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Defining the PACS Profession: An Initial Survey of Skills, Training, and Capabilities for PACS Administrators

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The need for specialized individuals to manage picture archiving and communications systems (PACS) has been recognized with the creation of a new professional title: PACS administrator. This position requires skill sets that bridge the current domains of radiology technologists (RTs), information systems analysts, and radiology administrators. Health care organizations, however, have reported difficulty in defining the functions that a PACS administrator should perform—a challenge compounded when the tries to combine this complex set of capabilities into one individual. As part of a larger effort to dene the PACS professional, we developed an extensive but not exclusive consensus list of business, technical, and behavioral competencies desirable in the dedicated PACS professional. Through an on-line survey, radiologists, RTs, information technology specialists, corporate information officers, and radiology administrators rated the importance of these competencies. The results of this survey are presented, and the implications for implementation in training and certication efforts are discussed.

KEY WORDS: PACS administrator, PACS, radiology management, information systems management

INTRODUCTION

The introduction of picture archiving and communications systems (PACS) into the radiology workplace was among the most important motivators in ushering in the digital revolution in medical imaging. This revolution changed not only the manner in which images were acquired, transmitted, stored, and interpreted, but profoundly altered the tasks associated with professional roles. Technologists acquired new skills, radiologists learned novel ways of interacting with images and reporting findings, and radiology administrators faced unfamiliar challenges in integrating information technology (IT) specialists into the ongoing work of the department. It soon became clear that the routine use of PACS in digital imaging called for a new and dedicated profession—the PACS administrator.

This position requires skill sets that bridge the current domains of radiology technologists (RTs), information systems analysts, and radiology administrators. The importance of the PACS administrator to the smooth and effective functioning of an imaging department or practice has been emphasized in both peer-reviewed literature and the medical press.[1–10] Health care organizations, however, have reported difficulty in defining the functions that a PACS administrator should perform—a challenge compounded when the search begins for those individuals with this complex set of capabilities. The result has often been the creation of site- and vendor-specific PACS administrative positions that function well

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enough on a day-to-day basis, but fail to contribute to or build on the possibilities inherent in creating a new professional identity.

At the same time, several organizations and private providers have begun to offer courses or training modules on PACS administration. Pioneered by the annual Society for Computer Applications in Radiology (SCAR) PACS Administration courses offered before the society's annual meetings,[11] such instruction is now offered at settings that include colleges, technical schools, vendor venues, and special conferences.[12–18] Yet, close inspection of the subject matter offered reveals a wide range of foci and suggests a lack of agreement (and in some cases frank disagreement) on appropriate tasks for PACS administrators and requisite training and preparation.

Even those individuals already practicing as PACS administrators bring diverse and sometimes divergent perspectives on the range and extent of their domain. Some current PACS administrators began their careers as RTs or radiology administrators and share understanding of daily imaging needs with their clinical colleagues. Others come from IT backgrounds and are more closely allied with the vocabularies and work processes of information and data specialists. Radiology technologists and radiology administrators understand departmental workflow and routine use of applications but may be unfamiliar with project management and systems management principles. Information systems analysts may have project management training and are competent with infrastructure and systems administration but may have trouble operationalizing these skills in real-time, real-world clinical use.

The capabilities needed for a successful PACS administration go beyond those conventionally included in the position descriptions of RTs, radiology administrators, or IT specialists. The PACS administrator must also have business know-how, including managerial training, as well as a not inconsiderable ability to deal effectively with a wide range of individuals—from patients to administrators—each with his or her own interests, investments, and agenda.

Several authors have noted the need to define the skills and tasks associated with PACS administration.[19–24] As part of a larger effort to define a professional framework and identify appropriate training and preparation for this position, we developed an extensive, but not exclusive, consensus list of competencies desirable in the dedicated PACS professional. After seeking input from a small but diverse on-line segment of the radiology and imaging informatics community, we rated these competencies by perceived importance. The results are presented here not as complete or definitive but as the beginning of a framework on which a generally agreed-upon definition of the PACS professional can be built. It is hoped that these lists will serve as an impetus for feedback and further discussion as we continue to refine approaches to training and certification for this pivotal member of the PACS team.

MATERIALS AND METHODS

The initial challenge for our research was how to approach the construction of a framework for understanding the body of knowledge and competencies a PACS administrator needs to successfully plan, implement, and support a PACS system in the clinical environment. Four experienced imaging informatics professionals [an academic radiologist, a private practice radiologist, a diagnostic medical physicist, and an ex-chief information officer (CIO)] used the information systems team model recommended by Gartner Group (Stamford, CT, USA). The Gartner model was generated outside of health care and has been used to build successful IT organizations.[25] This model segments professional competencies into three areas: behavioral, business, and technical. The model seemed especially appropriate because each area of competency corresponds with an educational profile of RTs, radiology administrators, or IT specialists who currently work as PACS administrators.

Behavioral, Business, and Technical Competencies

Behavioral competencies focus on workflow and skills engaged when working closely with all end users. An RT would most likely have strong behavioral competencies. Examples of behavioral-associated tasks include participating in reading room design, conducting training classes for physicians, and working with technologists to eliminate workflow steps by using advanced features in the PACS.

Business competencies would be more likely found in an administrator with training in and understanding of project management and organizational strategic vision. Typical administrative-associated tasks include developing project implementation plans, establishing benchmarks for measuring performance, developing return-on-investment analyses, and securing buy-in from organization leadership.

Technical competencies would be those most closely associated today with the systems administrator or information technologist who understands the technology and supports PACS as a mission-critical information system. Typical tasks

within these competencies include Digital Imaging and Communications in Medicine (DICOM) and Health Level 7 (HL7) troubleshooting when integrating new modalities, developing protocols for disaster recovery, monitoring system performance, and continuously assessing performance and capacity while planning for future growth.

Listing Tasks and Roles

Using these three competencies and the range of knowledge each represents, we attempted to identify the various roles needed in the planning, implementation, and operation of PACS (Fig 1). Within these distinct areas, we listed tasks and topics in which proficiency should be demonstrated by the dedicated PACS administrator. The result was a list of 127 tasks organized under 15 roles based on the three competencies. Our approach in devising this list was admittedly *ad hoc*, drawing on our own diverse experience with PACS implementation, on published reports, and on informal exchanges with PACS administrators and other radiology professionals. The list is long but by no means constitutes a complete or exhaustive summary of potential PACS administrator competencies.

It is unlikely that one individual could demonstrate competency in all of the roles or tasks listed here. In smaller facilities, the "PACS administrator" position might be filled satisfactorily by a technologist who handles the day-to-day operation of the system. A single administrator would need to be supported by the director of radiology or the IT department for business and technical tasks. In larger organizations, all of the roles listed here might be found distributed among the members of a PACS administration team. It is important to note that this model does not address the number of individuals necessary to support a PACS—this number will vary with patient load, size of institution, size and distribution of staff members, extent of integration with hospital and radiology information systems, and other factors.

Assessing the Model through an Informal Survey Instrument

To assess the tasks included in our initial model, a needs assessment survey was compiled and designed for completion on the Internet. A web site was constructed on a Red Hat Linux server (Red Hat, Inc., Raleigh, NC, USA) operating system using the Apache Web server (Apache Software Foundation, Forest Hill, MD, USA) to serve up the web pages. PHP, an open-source, server-side, HTML-embedded scripting language, was used to create dynamic web pages and send the responses into the database. MySQL, an open-source relational database management system, was used as the back end to record and tabulate results.

The questionnaire rated each task on a 7-point Likert scale, with 1 as the lowest and 7 as the highest priority. Descriptions of the survey and invitations to take the questionnaire were posted on the SCAR web site and in the on-line discussion group communities of Auntminnie.com and ClubPACS.com. The announcement was also sent to the Yahoo PACS Administrators mailing list. Through these venues, we invited individuals from across the PACS community to complete the questionnaire, and to provide information about their professional roles, educational backgrounds, years of experience, and affiliation with professional organizations. The questionnaire was lengthy, with pretesting indicating that more than 15 min were needed to complete the entire instrument. Session variables and Internet Protocol address tracking were used to ensure that no individual submitted the questionnaire more than once from the same location (although the length of the questionnaire was probably a sufficient deterrent for potential repeat participants).

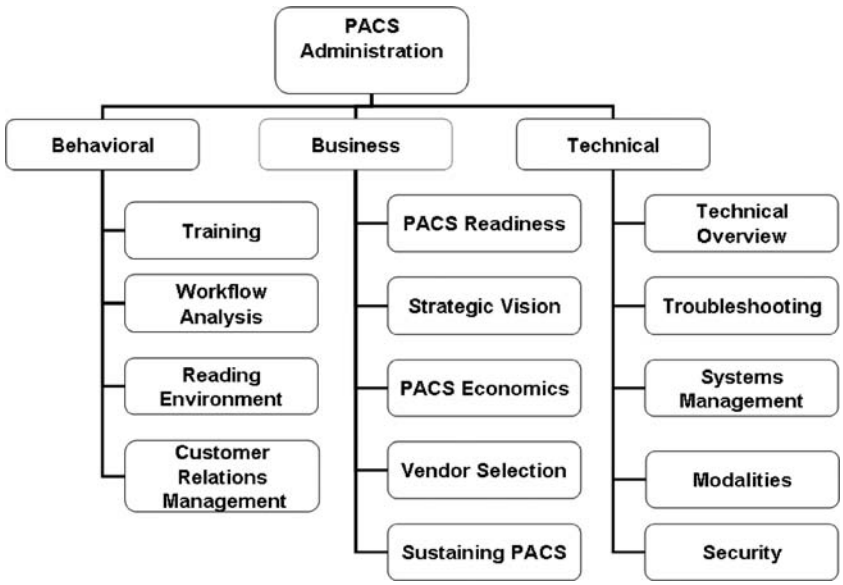

Fig 1. The competency framework for PACS administration.

Table 1. Survey participant information

Profession	Sample count	Academic degree/training				Professional affiliations					PACS admin.[a]
		ARRT	BS	MS	MBA	AHRA	ASRT	HIMSS	RSNA	SCAR	
Radiologist	5								5	5	1
Administration	36	18	20	4	3	9	10	2	8	16	27
Information systems	50	16	31	8	2	2	9	1	2	23	47
Physicist	4		2	2					1	3	1
Vendor	5		2	4	1	1		2	1	3	1
CIO	1				1	1					
Technologist	22	20	8			2	10		1	10	18

[a]Has responsibilities for PACS administration as part of current duties.

ARRT = American Registry of Radiologic Technologists; BS = bachelor of science or equivalent; MS = master of science or equivalent; MBA = master of business administration; AHRA = American Healthcare Radiology Administrators; ASRT = American Society of Radiologic Technologists; HIMSS = Healthcare Information and Management Systems Society; RSNA = Radiological Society of North America; SCAR = Society of Computer Applications in Radiology; CIO = corporate information officer.

More than 125 people completed the survey on-line. We received responses from radiologists, administrators, technologists, information system analysts, CIOs, and physicists. The on-line format eliminated printing and mailing costs and facilitated rapid aggregation of results. The database system tracked answers and enabled automatic tabulation of results so that data analyses were available at any point during the collection process and so that the database could be queried to answer a variety of questions.

RESULTS

Table 1 describes the individuals who responded to the survey, including their current professional roles, certification or academic degree, and professional society affiliations. The final column indicates whether or not individuals had PACS administration responsibility in their current role. The largest single group represented in the survey was information systems professionals. This raises the methodological concern that an on-line survey approach may give false weight to the IT community. Any extensions or sequel surveys should make efforts to reach those without web access. However, more than half of our respondents held American Registry of Radiologic Technologist certification (and so were well within the radiology community), and most technologists who are PACS administrators should have reasonable access to the Web at work or at home for future surveys.

Table 2 represents the survey results for each broad subheading under the three PACS administrator competencies. All of the competencies were

Table 2. Survey results for each group of PACS administrator competencies

Competency	Role	Sample count	Range	Average	SD
Behavioral	Workflow engineering	1,646	1–7	5.6950	1.1265
	Customer relations management	762	1–7	5.6877	1.1870
	Reading environment	1,138	1–7	5.3998	1.2911
	Training	1,391	1–7	5.2840	1.4083
Business	Strategic vision	1,094	1–7	5.8985	1.0358
	Vendor selection	734	1–7	5.8202	1.1939
	Sustaining PACS	982	1–7	5.8075	1.0759
	Project management	1,204	1–7	5.7367	1.1591
	PACS readiness	743	1–7	5.5585	1.2820
	Economics of PACS	743	1–7	5.3419	1.3213
Technical	Modalities	370	2–7	6.1595	0.8816
	Systems management	1,721	1–7	5.9436	0.9932
	Troubleshooting	614	1–7	5.7508	1.1827
	Technology overview	1,848	1–7	5.7208	1.1214
	Security	747	1–7	5.4913	1.2227

ranked high, and only a few tasks were viewed as nonessential. The highest ranked behavioral roles were customer relations management and workflow engineering. The highest ranked business roles were developing strategic vision and sustaining the PACS. The highest ranked technical roles were modality integration and systems management. The lowest ranking roles for these competencies were training (behavioral), PACS readiness assessment (business), and PACS basics overview (technical). It is significant that these were perhaps the most poorly defined of the roles and, therefore, may have been deemed less essential by survey participants.

Tables 3, 4, and 5 tabulate the detailed results for all 127 tasks in the behavioral, business, and technical competencies, respectively. The majority of tasks received high average ratings between 5 and 6. Only 11 of the 127 tasks averaged below 5 and 28 tasks averaged above 6. The highest average rating in the behavioral competencies was given to the ability to secure physician acceptance

Table 3. Survey rankings of behavioral competencies for PACS administration[a]

Role	Task	Sample count	Range	Average	SD
Training	Developing user training programs	127	3–7	6.1969	0.9724
	Customizing worklist management	127	2–7	5.8898	1.0289
	Configuring hanging protocols	127	2–7	5.8189	1.1666
	Technologist training	125	1–7	5.8000	1.1662
	Understanding HIPAA privacy	127	1–7	5.6142	1.2984
	Learning influencing skills	127	1–7	5.3150	1.1203
	Constructing reference cards	126	1–7	5.1587	1.1644
	Developing tools for infrequent users	126	1–7	4.8016	1.3802
	Implementing speech recognition	127	1–7	4.7638	1.4713
	Creating computer based training	126	1–7	4.5079	1.5366
	How to get CME credit for training program	126	1–7	4.2460	1.5207
Workflow engineering	Radiologist workflow	127	4–7	6.2520	0.7834
	Workflow analysis	127	1–7	6.0866	1.0797
	Technologist workflow	127	3–7	5.9528	0.8772
	Modality workflow analysis	127	2–7	5.8504	1.0124
	The role tech has in quality control	126	1–7	5.8413	1.1013
	The workflow of unidentified patients	125	3–7	5.8320	1.0713
	Physician workflow	127	3–7	5.6535	0.9588
	Technologist/radiologist interactions	126	3–7	5.6190	1.0530
	Radiologist/physicist interactions	127	2–7	5.5354	1.0997
	Integrating the Healthcare Enterprise	127	1–7	5.4646	1.2282
	Efficiency engineering	127	1–7	5.4409	1.2899
	Fundamentals of image processing	127	1–7	5.2835	1.2030
	Policies for wet reads	126	1–7	5.2222	1.2529
Reading environment	RIS–PACS dictation integration	126	1–7	5.9365	1.2198
	Usability analysis	127	3–7	5.7087	1.0126
	Workstation design in/out radiology	127	2–7	5.6693	1.0276
	Ergonomics	126	1–7	5.5635	1.1304
	Reading room design	126	1–7	5.5635	1.1717
	Understanding the role of ambient lighting	127	1–7	5.4961	1.3391
	Assessing environmental factors	126	1–7	4.9841	1.2970
	Designs to minimize background noise	127	1–7	4.8976	1.4299
	Temperature control	126	1–7	4.7778	1.3910
Customer relations management	Getting physician acceptance	127	2–7	6.2677	0.9676
	Initial user troubleshooting	127	3–7	6.1496	0.8519
	Understanding change management	127	3–7	5.7559	0.9938
	Dealing with hostile users	127	1–7	5.4882	1.2158
	Overcoming psychological barriers	127	1–7	5.2598	1.2872
	Conducting vendor management	127	1–7	5.2047	1.2880

[a]Items are listed by ranking, from the highest to the lowest in each category; items appeared in a different order on the original questionnaire.

Table 4. Survey rankings of business competencies for PACS administration[a]

Role	Task	Sample count	Range	Average	SD
PACS readiness	Defining objective	124	3–7	6.0323	0.9832
	Identifying key stakeholders	124	1–7	5.9194	1.1954
	Conducting a needs assessment survey	124	1–7	5.7016	1.2571
	Understanding the CIO perspective	123	1–7	5.4553	1.1979
	Understanding risk aversion	124	1–7	5.3790	1.1886
	PACS consultants	124	1–7	4.8629	1.4610
Strategic vision	PACS champion	122	1–7	6.2213	1.1417
	Getting leadership buy-in	122	1–7	6.1557	1.0637
	Understanding your staffing needs	122	4–7	6.0164	0.8296
	Project strategy	122	4–7	5.9918	0.8541
	Integrating the Healthcare Enterprise	121	2–7	5.7851	1.1586
	Vision of the electronic patient record	122	2–7	5.7541	1.0660
	Building strategic and operational committees	120	2–7	5.7500	0.9937
	Constructing a budget	121	1–7	5.7107	1.0240
	How to develop service level agreements	122	1–7	5.6967	0.9825
Economics of PACS	Continual innovation	124	1–7	5.7823	1.1469
	Total cost of ownership	123	1–7	5.5447	1.2575
	Conducting a return on investment analysis	124	1–7	5.4274	1.3209
	Economics issues	124	1–7	5.3387	1.1906
	Understanding software-only model	124	1–7	5.0968	1.2275
	Understanding application service provider model	124	1–7	4.8629	1.5415
Vendor selection	Vendor support	123	2–7	6.3577	0.8938
	Building a good vendor relationship	122	1–7	6.1230	1.0525
	Contract negotiation	123	1–7	5.9268	1.1768
	Developing a request for proposal	122	1–7	5.5164	1.3443
	Benchmarking	122	1–7	5.5164	1.1106
	Building a comparison matrix	122	1–7	5.4754	1.2362
Project management	Communication planning	121	4–7	6.1901	0.8654
	Managing expectations during implementation	120	1–7	6.0250	1.0365
	Measuring the success of PACS	122	2–7	5.9508	0.9654
	Project management 101	120	1–7	5.9083	1.1401
	Identifying risks	121	3–7	5.8926	0.9774
	Marketing to the enterprise	122	1–7	5.8115	1.1897
	Performance milestones	121	1–7	5.6446	1.1561
	Risk management plan	121	1–7	5.6198	1.1801
	Critical path determination	119	1–7	5.3950	1.2517
	Gantt chart	117	1–7	4.8974	1.2292
Sustaining PACS	Policies and procedures	123	2–7	5.9675	0.9622
	Retaining PACS professionals	122	1–7	5.9672	1.0475
	Continual improvements	123	1–7	5.8943	1.0654
	Developing user support policies	123	1–7	5.8293	0.9432
	HIPAA regulatory	123	1–7	5.8049	1.1939
	Continuing education	123	1–7	5.7886	1.1565
	Knowledge transfer policies	122	1–7	5.6639	0.9802
	Recruiting PACS professionals	123	1–7	5.5447	1.1565

[a] Items are listed by ranking, from the highest to the lowest in each category; items appeared in a different order on the original questionnaire.

(6.2677). The highest average rating in the business competencies went to the ability to secure and sustain vendor support (6.3577). The highest average rating in the technical competencies was given to the ability to perform proactive system support (6.4426). Perhaps not surprisingly, some of the lowest rated tasks corresponded to those that can be obtained routinely through contracts or purchases: finding out about continuing medical education programs for staff (behavioral; 4.2460), identifying PACs consultants and understanding the applications service provider model (business; tied at 4.8629), and managing wireless considerations (technical; 4.6748).

Table 5. Survey priority rankings of technical competencies for PACS administration[a]

Role	Task	Sample count	Range	Average	SD
Technology overview	Workstations and displays	123	4–7	6.1789	0.8557
	Web distribution	124	3–7	6.1290	0.8325
	DICOM standard	123	2–7	6.0813	1.0248
	Image quality and the role of QA/QC	123	4–7	6.0325	0.9190
	Networking overview	123	3–7	6.0081	0.8880
	Storage technology overview	123	3–7	5.9350	0.9260
	Integrating the Healthcare Enterprise	124	2–7	5.7581	1.1665
	Archiving architecture and policy analysis	123	3–7	5.7236	0.9483
	Health Level Seven standard	122	1–7	5.7049	1.1358
	Server architecture overview	124	2–7	5.6371	1.0575
	Architectural considerations	123	3–7	5.6341	0.9734
	Ongoing technology assessment policies	122	2–7	5.6148	0.9272
	Teleradiology	124	3–7	5.5565	1.0947
	Speech recognition	124	2–7	5.1452	1.2744
	Wireless considerations	123	1–7	4.6748	1.5434
Systems management	Proactive system support	122	4–7	6.4426	0.7134
	Recoverability policies	123	4–7	6.3740	0.7902
	24/7 operation policies	124	3–7	6.3065	0.8345
	Performance monitoring	122	4–7	6.1803	0.8200
	Quality assurance	123	3–7	6.1789	0.8929
	Developing good problem management policies	123	4–7	6.1707	0.8136
	Vendor relationship	123	4–7	6.0244	0.8211
	Understanding availability monitoring	122	4–7	5.8852	0.8415
	Understanding configuration management	124	2–7	5.8226	1.0476
	Analysis for capacity planning	123	3–7	5.7561	0.9823
	System upgrade policies	124	3–7	5.7339	0.9597
	Change management	123	1–7	5.5772	1.0821
	Asset management	123	3–7	5.4228	0.9457
	Basics of relational databases and SQL	122	1–7	5.3361	1.3466
Troubleshooting	Windows administration	124	2–7	6.0806	0.9967
	Network administration	123	2–7	5.8699	0.9956
	DICOM gap analysis	122	2–7	5.7787	1.0598
	Remote control tools	124	1–7	5.7097	1.2033
	Unix administration	121	1–7	5.3058	1.4593
Modalities	Integration with PACS via DICOM/IHE	123	2–7	6.3984	0.8529
	Capacity planning	123	3–7	6.1626	0.8398
	Understanding support policies	124	2–7	5.9194	0.8853
Security	Understanding HIPAA security and auditing	125	1–7	5.8160	1.2092
	Overview of virtual private networking	125	2–7	5.6480	1.0296
	Basics of intrusion detection	123	2–7	5.5935	1.2352
	Single sign-on architectural understanding	125	2–7	5.5520	1.1625
	Basics of encryption technologies (PGP)	124	1–7	5.3145	1.1098
	Overview of biometric verification tools	125	1–7	5.0240	1.3941

[a] Items are listed by ranking, from the highest to the lowest in each category; items appeared in a different order on the original questionnaire.

CONCLUSION

Our staffing model of the roles and tasks necessary for a successful implementation and operation of PACS provides an overview and framework for iteration and elaboration. The initial on-line survey indicates that many of these roles and tasks are, in fact, perceived by individuals already working with PACS on a routine basis to be significant elements in the position requirements and training for PACS professionals. Moreover, although the overwhelming majority of these tasks were rated highly, it is possible to identify skills more highly valued than others. Among the initial findings is the suggestion that interpersonal skills (such as securing physician

buy-in and vendor support) are much more highly valued than those tasks that can be purchased or contracted for on an *ad hoc* basis (such as consultation on wireless installation or identifying PACS consultants). It should be noted that many of the skills valued most highly depended on a broad knowledge of several fields, again emphasizing the place of the PAC administrator at the nexus of several professional domains. As we work to refine this framework as the basis for a curriculum in PACS to train individuals to fill these roles and become a part of the PACS administration profession, we will refine the model and its elements with others in the field who may want to adapt it for position descriptions, continued education planning, or self-assessment tools for PACS administrators who want to add to their expertise.

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