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A Pioneering Look at Current Trends in Nuclear Medicine Clinical Equipment in the State of Alabama: Findings from a 2010 Clinical Survey

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A Pioneering Look at Current Trends in Nuclear Medicine Clinical Equipment in the State of Alabama

Findings from a 2010 Clinical Survey

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Background

Nuclear Medicine (NM) is a significant yet small component of the larger field of medical imaging. With the development of camera systems that are uniquely sensitive to radioactive emissions, the functional workings of the human body are now being revealed for diagnosis of pathology. NM has had a great influence on the diagnosis and treatment of a number of different illnesses and diseases through non-invasive means while providing information that cannot be obtained from other imaging modalities. Diagnostic imaging using NM has seen increasing specialization in the last few years into areas such as oncology and cardiology which is driving the evolution of cameras. Perhaps the most groundbreaking advancement in medical imaging has been the introduction of hybrid imaging modalities, in which anatomy merges with function to produce some of the most penetrating scans to date. Capturing anatomical as well as physiological information in a single exam, hybrid imaging automatically merges this data to form a composite image allowing us to see a much more comprehensive picture of what is going on beneath the surface. This research comprises the foundational attempt at looking into the current reality and locations of the gamut of nuclear medicine clinical equipment in the state of Alabama.

Before the advent of hybrid scanners, patient images were either compared side-by-side or manually "fused" with special software programs, using anatomical landmarks to align and create a single image. Although "fusion imaging" has become synonymous with "hybrid imaging" there remains a distinct difference. A fusion image is inherently altered to fit its counterpart image while a hybrid image is created when two images are acquired and processed simultaneously on one scanner to eliminate the unavoidable tweaking of images in the fusion process. Instigated by the emerging popularity of hybrid PET/CT and the continual development of new radiopharmaceuticals, an evolution from older equipment to newer innovations offers exciting change with a vital need for technologists that comprehend these new scanners.

Hybrid imaging continues to gain momentum, especially among researchers but remains a hard sell to imaging departments because of the need for expenditure. Diffusion of these multi-modality machines is slow even though the usage of nuclear medicine procedures is expanding (Frost and Sullivan). Despite the lagging distribution of hybridized scanners, such as positron emission tomography/computed tomography (PET/CT) and single photon emission computed tomography/computed tomography (SPECT/CT), their steady, even if slow, infiltration will continue improving the accuracy of detection, localization, and characterization of disease.

It was this idea, on “advancement of imaging tools”, that prompted this survey and an interest in looking specifically at the current state of imaging in Alabama drove this project. This report summarizes the responses to a 2010 survey seeking to better understand the initial penetration of the newer technologies such as hybrid or fusion scanners in nuclear medicine departments across the state of Alabama. The report describes the demographic characteristics of scintillation cameras, licensure patterns of nuclear medicine technologists (NMT), the trends in NM patient volumes and, as an aside, the location of Geiger-Muller counters.

Survey analysis of department staff and equipment was necessary to understand first, what exists and second, where growing needs of the state of Alabama might exist with regard to hybrid imaging. Obtaining this data provides information for assessing the number of nuclear medicine facilities, the equipment currently in use, and the personnel staffing each facility. This survey is a first attempt at looking at the reality of nuclear medicine in Alabama. The poll was sent to 96 facilities within the state of Alabama with responses documented at 40 facilities. There were no incentives offered for answering the survey. It was expected that around 10% of surveys would be returned with recordable data. Surprisingly, 42% of the questionnaires were returned.

Design

The survey of nuclear medicine departments in the state of Alabama was designed with the help of faculty from the School of Health Professions at University of Alabama. Participating members were helpful in determining areas of interest to be included in the survey, framing questions and response options, and in advising about survey process and obtaining proper IRB approval. The sample was drawn from a list of hospitals and clinics in Alabama using public resources and verification of each facility’s nuclear medicine department by phone contact. The survey questionnaire consisted of 11 questions with three main topics of concern including certification data, information about cameras and finally, services provided. Due to time constraints the survey was not field tested to identify any confusing or poorly stated questions/responses. As a result, some questions had no responses and were not included in the final results.

Sample

In April of 2010, paper surveys were mailed to a sample of nuclear medicine imaging facilities in Alabama. The sample was drawn from lists of all identified nuclear medicine imaging facilities, including hospitals, stand alone clinics, and mobile units as well. The goal was to identify and locate every nuclear medicine camera used for clinical purposes in the state. Facilities have been categorized by geographic location, quadrant, and county in Alabama. What follows is a simple segmentation of the state of Alabama. It is used simply for charting and classifying information from the survey in a coherent manner. (Lines are arbitrarily chosen for this study).

Figure 1. Region Segmentation

Geographic Region	# Hosp. in AL	% Resp. per region	# NMTs	% NMTs per region	# Cameras in AL	% Cameras per region
NW	43	44.8%	61	49.6%	43	42.2%
NE	20	20.8%	23	18.7%	16	15.7%
SW	17	17.7%	14	11.4%	16	15.7%
SE	16	16.7%	24	19.5%	26	25.5%
unknown			1	.8%	1	1%
Totals	96	100%	123	100%	102	100%

Table 1. Region Distribution of Hospitals, NMTs and Cameras in Alabama

Table 1 and Figure 1 together provide a description of the geographic representation of hospitals, NMTs, and cameras throughout the state. Information for this table and all other graphics and tables come strictly from information gathered by the survey.

Cameras

Survey of Nuclear Medicine Cameras

Demographics tell us a number of interesting facts. We draw insight into the number and type of cameras per region, location densities of scanners, and uncover underserved areas. Not surprisingly, we also become privy to the trends of advancing technology as well. Although the majority of cameras in Alabama are tomographic, signifying progress toward better and improved technology, planar cameras are still widely used. The advent of rotational capabilities in scanners has served to increase the specificity of many studies while also aiding in the diagnosis and specific location of pathology.

Camera accessibility is displayed in the following map. The map compares number of cameras in Alabama counties with the population of those areas. The northern parts of the state show proportionality between scanners and the population while the southern parts of the state, especially in the Mobile area, reveal a possible disproportionality. Each of the four quadrants that the map (figure 2) displays represents a well covered region as scintillation cameras go. Cameras located in each section are represented. Although diminished camera populations exist, patient access to cameras is within a reasonable distance to those from under-populated areas.

In figure 2 the map shows a large central concentration of cameras with dispersed concentrations coinciding with populations centers in Alabama.

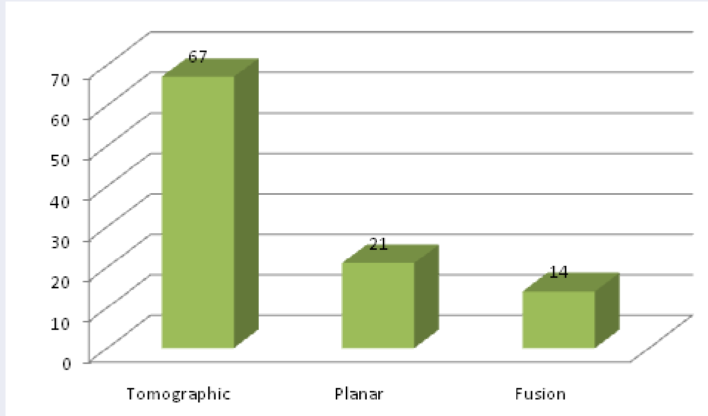

Figure 3. Camera Type and Count Demographics

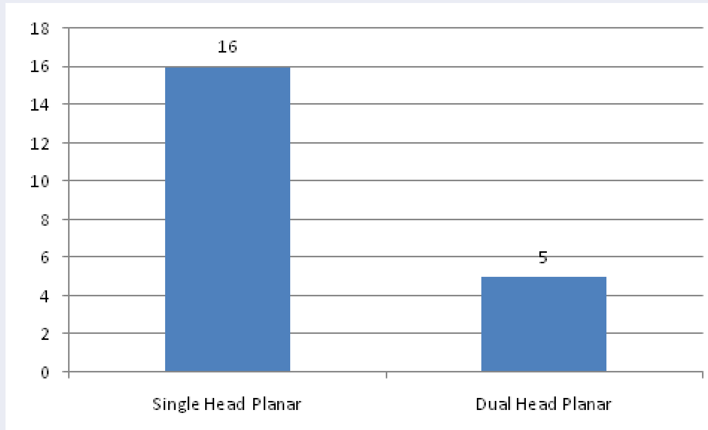

Figure 4. Planar Cameras Type and Count

The landscape is beginning to show that fusion or hybrid cameras have emerged but are not as prevalent as expected compared to the excitement they inspire. PET/CT and SPECT/CT are the most popular hybrid imaging systems found in Alabama. PET/CT studies are enjoying solid advancements due to the infrastructure of cyclotrons for PET radiopharmaceutical applications. In the series of figures 4-6 is information about cameras in use as well as the type of cameras. Hybrid cameras are creeping onto the scene which is especially depicted in figure 6.

SPECT/CT advancements are slow and difficult to comprehend. A variety of possibilities exist but without further information from a formal survey it would be irresponsible to speculate.

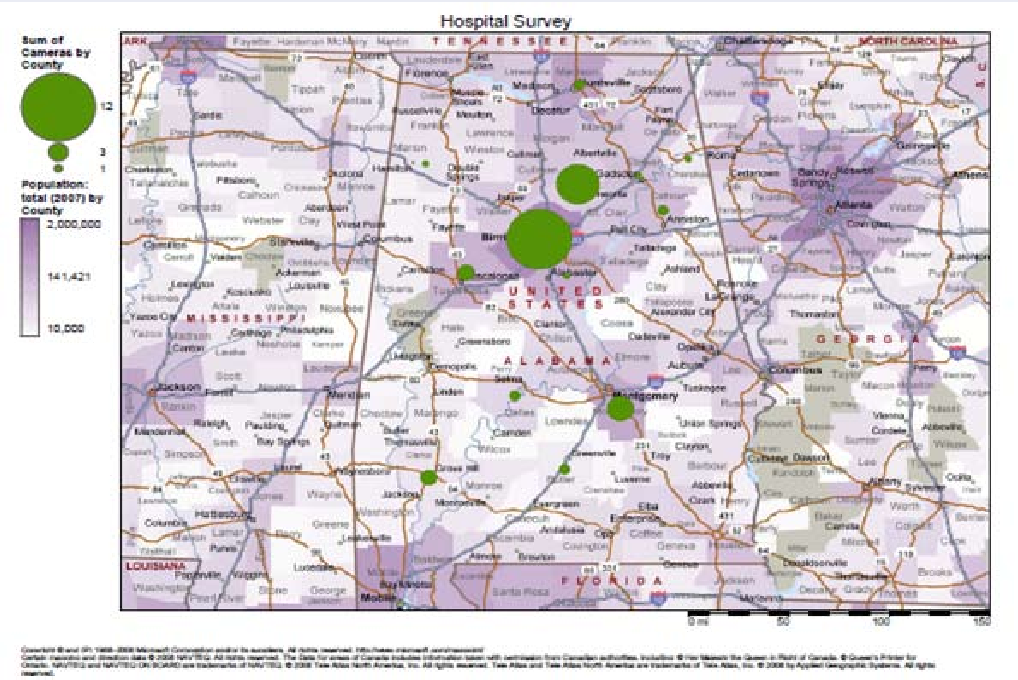

Figure 2. Camera Density by Location

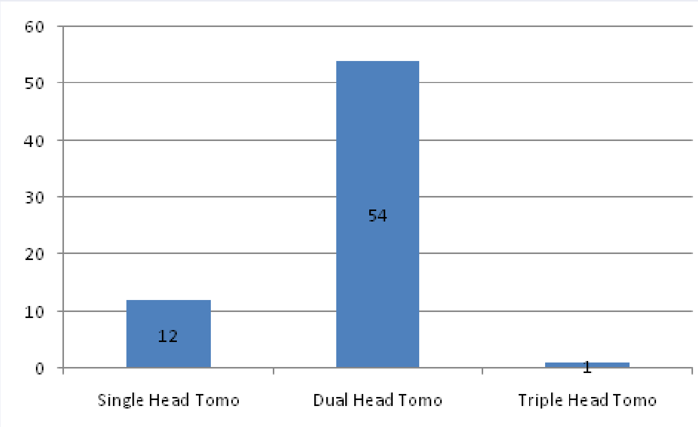

Figure 5. Tomographic Cameras Type and Count

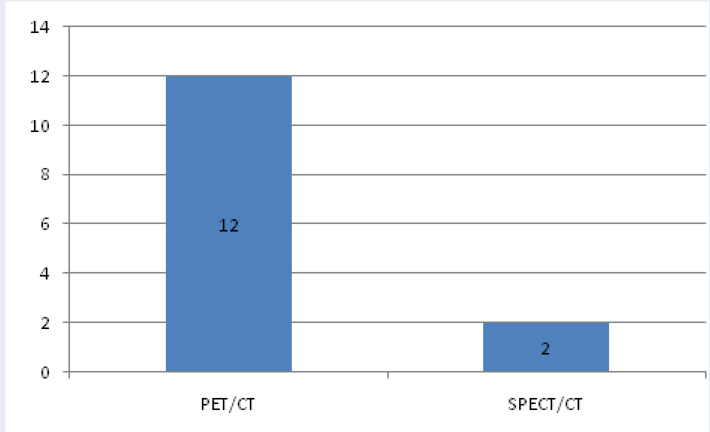

Figure 6. Hybrid Cameras Type and Count

The abundance of dual head tomography cameras illuminates one truth; at one time dual head cameras were the rage and the future of nuclear medicine. They have become the workhorse and continue to be an important acquisition for departments as shown in the statistics, since 33%, or 13 of 40, facilities responded that they have planned the future purchase of dual head or tomographic scanners.

Certification

NMTCB Certification

The certification background of nuclear medicine technology professionals helps in discerning the quality of technologists in the state. Even though the two primary certifying organizations are NMTCB and ARRT, for those seeking credentialing in nuclear medicine the survey focus was only on NMTCB certified technologists. One of the benefits of attaining the NMTCB certification is the level of recognition that it receives. According to the NMTCB, it is recognized not only by the profession of nuclear medicine, it is also recognized by state licensing agencies as well as by employers. All of these entities recognize the NMTCB certification as a premier, high-quality credential. The NMTCB is a strong supporter of federal legislation that would require basic educational and certification standards for health care workers who administer radiologic procedures in every state in the union (NMTCB). Although the ARRT is a nationally recognized certification board and highly respected throughout diagnostic imaging, it is the NMTCB that is nuclear medicine's standard certification.

The percentage of technologists in the sample with certification runs at 78%. There is a nearly 4 to 1 ratio of NMTCB certified techs to non-certified (figure 8), suggesting that the technologists in Alabama are

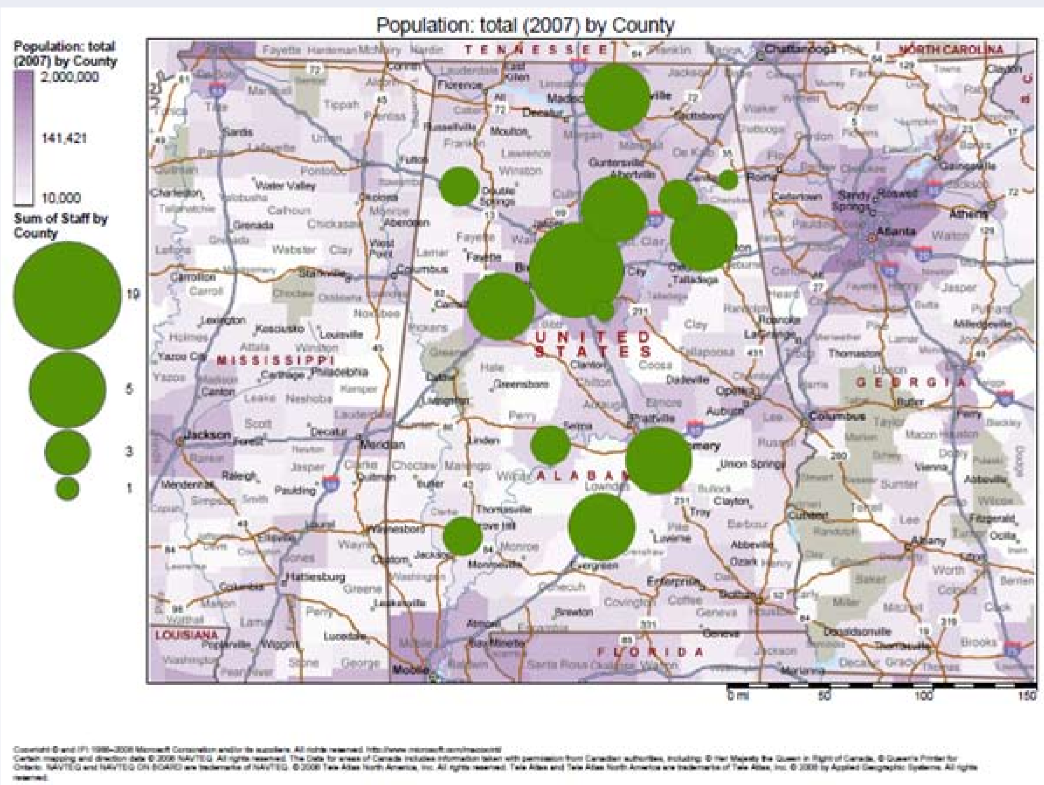

Figure 7. Population of NMTCB Certified vs. Non-Certified Techs in Alabama

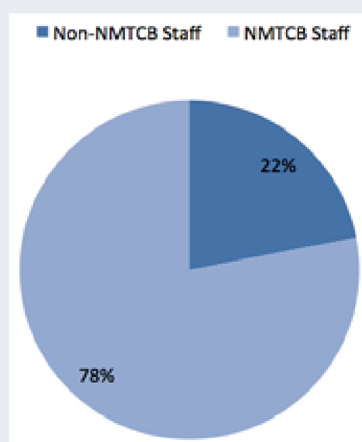

Figure 8. Percentage of NMTCB Certified vs. Non-Certified Techs in Alabama

well educated and experienced in nuclear medicine imaging. Indicators in addition to NMTCB certification are technologists that have been cross trained and even on the job trained. Although specific data was not tracked on other certifications many of NMTs with cross training and OJT training would have had other prior certifications in such modalities as x-ray, fluoroscopy, CT, MRI, suggesting a higher level of education also.

General vs. Specialized Staff

General NM studies represented the bulk of services provided by NMTs in Alabama. Only a small percentage of NMTs work in a specialized NM modality. As hybrid-type imaging moves into departments it is expected that staff will also undergo a type of merge following the scanners' model. As the future comes and changes arrive, departments may be forced to do away with staff trained in a single modality. It will become much more cost effective to pay one employee who has dual/triple certifications rather than hire three staff people to run one camera.

As hybrid imaging, such as PET/CT, has become more prevalent, employees are learning multiple modalities in advance and coming into the hybrid area with more experience and often with dual certification. As this trend continues, facilities such as clinics or hospitals will be able to conserve their funds by having one staff operating both aspects of the machine.

The survey questionnaire brought to light that many certified employees are either cross-trained in NM or on-the-job-trained, declaring evidence that a semi-merging of technologist's training has begun. See figure 11 in the next section for delineation of this. NMTs also must be aware of the shift in the locus of NM services beginning to take place. As is true for many imaging modalities, NM is shifting out of hospitals into ambulatory facilities. It is also shifting away from NM physicians toward cardiologists, oncologists, and other specialists who are becoming increasingly reliant on NM for both diagnostic and therapeutic purposes (SNM).

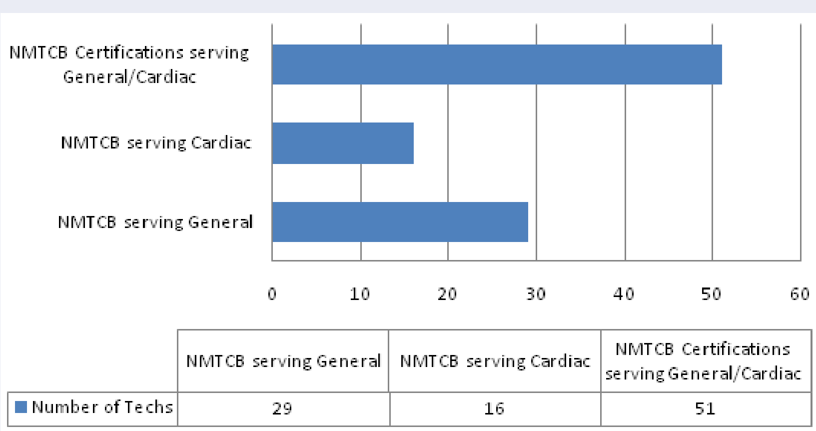

Figure 9. Facility Type and Number of NMTCB Certified Techs at Each Facility in Alabama

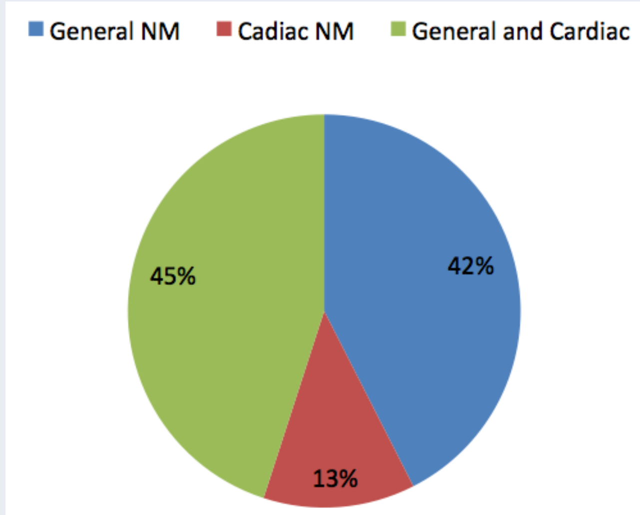

Figure 10. Percentage of Facility Type in Alabama

Cross Trained and On-the-Job Trained

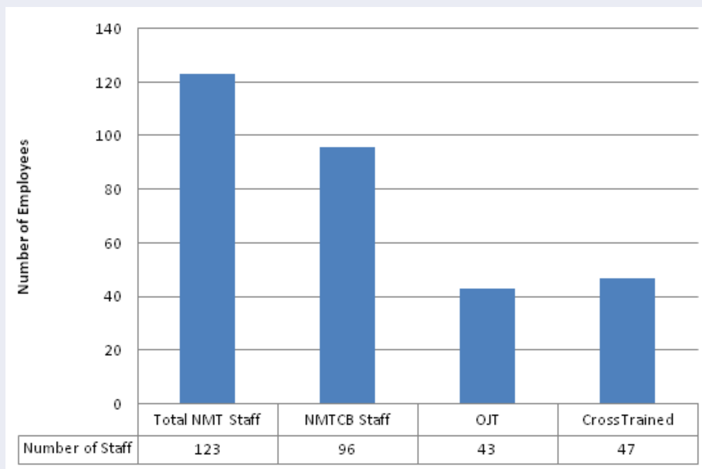

Figure 11. Diversity of NMT Training of Techs in Alabama

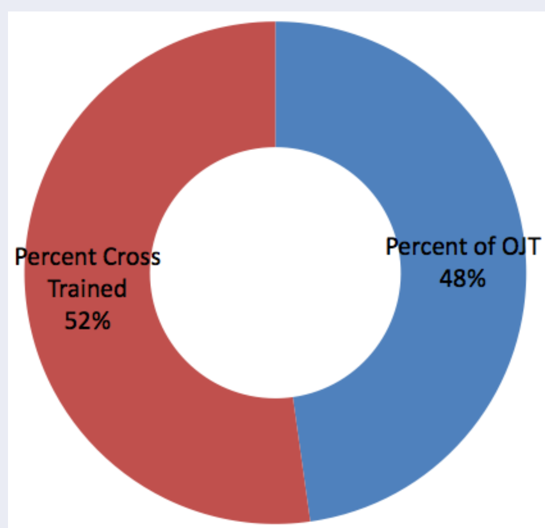

Figure 12. Comparison of NMT Backgrounds/ Alternative Training of Techs in Alabama

The background training of nuclear medicine technologists holds interesting information that lends itself to an interesting future study. For the purposes of this survey suffice to say there is roughly the same amount of cross trained techs as there are on-the-job-trained (OJT). Out of the 40 facilities that returned surveys statistics showed:

- 23 of the 123 employees are not NMTCB certified
- 4 facilities had all employees cross trained and OJT
- 12 facilities with no employees cross trained or OJT

Patient Trends

Patient Volume Increases or Decreases

Without actual statistical data from each department it is impossible to know the exact data concerning the patient volume. Polling the chief technologist at each facility as to whether there was an increase or decrease in services rendered was an exercise in speculation but it has yielded some interesting content. Of the facilities surveyed roughly 50% felt their departments had seen an increase in patient load while 45% said they were experiencing a decrease in patients.

Trend	Increase	Decrease
General facility	6	11
Cardiac facility	3	2
General/Cardiac facility	11	5
Totals	20	18
Percentages	50%	45%

Figure 13. Trends in Patient Volume

The questionnaire asked chief technologists if they were experiencing an increase or decrease in patient load. The data above shows the simple facts. Several imaging managers felt an onus to add information to the survey, stating they felt the decrease they were experiencing was only due to the profound and lasting ^{99m}Tc shortage gripping the industry. [The shortage was triggered by the shutdown of two reactors – one in Chalk River, Ontario and the other in Petten, The Netherlands.] Many additional closures followed due to scheduled maintenances. Closures exacerbated the preexisting crisis of aged reactors and brought their plight to the forefront. The confluence of dose shortages with the demise of reactors, a lack of reimbursement for PET studies and financial hardships have served to increase the pressure felt in the nuclear medicine imaging community.

Reactions to Decreased Patient Load

Facilities have resorted to a variety of measures in order to compensate for the shortages by switching to alternative imaging agents, switching to PET or CT scans when appropriate and finally, reducing dosages or even canceling procedures if needed. Cardiac facilities are relying on Thallium more for their studies. The most complex problems that arise are the financial ones impacting the facilities, the hospitals, the patients, and the pharmacies who supply radiopharmaceuticals, as they are all impacted by the reductions.

In an article in *Pharmacy Practice News* in December 2009 Bronstein and Jakubiak stated, "The Society of Nuclear Medicine recently released the results of a survey designed to assess the impact of the ^{99m}Tc shortage on several practice sites, including hospitals and outpatient imaging facilities. More than 90% of the respondents said they were affected by the shortages of the isotope. About one-third said they were only able to operate at 52% to 75% of their normal testing capacity. And 92% said they had to either cancel or postpone imaging procedures" (Bronstein and Jakubiak). It is reasonable to say that during the time the SNM survey was sent out, nuclear medicine in general was experiencing dire circumstances concerning isotope production. Cascading events undoubtedly impacted the results logged by department personnel who answered the inquiries to the SNM survey as well as the survey in Alabama. Since a direct relationship exists, between isotope production and nuclear medicine, without radiopharmaceuticals there is no nuclear medicine practice going on.

As odd as it may seem, there were plenty of facilities who responded to the survey that claimed an increase in nuclear medicine studies. Of the respondents, 50% said they saw an increase while 45% said they experienced a decrease in patient load. Without having exact information to substantiate the data it is again an educated guess as to the reason for these responses. Some have speculated that the increased supply in some departments had to do with the different radiopharmacy suppliers to each facility; some had supplies while others didn't. Some of the bigger hospitals had to go without radiopharmaceutical supply, while smaller hospitals were able to maintain and even increase their patients due to parceling by the pharmacies. Rationing most surely had a large part to play in the allotment of ^{99m}Tc, and it could have been the reason for shifting of patients to lesser used sites. Whatever the driving force for increased throughput of patients it turned out to be an exciting turn of events for Alabama. Any increase during a time of such tumult is a very positive sign.

Geiger-Muller Counters

One interesting side note to the distribution of gamma cameras is the fact that they are ideal screening tools for detecting the presence of fission products and therefore contamination from nuclear fallout. The scanners could be used to provide gross sensitivities that land between a whole body dose counter and a Geiger-Muller (GM) detector. GM detectors are portable and very sensitive to changes in radioactivity. It was a nuclear medicine radiologist that suggested the need to identify the location and count of GM detectors in the United States. In the event of a radiation emergency, response teams would know the logistics of these devices. As for Alabama, the statistics tallied from the respondents look like this:

- 77 GM counters are located in the 40 facilities
- An average of 1.95 GM counters per facility
- There should be at least 56 more in the state

Conclusion

A sturdy foundation for burgeoning growth in nuclear medicine is vital. With the onslaught of troubles facing medicine in general and the specific troubles plaguing nuclear medicine it is imperative to keep hope and efforts alive. Surveying departments in Alabama has been helpful to see how resilient our state is in coping with crises and adjusting to the many troubling setbacks. The recession, the reactor shut downs, the government's healthcare overhaul, reimbursement cutbacks, and no passage of *American Medical Isotopes Production Act of 2009* (H.R. 3276) have served to buffet the nuclear medicine industry in Alabama. As these storms blow through the landscape some have come and gone leaving more damage than others. Amazingly, some of the misfortunes have yielded opportunity for change and improvement.
It became clear that the state of Alabama, although well equipped with a variety of scintillation cameras, is not a hub for hybrid scanners. Alabama proved to be more of a nursery for new technology; the prospect for growth and expansion is rife. New cameras are planned for and anticipated for the present and future.

Alabama's nuclear medicine industry is showing a glimmer of preparedness with the existing sites that are purchasing, have plans to purchase, or have already purchased fusion scanners. Of the 40 responses, 4 sites are buying a PET/CT camera while another 4 of the 40 are looking to a future with additional SPECT/CT cameras. Many sites are planning to buy a dual head camera or cameras that have tomographic capabilities. There is evidence that there is a movement toward new technology which means certification in these new modalities is an important aspect of
job training/skill.

The greatest measure of the future for hybrid imaging is attitude. Twenty-seven (68%) chief technologists felt that there was a very strong need for fusion imaging in nuclear medicine. Only 33% opined there was not a need to move into new technology (most of these came from facilities in more remote areas). Comments in support of fusion imaging were varied and informative. Here are a few examples: "better attenuation correction", "need new PET agents to grow NM Fusion", "it is the future of all modalities", "it will cut down on false-positives in cardiac studies", "MR/NM will help with pacemaker problems", "better resolution and versatility", and finally, "tumor localizing is on the increase so more fusion is needed". These statements show without doubt that a warm welcome awaits the future. The technologists are key components in the acquisition process of new scanners and equipment. Their opinions matter and can often be prime movers since their skills and knowledge of the equipment and scans are the foundation on which the future of nuclear medicine is built.

Fusion imaging offers a panorama of possibilities like increased patient appointments, faster, more accurate images, and highly trained and skilled technologist all the while contributing to the development of more elaborate hybrid scanners, advances in molecular imaging, proliferating cyclotrons, PET/CT, SPECT/CT, PET/MRs, all adding onto the existing foundation.

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