

ORIGINAL ARTICLE



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Digital Imaging and the Certified Retinal Angiographer Program

INTRODUCTION

The last few years have seen an explosion in the use of digital cameras for both professional and consumer applications. The ophthalmic community was ahead of this trend with the introduction and acceptance of digital imaging equipment and techniques for fluorescein angiography as early as the mid-1980s. From this early introduction, digital imaging has steadily gained acceptance in ophthalmic imaging for use in fluorescein angiography, color fundus photography, ICG angiography, external and slit-lamp photography. As these changes have occurred, many ophthalmic photographers have had to learn new techniques to keep pace with the new technology.

This paper discusses the evolution of the Certified Retinal Angiographer (CRA) certification program and the changes necessitated by the increased use of digital imaging (Table 1). We will review the fundamentals of job analysis for establishing validity in a certification program, the history of the CRA program, and the rise of digital techniques in retinal imaging. We will also report on recent job analysis activities that look specifically at digital imaging skills, their place in the CRA program, and the results of a survey to determine the prevalence of use of digital imaging in retinal photography and angiography.

VALIDITY AND JOB ANALYSIS

Validity can be defined as the degree to which an examination actually measures what it intends to measure.¹ It is considered an

important element of a credentialing examination like the CRA program offered by the Ophthalmic Photographers' Society, Inc (OPS). In the field of ophthalmic photography, certification is voluntary and is not required for entry into the profession. Despite the voluntary nature of certification, hiring decisions, salary ranges, and job advancement can all be influenced by an individual's certification status. Certification is also intended to protect the welfare and safety of the public by establishing standards of competence and ethical practice. Because of the "high stakes" associated with achievement of the CRA credential, it is essential for the certification program to provide evidence that supports job relevance, or content validity. Content

Table 1. Timeline of CRA Program and Digital Imaging.

1971	Certification program for ophthalmic photographers proposed by Don Wong. OPS Education and Certification Committee formed.
1975	Job descriptions completed by the Education and Certification Committee.
1977	OPS representatives attend first NCHCA Meeting.
1978	Separate Board of Certification formed. OPS Board of Directors accepts proposal for a certification program.
1979	First CRA examination held in Erie, PA. Thirty-three candidates certified.
1985	First commercial digital angiography systems introduced.
1989	Introduction of 1024 resolution increases acceptance of digital systems. OPS Board of Certification becomes a member of the newly formed NOCA.
1990-91	Introduction of commercial ICG digital angiography systems.
1995	Formal task analysis survey conducted. New CRA test specifications and examinations created.
1996	New CRA examination unveiled.
1998	McGregor published independent task analysis of digital angiography.
1999	CRA program accredited by NCCA.
2001	Subject Matter Expert panel conducts job analysis update for CRA program. Recommends introduction of digital tasks to examination.
2002	Brief demographic survey conducted on use of digital imaging and film processing. Digital prints accepted for CRA portfolio requirements.
2003	Digital test items included in written examination.

NCHCA: National Commission for Health Certifying Agencies, NOCA: National Organization for Competency Assurance, NCCA: National Commission for Certifying Agencies

validity establishes a relationship between competent practice of a profession and the competencies tested by a credentialing examination.

A job analysis is the commonly accepted validation strategy for credentialing examinations.² This practice ensures that certification candidates are tested on the knowledge, skills and abilities that are directly related to competent performance on the job. A job analysis can be thought of as a very detailed job description; one in which the profession is broken down into performance domains that are broadly descriptive of the field. These domains can then be subdivided into individual tasks and the knowledge and skill statements that detail each task.

There are a number of different methods that can be used to perform a job analysis, including content analysis of job documentation (textbooks, practice manuals, training materials, job descriptions, performance reviews, etc.), direct observation of job incumbents, use of work diaries, interviews with incumbents or supervisors, questionnaires, expert judgment or some combination of these methods. The goal is to ensure an accurate inventory of the required tasks. Typically, the second phase of a formal job analysis requires surveying or observing a wide range of job incumbents to gather evidence that supports the accuracy of the analysis.³

HISTORY OF THE CRA PROGRAM AND TASK ANALYSIS ACTIVITIES

Don Wong, one of the founding members of the OPS, first proposed a certification program for ophthalmic photographers in 1971.⁴ As a result of this proposal the OPS Board of Directors (BOD) formed the Education and Certification Committee that same year. Although much time and effort was devoted to defining potential certification levels and drafting job descriptions, it was a number of years before a certification program was established. In 1977, after years of debate and revision, appropriate job descriptions and a proposal for certification began to take shape.

Momentum for the certification program increased that same year when OPS representatives attended the first convention of the newly formed National Commission on Health Certifying Agencies (NCHCA) in 1977. A direct result of this encounter was the decision by the OPS to pursue affiliation with the NCHCA and to follow the established testing practices and guidelines for credentialing bodies. The NCHCA later evolved into the National Organization for Competency Assurance (NOCA) and its accrediting arm, the National Commission for Certifying Agencies (NCCA).

The formation of a separate Board of Certification (BOC) in 1978 was the first step toward meeting the goal of compliance with NCHCA guidelines. The newly formed BOC reviewed all previously recommended job descriptions and certification levels in an effort to reach consensus on the level, or levels, to be certified. There were three proposed levels as part of a comprehensive

certification program accepted by the BOD in 1978. Once consensus was achieved, an informal job analysis was conducted for the CRA examination through the use of expert judgment by a panel of Subject Matter Experts (SME) from the BOD and BOC. It is interesting to note that an early point of contention was the issue of film processing and printing.⁴ The controversy concerning film processing in the CRA program would reappear some years later with the introduction and acceptance of digital imaging techniques for angiography.

The first CRA examination was conducted on June 17, 1979 and as a result, thirty-three individuals achieved recognition as CRAs in 1979. The CRA program continues to be a success today with over 720 people certified.

Although much of the early effort was spent on the logistics of conducting the examination, the BOC maintained the goal of meeting NCCA guidelines for certification programs and planned to eventually apply for NCCA accreditation of the CRA program. To this end, the BOC sought advice and education on established psychometric testing practices from consultants in the credentialing community. Consultants recommended that a complete, formal job analysis be conducted and documented to help establish validity of the CRA program. As a small, volunteer-driven organization, it was a number of years before the necessary manpower and financial resources needed for this effort were put in place.

In 1995, the BOC contracted with Applied Measurement Services (AMS) to perform a formal job analysis for the role of retinal angiographers. The goal of this analysis was to survey the profession and develop new test specifications for the CRA Program using a thorough, multi-phase approach that used a panel of subject matter experts (SME) to establish a profile of the job role, identify content domains, and develop a survey instrument for general distribution to professionals in the field. The survey instrument was pre-tested by a different group of experts and final adjustments were made before distribution.

The survey was distributed to 1,126 ophthalmic photographers in North America asking them to rate the importance of 162 individual tasks to determine the importance of each task to competent performance in fundus photography and retinal angiography.⁵ The survey also included a demographic questionnaire to provide a profile of the survey respondents. A total of 486 practitioners responded to the mailing. When combined with 40 pre-test survey responses, the overall response rate was an impressive 45%. A response rate of 27% or better is recommended to reduce the potential impact of unmeasured personal differences between respondents and non-respondents.³ The strong response to this survey provided high confidence in the results. The job analysis survey identified 133 tasks critical to competent performance of fundus photography and fluorescein angiography.

Information obtained from the task analysis survey was used to formulate test specifications for the written and performance components of the CRA examination

and establish content validity. The foundation provided by the job analysis report led to the eventual accreditation of the CRA program by the NCCA in 1999.

THE HISTORY OF DIGITAL IMAGING IN RETINAL ANGIOGRAPHY

Commercial digital systems designed specifically for fluorescein angiography and retrofitted to existing fundus cameras began to appear on the market as early as 1983.⁶ There was great excitement within the ophthalmic community over the potential of these new systems, but they were expensive and limited in resolution to 512 x 512 pixels.⁷ For these reasons, their acceptance was somewhat limited in the first few years of availability.⁸ Higher-resolution systems (1024 x 1024) began to appear on the market in 1989. With this increase in resolution came an increase in the interest and sales of digital systems. Most of these systems utilized digital capture for fluorescein angiography only, retaining the use of color film for fundus photography.

Digital technology facilitated the use of another dye, indocyanine green (ICG), for retinal and choroidal angiography. Flower and Hochheimer first performed ICG choroidal angiography in humans in 1972, but were hampered by the insufficient sensitivity of available infrared films.⁹ Until the advent of affordable digital imaging systems and scanning laser ophthalmoscopes, the use of ICG for ophthalmic angiography was limited to research applications. In 1992, two groups reported success with commercially available 1024 resolution digital systems used in conjunction with new fundus cameras designed to allow increased infrared transmission for ICG angiography.^{10, 11} The authors noted improved, high-resolution ICG angiograms. The introduction of these commercial systems spurred increased interest in ICG, which in turn, spurred an increase in the sales of digital systems capable of both fluorescein and ICG angiography. Considering that the applications and clinical efficacy of ICG angiography were still being investigated, the sudden increase in enthusiasm for this procedure, as well as the level of commercial development and sales activity were somewhat surprising.¹²

It is difficult to know with any precision how widespread the use of ICG angiography was at this time, but a 1994 demographic survey of the OPS membership included a checklist of photographic responsibilities.¹³ Although it was a limited sample size (113 – 11% response rate), 12% of respondents reported performing ICG angiography. In comparison, the top three categories in response to this question were fundus photography (89%), fluorescein angiography (82%), and film processing (67%).

Not long after digital systems first appeared on the market, the BOC began receiving inquiries from both CRAs and non-certificants regarding the possible inclusion of digital imaging in the CRA program. These questions persisted and increased as digital technology became more widespread in the early 1990's. Public discussion of this issue took place at OPS meetings, in the

OPS newsletter and on OPTIMAL, the professional email message board for ophthalmic photography that came online in 1994. The BOC publicly recommended waiting until a task analysis could be completed to determine the prevalence of digital angiography before it could be included in the certification program.¹⁴

In response to evolving digital technology, the 1995 CRA task analysis survey took a look at digital imaging and its potential place in the CRA program. Nine tasks associated specifically with digital fluorescein and ICG angiography were included in the task analysis survey. At the time of the job analysis, these tasks failed to achieve the required importance rating to support their inclusion in the test specifications. As a result, the decision was made to not include digital material in the examination or for use in the portfolio required for examination eligibility.

Because of the public debate over digital imaging and its relevance to the CRA program, the BOC recommended gathering additional information concerning the prevalence of digital imaging use within the profession. The Board hoped to establish a baseline for future surveys and plan for the eventual inclusion of digital imaging in the CRA program. The demographic questionnaire asked respondents to provide information describing the annual percentage of angiograms performed using a digital imaging system. The majority (67% of respondents) reported taking no digital photographs, with a combined total of 15% taking between 51 and 100% of all fluorescein angiogram photographs with digital imaging systems. This information indicated that while many retinal angiographers did not use digital imaging systems, there was a sub-group of professionals using digital technology for a significant part of their practice.

In 1998, McGregor reported on an independent task analysis that looked specifically at digital angiography.¹⁵ This study relied exclusively on expert judgment, utilizing a modified Delphi method to achieve consensus on a list of 121 tasks associated with digital angiography. The author suggested that additional research was necessary to determine how and when to incorporate digital techniques into the CRA program. In published discussion following this report it was suggested that the majority of these tasks are universal to competent practice, using either film or digital methods.^{16, 17} There was some debate over the fundamental question of whether digital angiography required a different skill set than film-based angiography or whether digital imaging is just a new tool for performing existing tasks.

JOB ANALYSIS UPDATE

It is generally recommended that job analysis data be reviewed every three to five years to determine each task's continued relevance to the role being certified, and the appropriateness of the technology used in practice.^{3, 5} Periodic task analysis review ensures the continued job relevancy of test specifications in response to changing technology.

The BOC began preparing for an update to the job analysis in 2000. The informal consensus of the BOC was that the profession had changed little since the time of the 1995 task analysis survey, except in one aspect, the increased use of digital photography in retinal angiography. This perceived increase in the use of digital imaging suggested that inclusion of digital photography in the certification process might be necessary. In reviewing the situation, the BOC determined that an update to the job analysis could be conducted on a relatively small scale, using a panel of subject matter experts. Informal methods like this are acceptable for updating a job analysis when changes in the profession are relatively minor such as using new tools (like digital cameras) to perform existing tasks.³

SME PANEL MEETING

In order to support the continuing validity of the CRA examination, the BOC convened a panel of SMEs on April 21, 2001. The panel was enlisted to evaluate the certification process in light of the increased use of digital imaging and to consider how to appropriately incorporate this information into the certification process.¹⁸ The BOC retained the services of Janice Scheuneman, President of Quality Assessment Services to facilitate the meeting and offer psychometric advice and consultation services.

The panel was selected from a list of over fifty candidates compiled by the BOC. Diversity in the panel makeup was an important consideration. Age, gender, practice setting and geographic location were all considered in order to ensure demographic diversity in the panel. Digital imaging experience was also taken into consideration when selecting panel members in order to represent the perspective of both film and digital users in the job analysis proceedings. All panel members were OPS members holding current CRA certification. Prior to the panel meeting, a copy of the 1995 job analysis report and other relevant job analysis documents were provided to panel members so they could familiarize themselves with the findings in advance of the meeting.

At the meeting, the panel discussed the overall importance of the photographic medium in general and digital photography in particular. The panel reviewed each of the three major components of the certification process: the qualifying portfolio, the performance examination and the written examination, to see where digital imaging might be appropriately included. Finally, they considered the development of a survey to determine the proportion of ophthalmic photographers currently using digital and film photography.

IMPORTANCE OF DIGITAL PHOTOGRAPHY

The discussion of digital photography included three major points:

1. The panel discussed the importance of the photographic medium to the practice of fundus photography and fluorescein angiography. The discussion considered whether the digital medium required new skills or

whether it was just a new means to perform established tasks. The panel concluded that the photographic medium itself, whether film or digital, is only of moderate importance to the practice of retinal angiography.

2. At present, the CRA designation states that a person is competent to produce angiograms on film. The panel felt that the prevalence of film-based photography would continue in the near future, but would change over time. The panel concluded that until further changes occur, the film requirements should probably not change even if digital photography is added to the examination process.
3. The panel believed that some potential candidates were not applying to the certification program because of limited experience in film photography. They suggested that some provision needs to be made to get these people into the certification program.

Overall, there was agreement by panel members on the importance of including digital photography in the certification program, but that its impact should be limited. The panel then considered how to appropriately integrate digital photography into the examination process.

PORTFOLIO

The panel reviewed the CRA portfolio requirements to see how digital images might be incorporated. The portfolio is used to demonstrate an applicant's eligibility for the written and performance examinations. The purpose of the portfolio is twofold: to demonstrate both camera technique and the ability to process and print film. The portfolio requirements consist of:

- A series of nineteen 35mm color slides of predefined subjects
- Grayscale contact sheets of three angiograms
- Enlargements of specified portions of the angiograms
- 35mm color slides from the same patients as the angiograms

The panel members recommended that the requirement for the 35mm color slides remain the same and that portfolio reviewers could adequately assess camera technique and angiogram sequencing with prints produced by either film or digital means. Assessing the ability to develop film would however, require at least one angiogram produced on film. For this reason, the panel recommended a requirement that one of the three angiograms be produced on film. The candidate would be given the option to produce the remaining two angiograms in either medium. The BOC later reviewed and approved the SME panel's recommended changes in the portfolio requirements in 2002. Candidates now have the option of submitting digital photographs for a maximum of two of the three required angiograms.

PERFORMANCE EXAMINATION

In the Performance Examination, the CRA candidate is required to photograph a volunteer patient, develop a

roll of film, print angiogram frames, and perform stereo orientation. Patient management, photographic technique, film processing, and printing are all important components of this examination. The panel discussed the feasibility of conducting the performance examination with digital imaging systems. Concern was expressed over the differences in software from different manufacturers and how testing difficulties might be overcome. A conclusion was reached that digital photography could be made available if it was desirable to do so by setting up stations in advance and minimizing the differences in software packages.

Panelists then discussed the concept of holding parallel examination tracks in the performance test and considered whether candidates could be given the option to produce the final product with either film or digital methods. The panel concluded that digital image processing is not strictly parallel to film and the tracks would not be equivalent in what they were measuring. For example, adjusting image contrast and brightness is much easier with a digital system and this could give digital candidates an advantage over candidates using film in the performance examination. The panel agreed that parallel tracks would not be desirable.

The panel members agreed that it is still important for the CRA to use film and that the performance examination in its present form is appropriate. Discussion followed about examination scoring rules and whether they should change. At the moment, failure on the film-processing component can automatically fail the candidate. The panel discussed the question of whether this decision rule was fair to candidates doing primarily digital work. It was pointed out that the scoring standard for this component would not prevent less-experienced candidates from passing if they were minimally competent at processing film.

The final SME recommendation was that the Performance Examination should not change. A recommendation was made that a committee be appointed to consider how to incorporate digital photography into the Performance Examination if it were to overtake film processing in importance in a future job analysis. As of this publication, this has not been completed.

WRITTEN EXAMINATION

At the time of the SME meeting the test specifications for the Written Examination consisted of nine major categories: Anatomy of the Eye, Physiology of the Eye, Pathology of the Eye, Patient Management, General Photographic Skills, Patient/Operator Safety, Fundus Photography, Fluorescein Angiography and Pharmacology.

The panel reviewed these content areas and discussed how to best incorporate digital material in the written examination. They agreed that digital photography could be included in the General Photographic Skills category of the written examination and that the weight

of this section should remain the same. The panel estimated that about a third of the test items in this content area should pertain to digital photography. It was agreed, however, that the relative weighting of film and digital items within this category should be set according to their prevalence in the field. The panel concluded that a survey of practitioners would be an important step in setting the final specifications.

In order to develop new material specific to digital photography, time was spent brainstorming to identify the tasks needed for digital photography. The list of tasks from McGregor's digital task analysis was used as a reference during the process. When the panel felt that the list was complete, a draft set of test specifications was written for this section. The General Photographic Skills section of the test specifications was used as a model to create a parallel list of digital skills with frequent checks to assure that all digital tasks on the brainstorming list were represented.

Finally, the 1995 job analysis was reviewed to see if any other tasks, previously judged unimportant, might now be considered for inclusion in the test specifications. Discussion included the tasks related to ICG angiography. At the time of the 1995 survey, many retina specialists were investigating various diagnostic uses for ICG angiography and use of this procedure had increased rapidly in the early 1990's. Despite this activity, the ICG-related tasks did not achieve enough statistical support to include them in the CRA test specifications at that time.

The panel discussed the current level of ICG use in the profession, and the consensus was that ICG use had not increased significantly since the 1995 survey. Some members speculated that use of this test might actually have decreased in recent years. Panel members agreed that research had defined a vital, but limited role for ICG angiography as an adjunct to fluorescein angiography, and felt that the current level of use did not warrant inclusion in the CRA program at this time.

The panel concluded that none of the non-critical tasks from the 1995 survey had changed in importance, except those dealing with digital photography. They agreed that no other changes to the specifications for the written examination were necessary.

THE SURVEY

The panel recommended that a brief survey be conducted to determine the comparative level of use of digital and film photography in the field. The results of the survey would be used to support the panel's recommendations and assist in setting the final test specifications. The survey would also provide a baseline for later studies to evaluate changes in the field. The panel discussed the appropriate sample size for the survey and means of ensuring an adequate return rate. Based on the response to previous professional surveys, the panel was confident that an appropriate return rate could be expected without any special incentives.

Ten survey questions were composed at the meeting. Four of the questions had been included in the 1995 task analysis survey's demographic questionnaire and the panel agreed that it was important to update any change in these categories since that time. These categories were: years of experience, practice setting, annual number of fluorescein angiograms, and percentage of angiograms performed using a digital system.

The panel also felt it was important to establish the current level of use of ICG angiography to support their conclusions, so the survey included a question that asked respondents to indicate the approximate number of ICG angiograms performed annually. Finally, the panel added a question concerning the use of color digital systems for fundus photography. Although the emphasis on digital imaging within the profession had been in its use for fluorescein and ICG angiography, a recent trend suggested that more color systems were being used for routine fun-

dus photography. The panel felt that this question would establish a baseline for tracking the prevalence of color digital imaging in future studies.

The questions were later put into a format for distribution and the survey was mailed in May, 2002 to all members of the Ophthalmic Photographers' Society as well as all non-member CRAs. A total of 1068 surveys were sent and 529 responses were received for a return rate of 49.5%. This is a very impressive response rate that creates high confidence in the reliability of the survey results. The survey results are summarized in Table 2.

OVERVIEW OF RESULTS

Of those responding to the survey, 270 (51%) stated that they were CRAs. Overall, the respondents were quite experienced with 238 (45%) indicating more than 15 years as a retinal angiographer. The majority of respondents work primarily in private practice with 357 (67%) indicating that work setting. (Note: some respondents indicated both private practice and a hospital or other work setting.)

Overall, the respondents reported performing a large number of fluorescein angiograms annually. More than 1000 angiograms per year were reported by 214 people (40%) and 600 to 1000 angiograms per year by 120 people (23%). When asked what percent of these angiograms were performed using a digital system, 154 (29%) said no digital and 179 (34%) said digital only. A total of 267 (50%) indicated that they did not perform ICG angiograms. Only 92 (17%) respondents reported performing more than 50 ICG angiograms per year. The majority of respondents (321 or 61%) indicated that they did process fluorescein angiogram film. Slightly fewer than half (253 or 48%) reported making contact sheets from fluorescein angiogram negatives and a smaller proportion (112 or 21%) indicated that they made enlargements. Use of a color digital system to perform fundus photography was indicated by 241 (46%) of those responding.

RESULTS BY CERTIFICATION STATUS

Since the requirements for certification were, until recently, based entirely on the use of film rather than digital systems, it might be hypothesized that CRAs participating in the survey (N = 270) could have different responses from those who are not CRAs (N= 259). Therefore, the remaining survey questions were analyzed separately for these two groups.

Table 2. Survey Results

Total respondents: 529			
1. Are you a CRA?	Yes	270	51%
	No	259	49%
2. Years of experience as a retinal angiographer:	0-2 years	15	3%
	2-6 years	85	16%
	6-15 years	190	36%
	>15 years	238	45%
3. Primary professional setting:	Non-academic Hospital	27	5%
	University Hospital	115	22%
	Private Practice	357	67%
	Other	47	9%
	No response	1	<1%
4. Approximate number of fluorescein angiograms performed per year:	None	10	2%
	1-100	52	10%
	101-600	134	25%
	601-1000	120	23%
	>1000	214	40%
5. Annual percentage of angiograms performed using a digital system:	None	154	29%
	1-24%	51	9%
	25-50%	14	3%
	51-75%	23	4%
	76-99%	106	20%
	100%	179	34%
6. Approximate number of ICG angiograms performed per year:	None	267	50%
	1-10	70	13%
	11-25	53	10%
	26-50	49	9%
	>50	92	17%
	No response	2	<1%
7. Do you process fluorescein angiogram film?	Yes	321	61%
	No	206	39%
	No response	2	<1%
8. Do you make contact sheets from fluorescein angiogram negatives?	Yes	253	48%
	No	273	52%
	No response	3	<1%
9. Do you make enlargements (prints) from fluorescein angiogram negatives?	Yes	112	21%
	No	418	79%
10. Do you use a color digital system to perform fundus photography?	Yes	241	46%
	No	288	54%
	No response	1	<1%

Chi square tests were used to identify survey items with significant differences.

Overall, the CRA group had more years of experience. In the CRA group, 58% had more than 15 years experience, while only 31% of non-CRAs had that much experience. CRAs also performed more fluorescein angiograms, with 48% of CRAs and 33% of non-CRAs indicating that they performed more than 1000 per year. The two groups did not differ significantly in their use of digital versus film, although CRAs were more likely to produce contact sheets (55% of CRAs vs. 41% of non-CRAs.)

RESULTS BY EXPERIENCE

Another hypothesis is that recently trained, or less experienced professionals might make greater use of digital systems. Therefore, the responses were analyzed separately for those with six or fewer years of experience (N = 100) and those with more than six years (N = 428).

Again, chi square tests were used to evaluate the significance of differences. These two groups did not differ significantly in the use of digital versus film. The only significant difference identified between the two groups was in contact sheet printing. In the more experienced group 50% reported making contact sheets compared with 39% of the less experienced group.

RESULTS BY PROFESSIONAL WORK SETTING

Another supposition is that digital systems may be more common in hospital settings, suggesting that individuals working in those settings are more likely to perform digital photography. Respondents that listed a non-academic hospital or university hospital as their primary work setting (N=134) were compared to those that indicated they worked in a private practice setting (N=343). Those indicating both work settings were not included in this analysis. Chi square tests were performed to identify significant differences.

Respondents working in hospital settings indicated a greater use of digital photography. In hospitals, 64% of respondents use a digital system for fluorescein angiography 75 to 100% of the time. Of those in private practice, 51% reported using digital 75% or more of the time. At the other extreme, 18% in hospital settings indicate that they do not use digital versus 34% of those in private practice. Those in hospitals are also more likely to perform ICG angiograms with 33% reporting they do not perform them versus 56% of those in private practice. Color digital systems are also more common in the hospital work setting with 56% reporting use of these systems versus 41% of those in private practice. No significant

differences were found in the processing of film for fluorescein angiograms. The differences between the groups on the number of fluorescein angiograms performed were significant, but no clear pattern emerges to show that one group performed more than the other.

COMPARISON WITH PREVIOUS DEMOGRAPHIC QUESTIONNAIRE

Four of the survey items were updates of similar or identical questions on the demographic questionnaire from the 1995 survey. Under years of experience, the greatest number of respondents (46%) in 1995 indicated they had been practicing for 6-15 years, while 36% indicated over 15 years of experience (Figure 1). In comparison, those percentages were nearly reversed in 2001, with 36% indicating 6-15 years of experience and 45% reporting greater than 15 years in the field. These numbers suggest the same overall group of professionals responded to both surveys and that they've mostly remained in the profession. From this comparison, it

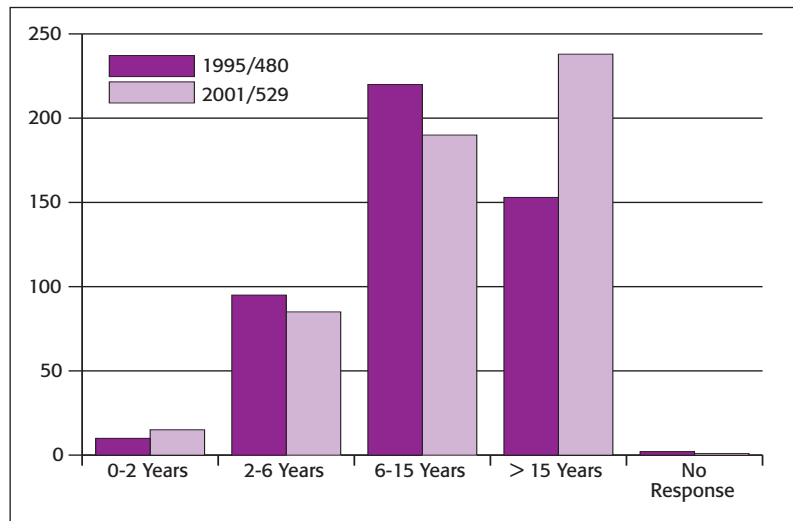


Figure 1: Years of Experience by Survey

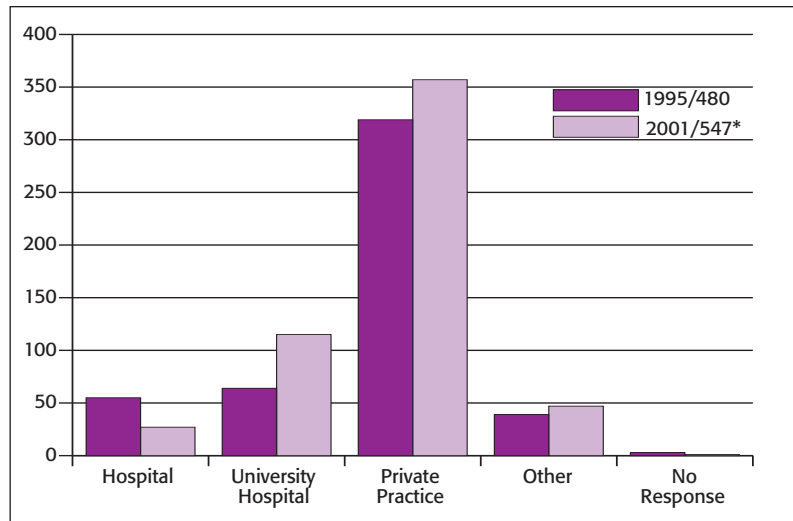


Figure 2: Primary Professional Setting by Survey

could be inferred that this group of respondents represent a stable, aging workforce with many years of experience in the field.

The majority of respondents in both surveys report working in private practice settings with almost identical percentages, 66% in 1995 and 67% in 2001 (Figure 2). The only significant change was an increase in the number of respondents indicating a university hospital as their primary practice setting (13% in 1995 and 22% in 2001), although these numbers were distorted by a number of respondents indicating more than one practice setting. Some differences were noted in the category reporting the number of fluorescein angiograms performed per year (Figure 3). In 1995, the greatest number of respondents (46%) reported performing 601-1000 angiograms per year. In 2001, the largest group (40%) reported over 1000 angiograms annually.

The category of greatest interest to the SME panel and the BOC was the question asking the respondents to estimate the annual percentage of angiograms they per-

form using a digital system (Figure 4). As expected, there was a significant increase in the use of digital angiography since the 1995 survey. Respondents indicating that they did not use digital at all for fluorescein angiography dropped from 71% in 1995 to 29% in 2001. Conversely, the greatest percentage of respondents in this category (34%) reported performing all of their angiograms digitally in 2001.

IMPRESSIONS AND RECOMMENDATIONS

The main purpose of this survey was to estimate the prevalence of use of digital equipment for fluorescein angiography. The survey provided the SME panel and the BOC with the information it was seeking, but the results also suggest some additional important information and trends.

The results show that 29% do not perform any digital angiography and 34% are entirely digital, leaving 37% of respondents performing both digital and film-based angiography. It is unclear why a significant number of

respondents perform both types, but possibilities include: travel to multiple clinics that are equipped differently, participation in clinical trials that require film angiograms, and preference for one medium or the other among different physicians within the same practice.

It is interesting to note that a majority (61%) of professionals still process black-and-white film, but just under half (48%) make contact sheets and fewer still (21%) make enlargements of these negatives. If this trend continues it is unlikely that printing (especially enlargements) would achieve a high importance rating in the next task analysis survey and it's possible that printing requirements could be dropped from the test specifications in the near future. A task analysis survey that utilizes importance ratings would offer a more detailed and reliable analysis to support inclusion or exclusion of these tasks in the CRA program.

As film processing and printing are performed less frequently, the implementation of digital technology for conducting the performance examination may be indicated. With over 70% of respondents reporting at least some experience in digital angiography, the BOC should look at converting to a digital testing environment soon, as long as test site facilities with appropriate digital equipment can be identified.

The responses to the question concerning the approximate number of ICG angiograms performed per year provide an interesting look at the current use of ICG. Although half of the respondents reported performing ICG angiography, the number of procedures per

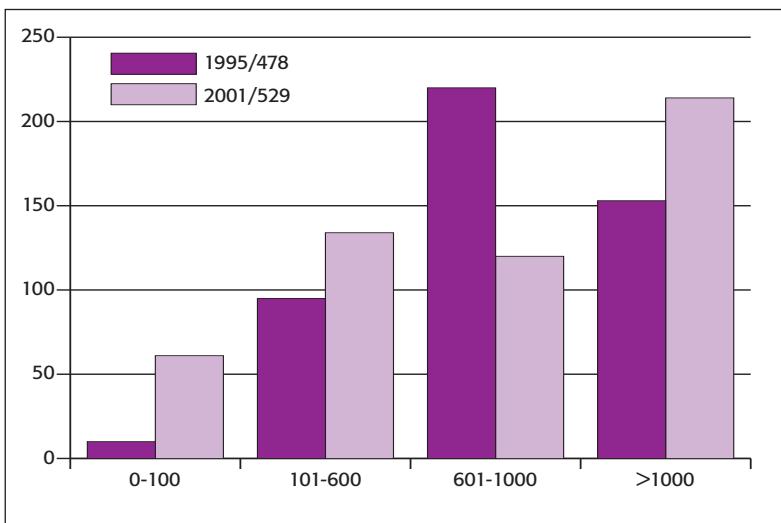


Figure 3: Angiograms Per Year by Survey Year

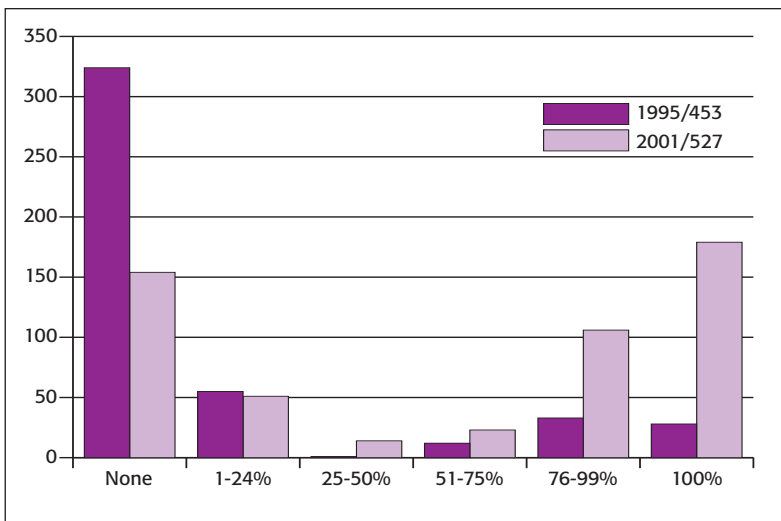


Figure 4: Percentage of Digital Angiograms Per Year by Survey Year

year was quite low with only 17% of the respondents reporting more than 50 ICG angiograms a year. These results confirm the panel's impression that ICG has an important but limited role in retinal angiography and the level of use is not significant enough to include in the CRA program.

The number of respondents reporting use of a color digital system (46%) was somewhat surprising to the BOC. The BOC and SME panel was mainly focused on the steadily increasing use of digital technology for fluorescein angiography and the survey question on color digital use was added as an afterthought. In retrospect, this result should have been expected. New high-resolution color systems that rival the spatial resolution of film were introduced to the market in the year prior to the SME meeting. The high quality of these color systems is certainly a factor in the current prevalence of their use for fundus photography. Most new systems for digital angiography now include standard color digital capabilities and many digital users are converting to color digital use as they upgrade their aging systems. The delay in distributing the survey to the profession was also a factor and the BOC will need to be more timely and responsive with future task analysis activities as technology continues to change.

Although this finding was not expected by the BOC, it should not have a significant impact on the CRA program since color film processing has never been a requirement for certification. The transition from color film photography to color digital requires few, if any, additional tasks that aren't already included in the new digital test specifications. The prevalence of color digital use would also support a shift to conducting the performance examination on digital systems in the near future.

CONCLUSION

The results of this study confirm the judgments of the panel of SMEs that the use of digital photography has increased in importance in recent years and continues to increase today. The survey results also support the recommendations made by the panel to include some representation of digital photography in the portfolio requirements and examination process.

The primary decision dependent on the results of this survey concerned the weight to be given to the digital photography questions in the written examination. Although all of the survey questions help to illuminate the current circumstances in the field, perhaps the most directly relevant question concerns the percent of angiograms performed using digital systems. The survey identifies 29% who say they do not perform digital angiography and 34% who say they use it exclusively. This suggests that the division between digital and film photography in the section on General Photographic Skills should be fairly equal. The new test specifications reflect this distribution.

Finally, the information provided by this survey conveys a good picture of the field with much information to guide decision making in the near future. A repeat of such a survey in three or four years, perhaps as a part of a more general practice analysis, would provide a good look at changes in the field in order to keep the CRA certification program up-to-date and relevant to the needs of practitioners and those who use their services.

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