Published in final edited form as:

J Am Coll Radiol. 2011 January ; 8(1): 39–48. doi:10.1016/j.jacr.2010.07.007.

Policies and Procedures for Reviewing Medical Images From Portable Media: Survey of Radiology Departments

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Abstract

Purpose—The purpose of this study was to survey current practices for portable media (CDs and DVDs) use for medical imaging in both academic and nonacademic radiology departments in the United States.

Methods—This survey was a stratified, nonrandom sample, 22-question electronic survey, using SurveyMonkey, of members of the Association of Administrators in Academic Radiology, the Association for Medical Imaging Management, and the University HealthSystem Consortium, conducted in November 2009. Questions were grouped by media production and media viewing practices.

Results—One hundred and two individual responses to the survey were received. Ninety-eight percent of respondents said that their institutions produced Digital Imaging and Communications in Medicine (DICOM)-compliant media, with only 2.0% uncertain. Only 22.2% of respondents claimed that their institutions produced Integrating the Healthcare Enterprise (IHE) Portable Data for Imaging (PDI)-compliant media, while 71.6% were uncertain. Rates of DICOM and IHE PDI compliance did not differ between academic and nonacademic centers. As for testing digital media produced at the institutions for DICOM and IHE PDI compliance, only 16.0% of respondents' institutions routinely did so.

Conclusions—Three main problem areas regarding portable media became evident from this study: (1) access, (2) importability, and (3) viewing issues, and problems with any of the 3 can delay patient care. Noncompliance and a lack of knowledge about compliance were found to be major issues in the present study, more so for IHE PDI than for DICOM, and there is much room for improvement. Recommendations include that radiology practices should routinely generate only media compliant with DICOM and IHE PDI and should test for compliance.

Keywords

DICOM; IHE; portable media; CD; DVD; medical imaging

INTRODUCTION

Because of the multitude of user interface software applications, file formats, hardware configurations, security settings, and types of media in use today, review of outside medical imaging delivered on portable media may be a burdensome or problematic venture in many instances, to radiologists and to clinicians from other specialties. Many radiologists receive assistance for viewing images on portable media through the IT infrastructure in their departments, and this expertise may or may not be available or exist for referring providers. Review of outside imaging brought by patients on various media (CDs, DVDs) may be problematic to referring providers and radiologists alike for several reasons [1,2]: (1) some media may contain images in proprietary file formats, which mandate specialized (often proprietary) viewers for display, which need to be embedded on the media; (2) the proprietary viewer user interface may be unfamiliar to the provider (radiologist or otherwise) and thus may be cumbersome to navigate; (3) desktop computer security measures in place at some institutions prohibit the auto-load functionality of many of these portable medical imaging media or restrict the running of unapproved software applications; and (4) rendering images from a CD or DVD can be slow and interfere with the normal clinical workflow.

Purpose of the Survey

Considering the multitude of potential obstacles to the efficient distribution and review of medical imaging on portable media, we set out to explore the experience, policies, and procedures in imaging departments with regard to receiving outside and generating inside examinations on both CDs and DVDs. The purpose of this survey was to obtain data on the current experiences and practices for handling portable media (for medical imaging) in both academic and nonacademic radiology departments in the United States.

METHODS

This survey was a stratified, nonrandom sample electronic survey of members of the Association of Administrators in Academic Radiology (n = 93), the Association for Medical Imaging Management (n = 510), and the University HealthSystem Consortium (n = 239) conducted in early November 2009 over a time period of 2 weeks. Respondents were promised confidentiality, though institution name was requested to help detect any overlap in memberships (ie, duplicate entries). All duplicate entries were excluded, and only one entry was allowed per institution. The strata analyzed were academic and nonacademic radiology departments.

An e-mail message from the investigators with a link to the Web survey was sent to 842 members of the above associations with known e-mail addresses via a list server. There was no paper or nonelectronic component to the survey. An e-mail reminder was sent to e-mail sample nonrespondents 1 week after opening the survey and again 2 days before closing the survey (day 12). Follow-up phone calls were not made.

The survey instrument was a 22-question online questionnaire implemented through the SurveyMonkey online survey tool (SurveyMonkey, Portland, Oregon). The questions were

designed by a team of 3 investigators and revised several times before the administration of the instrument to ensure question clarity and utility. Questions were grouped into two categories: questions pertaining to the production of portable media for image distribution outside of the imaging center and those focusing on the review process of imaging data delivered on portable media from outside institutions. Questions were designed to screen for current experiences and practices regarding the use of portable media in both academic and nonacademic radiology practices. In total, 102 responses (response rate, 12.1%) to the survey were received over the period of 2 weeks in November 2009, each from a different institution.

All statistical analysis was performed with Stata version 11.0 (StataCorp LP, College Station, Texas). Data were kept in two main categories: academic practices and nonacademic practices. Analysis was performed comparing responses from these two groups to determine if there were different experiences and practices between these types of enterprises. *P* values were obtained from *z* tests for two proportions, with a significance level of .05.

RESULTS

Respondent and radiology institution characteristics are summarized in Table 1. Respondents fell into the following US census regions: 19.6% from the Northeast, 35.3% from the Midwest, 29.4% from the South, and 15.7% from the West. Of the 102 respondents, 58% were from academic centers, 20.5% were from hospital-based private practices, 3.4% were from private practice outpatient clinics, and 18.2% were from both hospital-based and outpatient clinic-based private practices. The respondents to the survey were mostly PACS administrators (71.2%), IT managers (5.0%), or radiology practice administrators (21.8%). Table 2 presents a condensed summary of the 22 survey questions asked of respondents.

In terms of compliance when producing portable media for image distribution outside of the imaging center, 98.0% of respondents claimed that portable digital media produced at their institution were Digital Imaging and Communications in Medicine (DICOM) compliant, with only 2% uncertain. Comparatively, as for compliance with Integrating the Healthcare Enterprise (IHE) Portable Data for Imaging (PDI), only 22.2% of respondents claimed that their institutions produced compliant media, while 71.6% were uncertain, a very high proportion compared with uncertainty about DICOM compliance. These results are depicted in Figure 1.

As for compression and encryption of imaging on portable media, 27.3% of respondents said that their institutions do use compression, while 55.6% do not, and only 8.0% of institutions use encryption, while 74.0% do not (Figure 2). Notably, the 3 most common reasons respondents cited, in order of frequency, for why outside portable media are not readable or accessible were (1) non-DICOM-format incompatible imaging files; (2) corrupt discs, due to scratches, failed data writing, or other reasons; and (3) the onboard image viewer does not auto-run and cannot be executed. Out of 188 individual reasons cited, 69 (36.7%) were related to non-DICOM-format incompliance. As for testing digital media produced at the

institution for DICOM and IHE PDI compliance, only 16.0% of respondents' institutions routinely did so, while 49.0% did not and 35.0% were uncertain. These results are depicted in Figure 3.

In terms of handling outside imaging data delivered on portable media, official policies or methods for managing outside media (CDs or DVDs) were in place at 72.5% of responding institutions, while 26.5% did not have official policies. Of note, only 60.8% of respondents claimed that most (75%–100%) outside digital media were readable or importable. However, the majority of respondents (52.9%) felt that <10% of patients underwent repeat imaging examinations because of malfunctioning or inaccessible media. The distribution of responses is shown in Figure 4.

The respondents were split on the issue of whether particular modalities (x-ray, CT, MRI, etc) were more problematic when importing imaging data, with many claiming that the problems with digital media did not seem modality specific but rather software dependent. Importantly, 20.5% of respondents noted that their institutions blocked auto-run or executable files because of heightened security, while the other 79.5% allowed such files on any workstation (43.6%) or on designated workstations (35.9%).

Most institutions (76.5%) included in the responses import data into local PACS when distributing data for medical consultations within their home institutions. In the operating room, access to imaging from portable media was provided by PACS at 79.1% of the institutions, and 38.5% also had workstations that could execute the viewers bundled on the portable media. Some respondents, however, noted that they would not risk corrupting their operating room PCs with outside imaging data on portable media.

When respondents were asked about the most common complaints from physicians regarding the use of portable digital media from outside institutions, the 3 most common responses were, in order of frequency: (1) inability to load images from proprietary formats, (2) lack of familiarity with the onboard viewing software, and (3) the amount of time it takes to load the portable media and get the viewer running, with the studies loaded and ready to be manipulated. Other problems frequently encountered were (1) poor image quality, (2) incomplete studies or images that are snapshots or screen captures, (3) wrong or missing studies on the portable media, and (4) images that cannot be manipulated.

Table 3 summarizes the responses from the radiology practices classified as academic (n = 51) and those classified as nonacademic (n = 37). In terms of the method of handling outside imaging data, 86.3% of academic centers reported having official policies, and 13.7% reported not having official policies, while 62.2% of non-academic centers reported having official policies, and 37.8% reported not having official policies ($P = .009$ for both comparisons). In terms of customer services offered by the two groups, the only significant difference was the proportion that reported importing outside institution data from media at academic centers (94.1%) vs nonacademic centers (67.6%). Other customer services were offered equally between the two types of practices.

The percentage of outside media that were readable or importable, when asked categorically as <10%, 10% to 25%, 26% to 50%, 51% to 75%, or 76% to 100%, did not differ between

type of radiology practice. Interestingly, nonacademic centers reported more confidence that a very small percentage of patients (<10%) underwent repeat examinations because of malfunctioning or inaccessible data, which was of borderline significance ($P = .052$).

No particular imaging modality was noted to be more problematic than others when importing images, and no differences existed between academic and nonacademic centers. We also found that nonacademic centers were significantly more likely to allow review of imaging data on individual workstations with the native viewer bundled on the media (48.6% vs 28.0% at academic centers). Academic centers seemed to be more likely to import data into local PACS than nonacademic centers (86.0% vs 68.6% at nonacademic centers), though this result was not statistically significant ($P = .066$).

The methods used to provide access to imaging provided on portable media in the operating room were not different between the two groups. Rates of compliance with DICOM and with IHE PDI did not differ between academic and nonacademic centers. The use of compression on media produced by institutions did not differ between academic and nonacademic centers, but nonacademic centers seemed to be slightly more likely (8.3%) to use encryption on media produced by their institutions than academic centers (3.9%), which was not significant ($P = .063$).

The responses showed that nonacademic centers were significantly more likely to skip testing discs they produced for DICOM and IHE PDI compliance (63.9% vs 43.1% at academic centers).

DISCUSSION

To understand the barriers to efficient imaging transfer and viewing seen in the present study, some background information and a historical perspective are needed. Subtle variations in imaging formats between make, model, and modality create a technical nightmare for manufacturers who are forced to develop custom interfaces to read each new imaging format. To address the standardization of medical image handling, the ACR and the National Electrical Manufacturers Association in 1983 created a standard method for transmitting medical images and associated information through a standardized format, now called the DICOM standard. The DICOM standard was developed to solve inherent problems of transmitting and receiving digital medical images between incompatible imaging devices. Since its inception, DICOM has grown to incorporate a wide spectrum of medical imaging from other specialties, such as cardiology, dentistry, pathology, surgery, and gastroenterology. The standard format for images and related information (metadata) provided by DICOM helps prevent incompatibility between different imaging equipment, though this benefit can be accomplished only if institutions produce DICOM-compliant digital media and incorporate robust testing protocols for DICOM compliance. The DICOM standard has advanced in quality because of the cooperation of major diagnostic medical imaging vendors who have almost universally incorporated the standard into their product devices and publicly participate in testing at demonstrations known as “connectathons” [3]. The DICOM standard is not platform specific; that is, it does not specify or depend on a particular PACS architecture to function. Also, DICOM conformance is not an all-or-none

characteristic, and there are usually several items that may need to be configured or negotiated between devices.

Although the DICOM standard is versatile and solves many issues related to connectivity between imaging devices, it lacks the capability to fully integrate all of the information systems in radiology. The IHE initiative was founded in 1997 by members of the Radiological Society of North America and the Healthcare Information and Management Systems Society for the purpose of improving interoperability between information systems [4]. The IHE initiative was charged with the task of using existing standards of health care data communication such as DICOM and Health Level 7 to improve the exchange of medical information beyond the radiology department, and IHE develops and tests profiles for users on the basis of these existing standards. The IHE PDI integration profile addresses how images and related information can be exchanged among imaging storage and viewing devices using DICOM-conformant media.

Viewing of imaging distributed on portable media poses a burden when either DICOM file formats or IHE PDI profiles are not used. Most radiologists receive assistance in viewing images on portable media through the IT infrastructure in their departments. Such assistance may not be available to other clinicians dealing with outside portable media, especially at freestanding outpatient clinics.

To understand the problems inherent at each stage of the image viewing process for portable media, it is useful to examine the pathways that imaging data on a CD or DVD may take for rendering to occur: (1) access to the imaging examination on the portable media, (2) importation of the image files, and (3) viewing and manipulation of the images. First, the imaging examination must be received on a portable medium (most often a CD or DVD) from an outside institution, possibly through an official policy involving the IT department or other entity; most often media are delivered by patients. The receiving institution must then be able to access the imaging data; at this stage, many problems can prevent progress, such as corrupt discs, blank discs, lack of embedded viewer software, lack of self-executing files for the viewing client, security measures that prevent auto-run and executable files on the recipient's workstation, compressed data, a mixture of DICOM and other image formats (which may not be of diagnostic quality), institutional policy preventing the launch of third-party software, and others. Sometimes, the user is forced to render the images on a noninstitutional computer that allows the embedded software to run. Furthermore, the loading time for high-resolution images from a CD or DVD can be long, which can be perceived as a disproportionate waste of time during a clinical encounter. Storage of the media raises additional issues.

From a radiology perspective, there are advantages of placing outside examinations within the PACS. These advantages include a viewer graphical user interface that is familiar and facile, ease of comparison with other examinations, and the maintenance of a longitudinal imaging record for patients who may receive continuing care at a particular facility. Several vendors provide solutions for importing images into PACS. The main technical obstacle to importing images from portable media into PACS is the file format, that is, the absence of DICOM images on the media.

In the last stage, consisting of viewing and manipulating the imaging studies, the issues revolve around the graphical user interface. The lack of familiarity with third-party software interfaces and the existence of disparate and increasingly complex viewers (prohibiting the mastery of any one of them) promulgate the notion that there is the lack of “standardization” for display software.

For example, access, readability, and view-only issues frequently may lead to the need for repeat patient imaging studies, which cause increased financial and time burdens on patients, frustration for radiologists or clinicians trying to view the original examinations, delays in treatment, and unnecessary repeat radiation exposure for certain examination types.

Our survey showed a number of interesting items in the practice of US radiology departments’ policies and procedures for portable media use, with some notable differences between academic and nonacademic centers. A key finding was that although 98.0% of respondents claimed that portable media produced at their institutions were DICOM compliant (with 2% of respondents uncertain), only 22.2% of respondents claimed that they produced IHE PDI-compliant media, while 71.6% were uncertain. Certainly a gap this large in knowledge of compliance between the two standards needs to be addressed promptly. Although the current study design does not definitively prove that IHE noncompliance is the principal problem in handling outside images on media, our results suggest that it is a significant barrier. Experience from our own home institution suggests this as well: we have a policy to import all images into a PACS, and at present, noncompliant media cannot be imported, which is a significant impediment to workflow because imaging studies must be reviewed on non-PACS workstations, and comparisons between studies cannot be done easily. Longitudinal record keeping in a PACS archive allows comparisons and image manipulations to be done quickly because of ease of use and availability of the images. This is especially crucial for oncology patients; when a patient returns for a follow-up imaging examination, the prior examinations will not be readily available in the PACS if it was done at an outside institution that does not produce media compliant with DICOM or IHE. Alternatively, the original piece of physical media must be kept and stored, which is a logistical challenge when applied to thousands of imaging examinations.

Another key finding in our study concerns the use of compression and encryption at host institutions. Although 27.3% of respondents use compression techniques at their institutions (same percentage for academic and nonacademic centers), only 8% of respondents replied that they use encryption techniques (8.3% at nonacademic centers and 3.9% at academic centers, $P = .063$). Last, we found that nonacademic centers are less likely (11.1%) to test their discs for DICOM and IHE PDI compliance than academic institutions (17.6%).

Noncompliance and lack of knowledge about compliance or testing for compliance were all found to be major issues in the present study, more so for IHE PDI than for DICOM. With 71.6% of respondents uncertain whether the portable media their institutions generate are IHE PDI compliant, there is much room for improvement. The IHE PDI integration profile has been specified to address how images and related information can be exchanged among imaging and viewing devices using DICOM-conformant CDs. In evaluating institutions’ policies and practices for quality control for portable media generation, it was discovered

that only 16.0% of respondents noted that their institutions routinely tested for DICOM and IHE PDI compliance, while 49.0% answered that they did not and 35.0% were uncertain.

The implications of this study are several. First, it illustrates the relative lack of knowledge about compliance issues for both DICOM and IHE PDI. Because there are no governing bodies that can absolutely mandate conformance to recommendations for producing DICOM and IHE PDI compliance, it is up to radiologists, other users, and professional societies to provide guidelines and endorse support. This is possible only after understanding the importance of compliance and the barriers to competent patient care that emerge with lack of compliance. Furthermore, this study illustrates the need for the adoption of a common viewer rather than individual, distinct third-party viewers that are inscrutable and cumbersome to manage on a day-to-day basis as they evolve rapidly. An additional insight from this study is that there seems to be an opportunity and need for IT standards use education.

Future implications of the findings of this study include the potential emerging role of limited virtual private network permissions for online access to radiology examinations from frequent referral sites and also the potential role of regional health information organizations, a specialization of health information exchange systems. In the future, we may see the emergence of “image sharing” among various centers, eliminating the need for each and every center to store all examinations in its local PACS. This image sharing could occur regionally or more broadly. This would essentially make the use of portable media unnecessary among frequent referral sites, a prospect that would help patients and practitioners avoid the problems associated with portable media use discussed in this study.

Study Strengths and Limitations

The strengths of the present study are that (1) we received 102 responses from both academic and nonacademic centers, with good regional distribution throughout the United States; (2) we allowed open-format responses to many questions to glean more information about issues faced in various practice settings; (3) we anticipated the most common problems faced by reviewing the literature on the topic and incorporated this knowledge into our questioning; (4) Internet surveys tend to yield more honest answers from respondents because of the complete anonymity inherent in them; and (5) Internet surveys are recommended for samples such as ours to avoid selection bias, samples in which the target population consists entirely or almost entirely of Internet users.

The limitations of the present study include the following: (1) We designed the questions on the basis of the scant body of literature available on the subject. (2) Although we carefully combed the responses for duplicate entries on the basis of the institution designation codes and Internet protocol address, we cannot entirely eliminate the possibility of two individuals from the same institution both having replied to the survey. (3) Although it would have been useful and may provide insight to know the distribution of the sources of outside images, it was not obtained in the present study because this information is not routinely collected by sites and would be very difficult to extract. It is recognized that a potential sample bias exists in that sites that do not produce media compliant with DICOM or IHE may be more reluctant to respond to the survey. However, the problems identified in this study, despite a

potential sample bias, are serious enough to warrant the interventions proposed. In the future, a follow-up survey may be performed that can address improvements in compliance and will allow us to collect more data at that time. (4) Data were collected on the number of examinations repeated because of malfunctioning media, but no data were collected on how often imaging was repeated because the outside examination was not sent at all. Although this was not specifically relevant to the purpose of the current survey (observing the practice of reviewing outside media once received), it is valuable information and should be collected in any follow-up surveys. (5) Data were not collected regarding the characteristics (DICOM and IHE compliance) of incoming media accepted by institutions because this information is not routinely recorded in any systematic way, whereas data were collected from media-generating sites regarding the characteristics of their outgoing media because many of them record information on the media-burning practices they use.

CONCLUSIONS

This survey elucidated the current state of radiology practice for handling portable media containing medical imaging. The problems highlighted by this study can be grouped into 3 domains: (1) access, (2) importability, and (3) viewing issues. Problems in any of these domains delay the delivery of appropriate clinical or surgical care and could potentially have a detrimental effect on patient outcomes.

We have several recommendations given the findings of this study and the current state of portable media use. Radiology practices should make it routine to make only IHE PDI-compliant media and to routinely test for compliance. Testing can be done on each individual disc produced or in a random fashion on discs produced at an institution at regular time or production intervals (ie, every few days, every fourth disc). It should also be made routine to review burned media to ensure that all the necessary files are present on the disc and to ensure proper compression techniques (if used) were used before sending patients home with them. Testing of newly created media should be performed on a separate computer to ensure that no on-board data are being accessed that will not be present on the disc once it is removed from the computer and put into another computer. Use of an IHE PDI test application is also recommended (eg, the Northwestern University PDI Disk Validator, available at <http://ihedoc.wustl.edu/mesasoftware/11.11.0/dist/index.htm>).

Furthermore, “repeat offenders” (ie, those institutions or providers who repeatedly send patients out with non-compliant media) should be contacted to address the issues in a professional manner and to encourage compliance. The consequences of not taking such action are largely felt by patients who must undergo repeat examinations and incur the associated costs (financial and radiation) and who must schedule more appointments and see more providers.

Acknowledgments

We thank Martin Bledsoe, MSPH, Peg Cooper, MBA, RT(R) (both from the Department of Radiology at the Johns Hopkins Hospital), and Donald Peck, PhD (Physics Division head, Department of Radiology, Henry Ford Hospital) for their assistance with instituting the survey.

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Fig 1.
Digital media compliance with Digital Imaging and Communications in Medicine (DICOM) and Integrating the Healthcare Enterprise (IHE) Portable Data for Imaging (PDI).

Fig 2.
The use of compression and encryption on digital media.

Fig 3.

Most institutions do not routinely test digital media they generate for Digital Imaging and Communications in Medicine (DICOM) and Integrating the Healthcare Enterprise (IHE) Portable Data for Imaging (PDI) compliance.

Fig 4.
Percentage of patients who undergo repeat examinations because of malfunctioning media.

Table 1

Respondent and institution characteristics

Characteristic	Distribution
Census region of respondents	
Northeast	19.6%
Midwest	35.3%
South	29.4%
West	15.7%
Nature of institution	
Academic	58.0%
Private practice, hospital based	20.5%
Private practice, outpatient clinics	3.4%
Private practice, both hospital based and outpatient-clinics	18.2%
Occupation of respondent	
PACS/IT staff member or administrator	71.2%
Imaging technologist	5.0%
Radiologist	1.0%
Medical physicist	1.0%
Radiology department administrator	21.8%
Method of handling outside imaging data	
Have official policy or method	72.5%
Do not have official policy or method	26.5%
Refuse to accept outside imaging	1.0%
Unaware of method of handling	0%
Customer services offered by institution	
Writing of institution data onto media	99.0%
Importing outside institution data from media	80.4%
Interfacing with patients or clinicians outside of radiology	47.1%
Percentage of outside media that are readable or importable	
<10%	3.9%
10%–25%	2.9%
26%–50%	10.8%
51%–75%	21.6%
76%–100%	60.8%
Percentage of patients who undergo repeat examinations because of malfunctioning or inaccessible media	
<10%	52.9%
10%–25%	11.8%
26%–50%	2.9%
51%–75%	2.0%
76%–100%	1.0%
Most problematic modalities when importing images	
X-ray	17.9%

Characteristic	Distribution
CT	56.7%
MRI	49.3%
Mammography	37.3%
Other	36 comments
Method of distribution of images from media for medical consultations at institution	
Import data into local PACS	76.5%
Provide dedicated standalone workstation with preinstalled viewer	6.1%
Allow review of imaging data on individual workstations with viewer bundled on media	36.7%
Distribute copies of all pertinent media containing imaging with consultation requests	8.2%
Method of handling the import of outside imaging into local PACS	
For second official review and storage in PACS	5.1%
For storage in PACS without official second review	30.8%
Accessible temporarily for consultation	7.7%
Any of the above, depending on the request	56.4%
Use of auto-run or executable files and which workstations can run them	
Allow on designated workstations	35.9%
Allow on any workstation	43.6%
Allow opening files from media via local image browsing software, but block auto-run/ executable	20.5%
Access to imaging provided on portable media in operating room	
Via PACS	79.1%
Dedicated workstation with preinstalled viewer	8.8%
Workstation that can execute viewer on media	38.5%
Other	18 comments
DICOM compliant	
Yes	98.0%
No	0.0%
Uncertain	2.0%
IHE PDI compliant	
Yes	22.2%
No	6.2%
Uncertain	71.6%
Use of compression on media produced by institution	
Yes	27.3%
No	55.6%
Uncertain	17.2%
Use of encryption on media produced by institution	
Yes	8.0%
No	74.0%
Uncertain	18.0%
Testing for DICOM and IHE PDI compliance at institution	
Yes	16.0%
No	49.0%

Characteristic	Distribution
Uncertain	35.0%

Note: DICOM = Digital Imaging and Communications in Medicine; IHE = Integrating the Healthcare Enterprise; PDI = Portable Data for Imaging.

Table 2

Summary of topics included in questions in survey

1	Describe your institution (academic, private, etc)
2	City/state of institution
3	Name of institution
4	Occupation of respondent
5	Method of handling outside imaging data on portable media
6	Customer services provided in handling CDs and DVDs
7	Percentage of media presented to institution that are readable or importable
8	Percentage of media that are viewable only but not importable
9	Percentage of patients who undergo repeat examinations because of malfunctioning/inaccessible media
10	Modalities that are most problematic
11	Most common reasons portable media are not readable/accessible
12	Most common complaints from clinicians regarding outside media
13	Method of distribution of images from media for medical consultations at institution
14	Method of handling the import of outside imaging into local PACS
15	Use of auto-run or executable files and which workstations can run them
16	Access to imaging provided on portable media in operating room
17	DICOM compliance and IHE PDI compliance
18	Use of compression on media produced at institution
19	Use of encryption on media produced at institution
20	Testing for DICOM and IHE PDI compliance at institution
21	Process of testing for DICOM and IHE PDI compliance
22	Quality control of portable media generation at institution

Note: Not the exact text of the questions.

Table 3

Comparison of survey responses from academic vs nonacademic centers

	<u>Academic Centers</u> (n = 51)	<u>Nonacademic Centers</u> (n = 37)	<i>z</i> (<i>P</i> [*])
Method of handling outside imaging data			
Have official policy/method	86.3%	62.2%	2.620 (.009)
Do not have official policy/method	13.7%	37.8%	−2.620 (.009)
Refuse to accept outside imaging	0.0%	0.0%	—
Unaware of method of handling	0.0%	0.0%	—
Customer services offered by institution			
Burning of institution data onto media	98.0%	100.0%	−0.857 (.392)
Importing outside institution data from media	94.1%	67.6%	3.270 (.001)
Interfacing with patients or clinicians outside of radiology	49.0%	48.6%	0.034 (.973)
Percentage of outside media that are readable or importable			
<10%	5.9%	0.0%	—
10%–25%	3.9%	0.0%	—
26%–50%	7.8%	13.5%	−0.867 (.386)
51%–75%	17.6%	24.3%	−0.767 (.443)
76%–100%	64.7%	62.2%	0.245 (.807)
Percentage of patients who undergo repeat examinations because of malfunctioning or inaccessible media			
<10%	41.2%	62.2%	−1.94 (.052)
10%–25%	11.8%	16.2%	−0.601 (.548)
26%–50%	3.9%	2.7%	0.311 (.756)
51%–75%	3.9%	0.0%	—
76%–100%	2.0%	0.0%	—
Uncertain	37.3%	18.9%	1.861 (.063)
Most problematic modalities when importing images			
X-ray	21.2%	14.8%	0.628 (.530)
CT	60.6%	48.1%	1.131 (.258)
MRI	60.6%	40.7%	1.877 (.061)
Mammography	36.4%	40.7%	−0.312 (.755)
Method of distribution of images from media for medical consultations at institution			
Import data into local PACS	86.0%	68.6%	1.837 (.066)
Provide dedicated standalone workstation with preinstalled viewer	6.0%	8.6%	−0.409 (.683)
Allow review of imaging data on individual workstations with viewer bundled on media	28.0%	48.6%	−2.041 (.041)
Distribute copies of all pertinent media containing imaging with consultation requests	4.0%	5.7%	−0.330 (.741)
Access to imaging provided on portable media in operating room			
Via PACS	84.0%	75.9%	1.013 (.311)
Dedicated workstation with preinstalled viewer	12.0%	6.9%	0.559 (.576)
Workstation that can execute viewer on media	32.0%	44.8%	−1.394 (.163)

	<u>Academic Centers</u> (n = 51)	<u>Nonacademic Centers</u> (n = 37)	<i>z</i> (<i>P</i> [*])
Discs produced are DICOM compliant			
Yes	96.0%	100%	-1.218 (.223)
No	0.0%	0.0%	—
Uncertain	4.0%	0.0%	—
Discs produced are IHE PDI compliant			
Yes	24.4%	19.4%	0.519 (.604)
No	9.8%	0.0%	—
Uncertain	65.8%	80.6%	-1.499 (.134)
Use of compression on media produced by institution			
Yes	30.0%	22.2%	0.821 (.412)
No	52.0%	61.1%	-0.862 (.389)
Uncertain	18.0%	16.7%	0.176 (.860)
Use of encryption on media produced by institution			
Yes	3.9%	8.3%	-1.859 (.063)
No	76.5%	69.4%	0.653 (.513)
Uncertain	19.6%	22.2%	-0.231 (.817)
Testing of discs produced for DICOM and IHE PDI compliance			
Yes	17.6%	11.1%	0.892 (.372)
No	43.1%	63.9%	-2.014 (.044)
Uncertain	39.2%	25.0%	1.467 (.142)

Note: DICOM = Digital Imaging and Communications in Medicine; IHE = Integrating the Healthcare Enterprise; PDI = Portable Data for Imaging.

* *P* values from *z* tests for two proportions, with a significance level of .05.