14.8)	117 (15.0)	167 (14.7)	0.86

Abbreviations: *CBNC= Certification Board in Nuclear Cardiology; †CE=continuing education; ‡CME=continuing medical education; §CNMT=Certified Nuclear Medical Technologist; ?PET= positron emission tomography; ¶NCT=Nuclear Cardiology Technologist; #MPI= myocardial perfusion imaging; **RT[CT]=Registered Technologist (Computed Tomography); *RT[MR]=Registered Technologist (Magnetic Resonance); †RT[N]=Registered Technologist (Nuclear Imaging); ‡RT[R]= Registered Technologist (Radiology); §SD=standard deviation

Table 4. Impact of lab characteristics and staff training and credentials on MPI accreditation decisions

Characteristic	Adjusted Odds Ratio (95% Confidence Interval)
Number of sites	1.01 (0.97 to 1.05)
Annual lab volume *per 1000 MPI*[#]	1.06 (0.96 to 1.18)
Application cycle (per subsequent cycle)	1.00 (0.91 to 1.11)
Consultant assistance with application	1.94 (1.49 to 2.53)
Hospital facility	1.08 (0.75 to 1.57)
Doing GNM[′] and/or PET[¶] oncology/neurology	0.89 (0.58 to 1.37)
Medical director with CBNC* status	1.28 (1.03 to 1.58)
Cardiovascular pathway of medical director	1.03 (0.82 to 1.29)
Medical director compliant with CME[‡]	1.97 (1.53 to 2.54)
Volume of studies interpreted by medical director, quartiles	
0 to 300	Referent
301 to 500	1.21 (0.92 to 1.60)
501 to 900	1.03 (0.78 to 1.36)
901+	0.75 (0.55 to 1.03)
Number of medical staff	0.82 (0.75 to 0.89)
At least 50% of medical staff with CBNC	1.06 (0.85 to 1.31)
Number of medical staff compliant with CE[†]	1.28 (1.16 to 1.42)
Technical director with NCT** or PET versus CNMT[§] or RT(N)*	1.49 (1.06 to 2.10)
Technical director compliant with CE	2.48 (1.86 to 3.31)
Number of technical staff	0.91 (0.80 to 1.04)
Number of technical staff compliant with CE	1.12 (0.97 to 1.29)

Abbreviations: *CBNC= Certification Board in Nuclear Cardiology; [†]CE=continuing education; [‡]CME=continuing medical education; [§]CNMT=certified nuclear medical technologist; [?]GNM=general nuclear medicine; [¶]PET= positron emission tomography; [#]MPI= myocardial perfusion imaging; [**]NCT=Nuclear Cardiology Technologist; *RT[N]=Registered Technologist (Nuclear imaging)

Table 5. Impact of lab characteristics and staff training on IAC-Nuclear/PET review deficiencies in Protocols and Reporting

Characteristic	Adjusted Odds Ratio for Deficiency in Protocols (95% Confidence Interval)	Adjusted Odds Ratio for Deficiency in Reporting (95% Confidence Interval)
Number of sites	1.06 (0.96 to 1.19)	1.08 (1.02 to 1.13)
Annual lab volume *per 1000 MPI***	0.93 (0.84 to 1.02)	0.95 (0.86 to 1.04)
Application cycle (per subsequent cycle)	1.07 (0.96 to 1.19)	1.00 (0.91 to 1.10)
Consultant assistance with application	0.55 (0.41 to 0.73)	0.63 (0.48 to 0.81)
Hospital facility	1.24 (0.85 to 1.82)	0.78 (0.54 to 1.13)
Doing GNM[ʹ] and/or PET[¶] oncology/neurology	1.70 (1.12 to 2.56)	0.99 (0.66 to 1.49)
Medical director with CBNC* status	0.88 (0.71 to 1.09)	0.78 (0.63 to 0.95)
Cardiovascular pathway of medical director	0.99 (0.79 to 1.24)	0.82 (0.66 to 1.02)
Medical director compliant with CME[‡]	0.55 (0.44 to 0.69)	0.64 (0.51 to 0.80)
Volume of studies interpreted by medical director, quartiles		
0 to 300	Referent	Referent
301 to 500	0.87 (0.65 to 1.16)	0.91 (0.70 to 1.20)
501 to 900	0.98 (0.74 to 1.30)	0.93 (0.71 to 1.22)
901+	1.51 (1.12 to 2.03)	1.09 (0.81 to 1.45)
Number of medical staff	1.16 (1.08 to 1.24)	1.04 (0.97 to 1.11)

At least 50% of medical staff with CBNC	0.85 (0.68 to 1.06)	0.90 (0.73 to 1.11)
Number of medical staff compliant with CME	0.84 (0.77 to 0.91)	0.94 (0.87 to 1.02)
Technical director with NCT[#] or PET versus CNMT[§] or RT(N)*	0.79 (0.55 to 1.13)	0.67 (0.47 to 0.95)
Technical director compliant with CE[†]	0.56 (0.44 to 0.72)	0.53 (0.41 to 0.67)
Number of technical staff	0.92 (0.81 to 1.04)	1.00 (0.90 to 1.11)
Number of technical staff compliant with CE	1.06 (0.92 to 1.21)	0.98 (0.87 to 1.11)

Abbreviations: *CBNC= Certification Board in Nuclear Cardiology; [†]CE=continuing education; [‡]CME=continuing medical education; [§]CNMT=certified nuclear medical technologist; [?]GNM=general nuclear medicine; [¶]PET= positron emission tomography; [#]NCT=Nuclear Cardiology Technologist; **MPI= myocardial perfusion imaging; *RT[N]=Registered Technologist (Nuclear imaging)