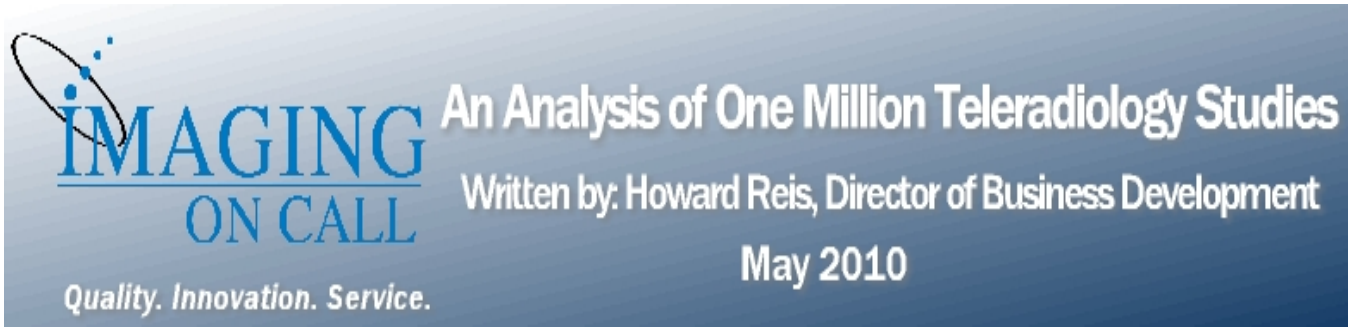

Abstract

On April 25, 2009, Imaging On Call (IOC), a full-service teleradiology provider based in Poughkeepsie, New York, read its one millionth study since its inception in 2002. An analysis of these studies provides an opportunity to examine the teleradiology industry in today's market and to make some predictions as to where the industry might be headed.

Introduction

As observed by national medical correspondent Robert Steinbrook, M.D., several years ago, "teleradiology has become an essential part of the practice of radiology."[1] The popularity of teleradiology is largely based on its ability to relieve radiologists of the burden of being "on-call" at night, allowing them to sleep without fear of having to run to the hospital to read exams. Another positive associated with teleradiology services is the provision of subspecialty support that may be beyond the skills of an individual radiologist. Further, the growth in imaging volume far exceeds the number of new radiologists, leaving a shortage of radiologists conveniently filled by teleradiology providers.

The primary customers for teleradiology services have been radiology groups that hold the radiology contracts with the hospitals. IOC's main focus has been to read emergency room

studies after working hours, after the radiology group has retired for the night. The mix of studies (*Fig. 1)* has stayed relatively consistent from the start. IOC reads all types of radiology studies with the exception of mammography. Over 81% of the studies read are computed tomography (CT) scans, with 11% ultrasound (US), 2% magnetic resonance (MR), 1% nuclear medicine (NM), and 5% plain films. The percentage of

X-rays has risen somewhat over the past year, as IOC has added some non-hospital urgent care centers and additional daytime hospital support to its usual mix of emergency room services.

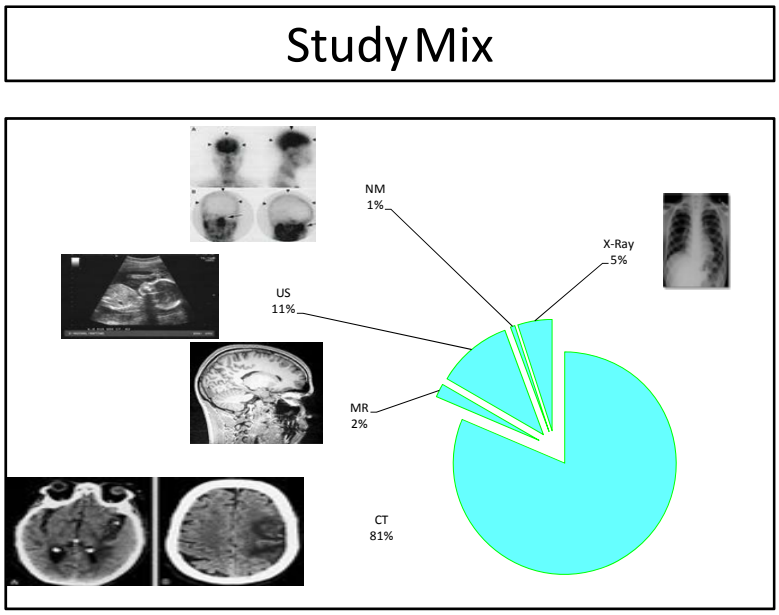

Fig. 1. Distribution by study type (2009).

The story of IOC has been one of consistent growth (*Fig. 2*). For the past 5 years, it has added about 100 studies per night so that its current average volume is approximately 750 studies per night. This is distributed over 75 unique facilities in a 10-state area. Growth has been a

combination of adding new facilities, maintaining steady growth at existing facilities, and minimizing customer turnover.

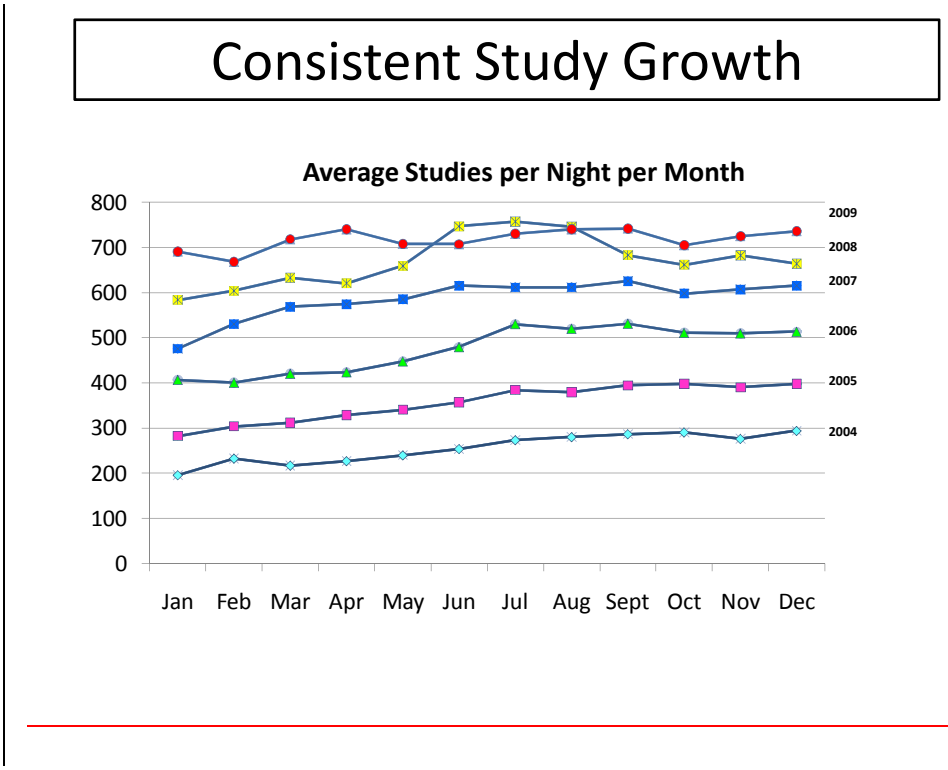

Fig. 2. Year-to-year growth in volume.

Many IOC customers have been utilizing its services for extended periods. For existing customers, there has been steady growth in the number of images sent on a nightly basis. Represented in Figure 3, Vassar Hospital in Poughkeepsie, New York, was one of IOC's first customers and continues to be one of the largest, reflects a growth of approximately 5% each year. Vassar sends more than 120,000 studies per year and is somewhat more likely to send emergency ultrasound studies than many of IOC's other customers.

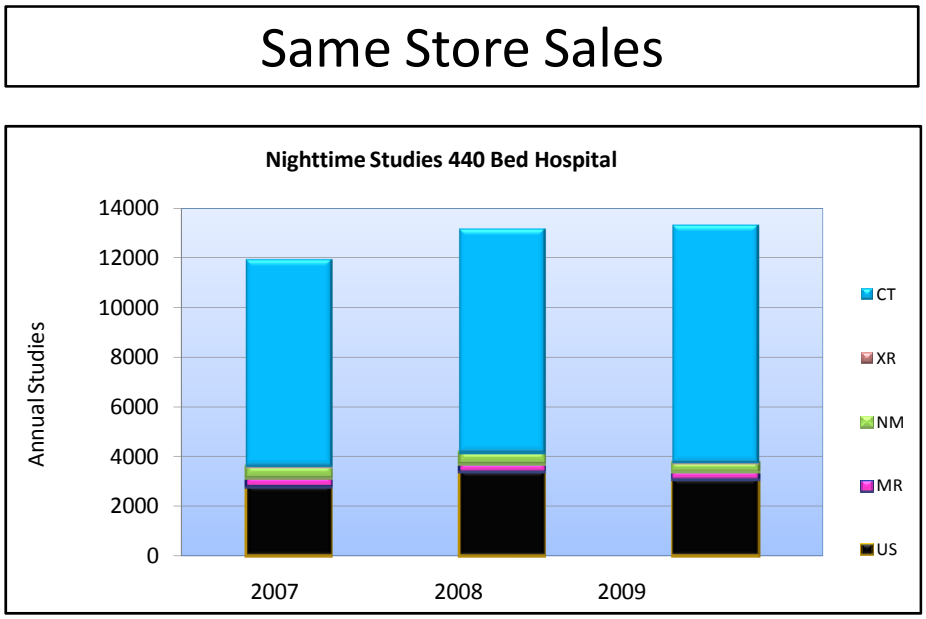

Fig. 3. 3-year volume growth for 1 hospital (~5% per year).

Anticipating Imaging Volume

One of the keys to the success of a teleradiology operation is the proper scheduling of the number of physicians who will be reading at any time. Therefore, accurate anticipation of the volume of reads is essential. Evaluations of client case volume indicate that the size of the hospital coincides directly with the number of cases sent to IOC on a nightly basis. Large teaching hospitals are exceptions to this rule. These facilities generally use residents at night and therefore do not need the services of a teleradiology provider.

An analysis of bed count compared to the number of studies sent each night yielded a trend line that indicated a rise of approximately 5 cases per night with each 100-bed increment in hospital capacity. The majority of facilities have between 150 and 450 beds and sends between 5 and 20

cases per night. Not all hospitals utilize IOC's services for the same number of hours each night. Taking the nightly number of hours of reading into account (cases sent per hour per hospital), does not, for the most part, appear to significantly change the trend line. The smallest facilities still send the smallest number of cases. The largest hospital sends a disproportionately high volume, as evidenced by its sharp departure from the trend line (*Fig. 4*). This phenomenon is partially attributable to the facility's request for full 24-hour support on weekends in addition to nighttime and occasional daytime coverage. Starting June 1, 2010, this facility will move to 24-hour support, 7 days a week. IOC will begin with one or two radiologists until demand for the additional service hours grows.

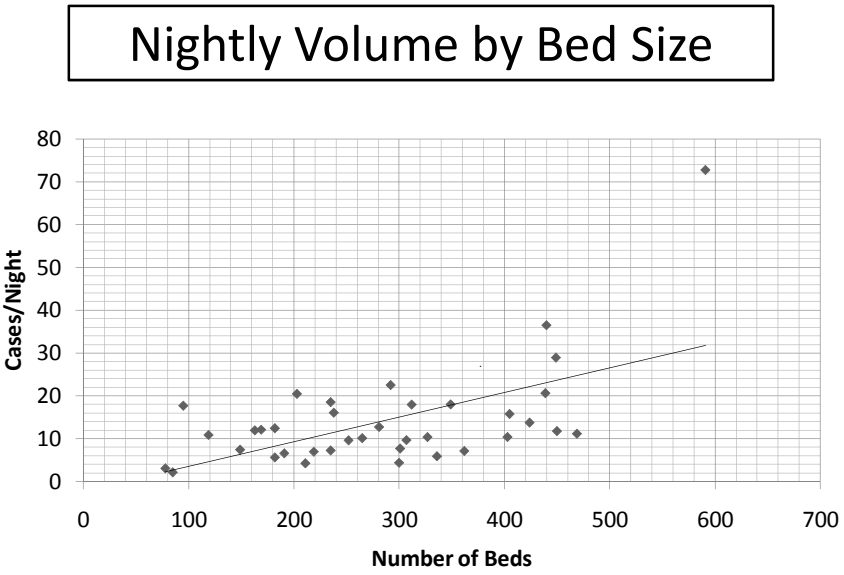

Fig. 4. Comparison of hospital capacity (number of beds) to cases sent nightly (2009).

Case volume is not constant within each night. Several factors impact the busy hours, or the hours when the most physicians need to be on the schedule. IOC's busiest period is usually from

10:00 pm to 2:00 am (*Fig. 5*). This is probably also consistent with the nighttime busy hour in most emergency rooms that are also designated trauma centers. These centers constitute approximately 50% of IOC's clients but are responsible for a greater proportion of case volume. In truth, since IOC's clientele is largely emergency rooms, many unplanned for events may disrupt any planning set into place. For example, it is impossible to schedule in a way that accommodates the needs precipitated by a large-scale highway accident. Another important factor in imaging volume is that individual hospitals decide their own start times, which can range from 5:00 pm to 12:00 am. IOC also provides flexibility; contracted start times may vary from actual start times, depending on client needs, further complicating scheduling optimization.

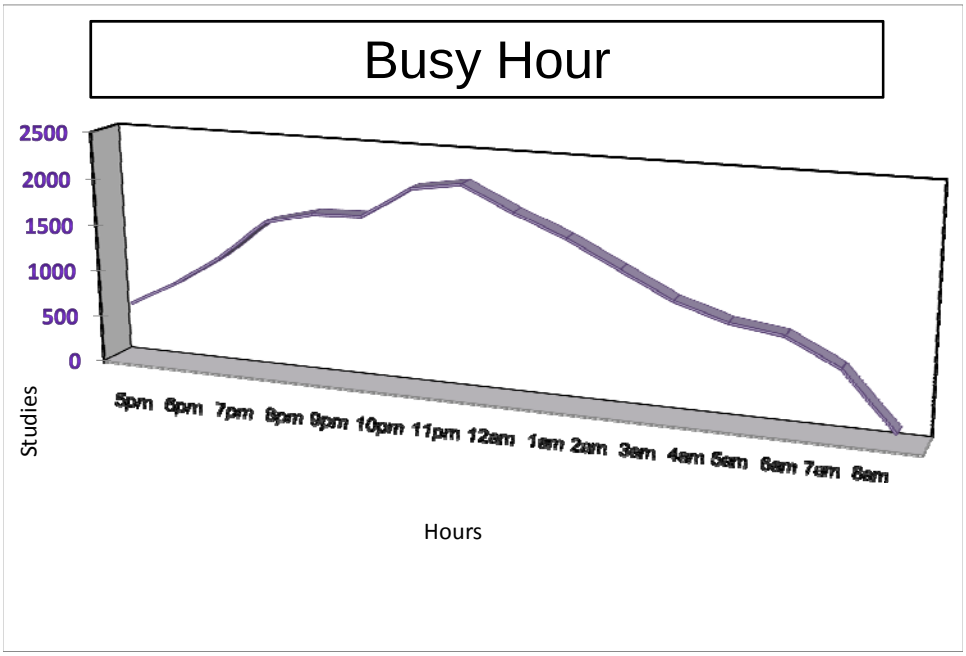

Fig. 5. Total number of studies per hour for 1 month (1/10).

For scheduling success, it is advisable to determine trends in volume by season as well as by hour. For IOC, overall volume always peaks in July, perhaps because newly hired doctors are

overly cautious and order additional studies. Volume at each hospital is also dependent on which ER physician is on call that night. Knowledge of client habits and scheduling can facilitate an efficient scheduling process of physicians. In addition to differing tendencies among individual referring physicians, there is inter-institutional and geographic variability (*Fig. 6*). A hospital in Florida may become very busy in the winter months when the tourist season is in full swing. A Colorado hospital warned IOC to expect increased volume during ski season, but as shown in Figure 6, this does not always happen. In any case, seasonality must be taken into account to optimize scheduling.

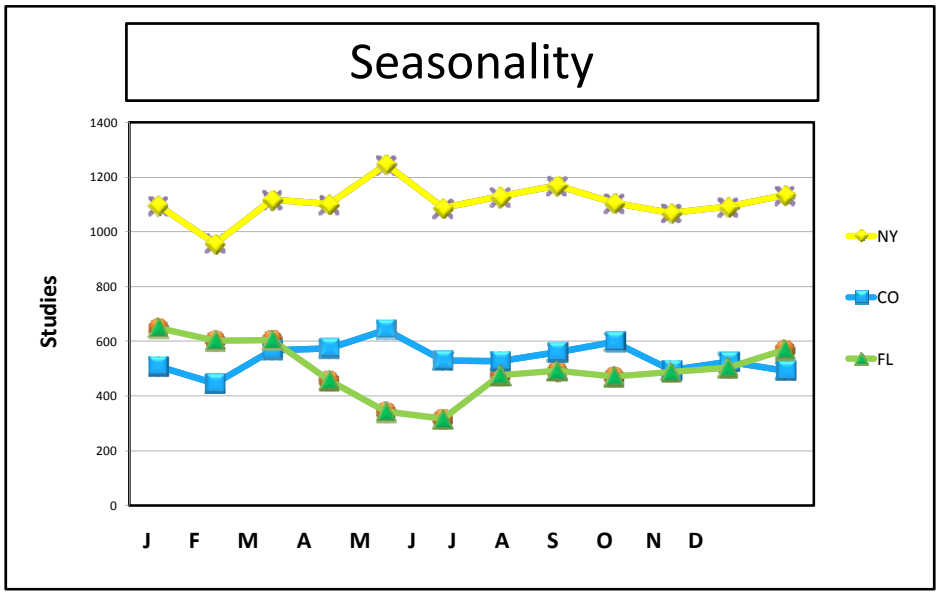

Fig. 6. Comparison of monthly volume for 3 hospitals by geographic region (2009).

Licensing and credentialing issues comprise major components in the daily operation of a teleradiology provider. Each physician must be licensed in the state in which the exam is taken; physicians at IOC have licensure coverage in 39 states. In addition to state licensure, the

physician must be appointed to the medical staff of each individual facility. Figure 7 illustrates the distribution of the number of IOC physicians credentialed at each hospital. IOC currently has an average of 16 physicians credentialed per hospital, with an overall range of 4 to 30 physicians at each facility. The hospital at the low end of the range only requires subspecialty (Neuroradiology) coverage. At the top of the range is a hospital primarily concerned that coverage be sufficient at all times. The number of credentialed physicians is also a function of the hours of coverage and the length of time a hospital has been a customer. Since credentialing is a lengthy process, IOC is reluctant to resign a doctor from a hospital's medical staff. IOC generally starts with a group of approximately 12 physicians credentialed at an individual hospital. This develops a rapport and familiarity with the local emergency room doctors. Some of IOC's larger competitors will credential in excess of 30 doctors on a hospital's staff as a regular practice.

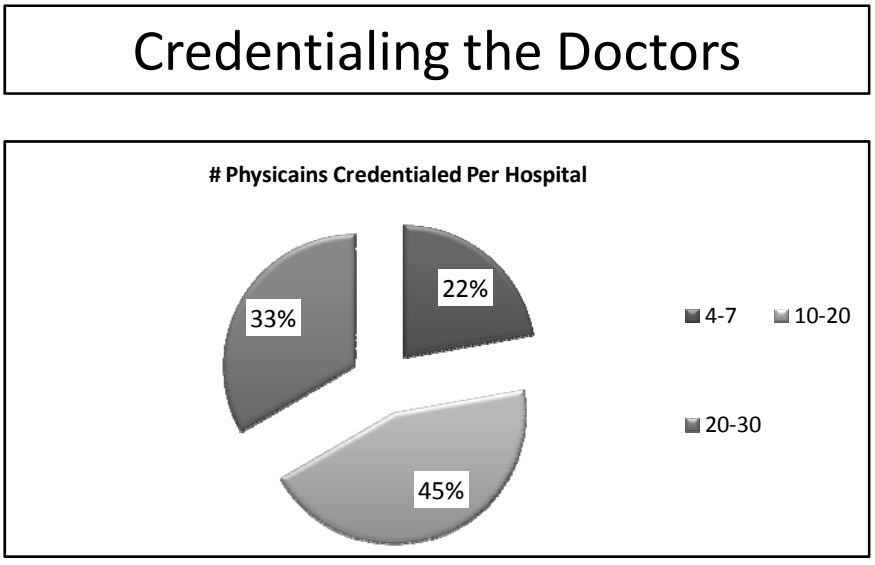

Fig. 7. Tracking the number of doctors credentialed.

Turnaround Times

Speed and accuracy are two critical measures of success for a teleradiology provider. The speed at which a study is returned to the emergency room is referred to as the turnaround time (TAT). Accuracy is measured via the miss rate of preliminary studies. The industry standard for TAT, generally specified within contracts, is that studies be returned within 30 minutes of receipt. Most customers request tracking of TATs to determine if a teleradiology provider is meeting the 30-minute standard.

Many factors affect the speed at which studies are read. A difficult study in a doctor's queue will impact the next study. An unusually busy night will lengthen the queue of the individual physician. An imbalanced workload due to lack of credentialing among a segment of the doctors on call on a particular evening can also make the 30-minute TAT a difficult standard to meet by limiting coverage. Figure 8 shows one year of service for one facility. The number of studies sent in a particular month does not appear to have a direct impact on TAT. A measurement more likely to yield significance is the TAT for the hospital against total studies received. It is unusual for one hospital's volume to have a large impact on the speed of returning studies.

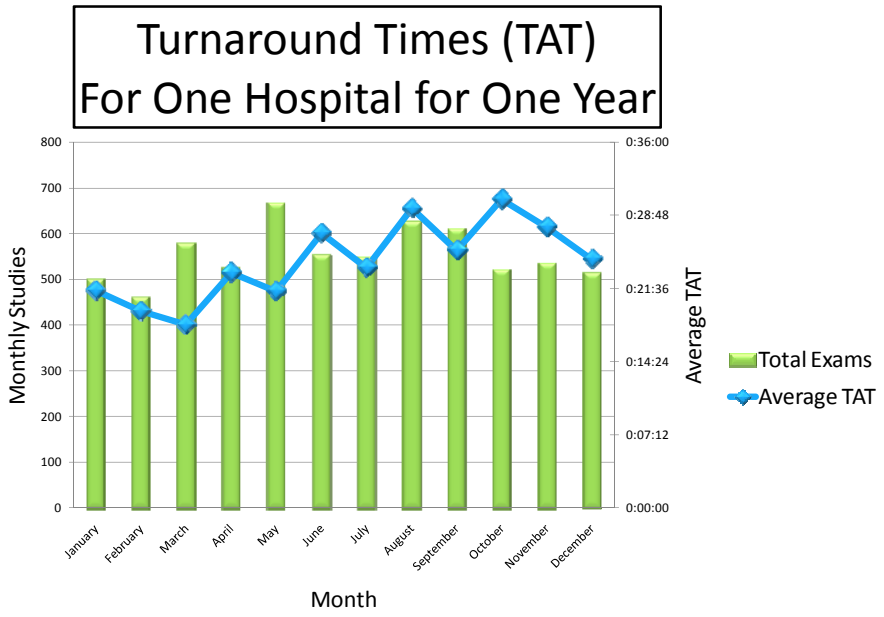

Fig. 8. Correlation between TAT and volume.

To better understand the importance of TATs in teleradiology, IOC reviewed the average read times for the various types of studies it interprets. This data is essential for decisions regarding commitments to customers, pricing of services, and compensation for physicians. As demonstrated in Figure 9, there is an increasing movement toward final exams. The difference in time needed to read a preliminary study versus a final study becomes very important. As shown on the chart, MRI exams take longer than CTs, which take longer than X-rays. IOC's services are priced accordingly. Finals take approximately 4 minutes longer to read than preliminary exams (12 vs. 8 minutes).

Please note that the long reading time for the CT angiography (CTA) final that jumps off the chart is an obvious statistical anomaly related to the small volume of these studies received.

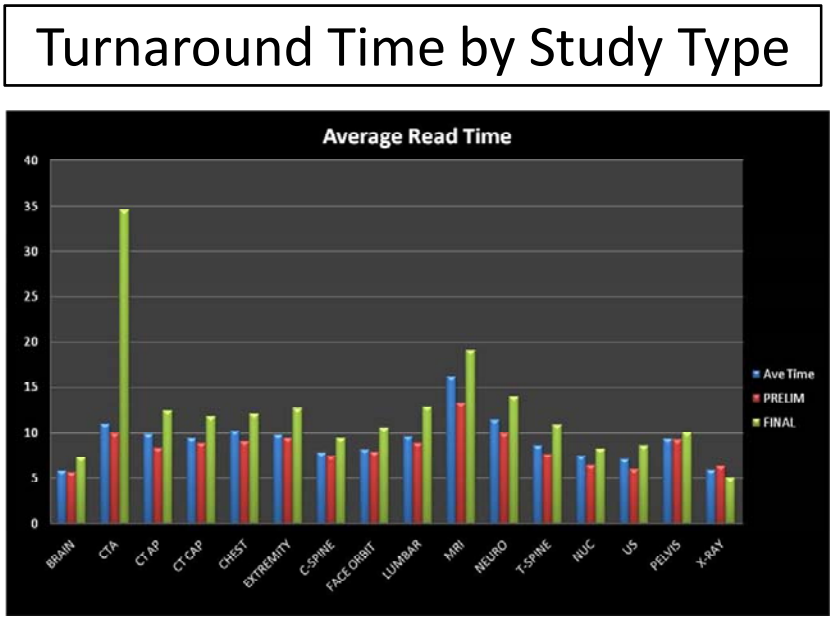

Fig. 9. TAT by study type, preliminary vs. final (2009

Even more critical than the promise of a general 30-minute TAT is the promise to return stroke studies within 10 minutes. One half of IOC's customers are designated stroke centers. A procedure is in place whereby hospitals notify IOC of stroke studies, often while a patient is en route to the emergency room. Performance on stroke studies is monitored on a daily basis (*Fig. 10*). When a variance in the month of November was noted, workflow corrections were put in place to ensure that the average TAT was within the acceptable range.

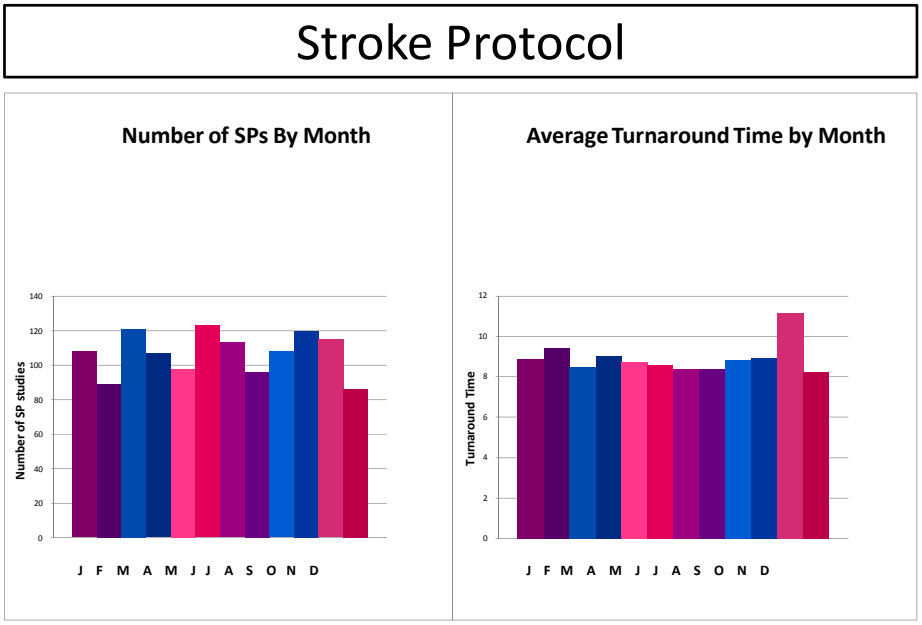

Fig. 10. Monthly stroke protocol studies and average stroke TAT.

Measuring Physician Quality and Productivity

IOC closely monitors its doctors, both with regard to the speed in which they read studies (productivity) and the efficiency of delivering correct results (quality). Every preliminary exam is overread by the individual hospital the next morning. Customers are encouraged to report discrepancies between their own interpretations and the night radiologist's findings. Discrepancies are reported on a scale of 1 to 4, with a "1" indicating that the physician agrees with the findings and a "4" signaling a major miss that could likely affect patient care. Figure 11 compares miss rates to radiology value units (RVU) for the calendar year 2008. Although one doctor was able to read significantly more quickly than his or her peers, the reads were at an unacceptable miss rate and corrective actions were taken.

Fig. 11. Comparison of RVU and reported miss rate (2008). RVU, radiology value units.

Future Trends

One significant trend is the move from preliminary to final reports. Whereas a teleradiology company originally delivered only "wet" reads, over the past 3 years there has been a significant movement to final reads. Final read interpretations represented 11% of IOC's business in 2009; they are projected to be at least 15% in 2010 and grow from there. The major benefit of issuing final reports for hospitals is that it eliminates the need to overread the exam the following morning. Final exams require additional information from the sending site, including complete patient histories and prior imaging studies. Transmitting final reports can require an electronic interface to the hospital's information system. The electronic interface provides additional accuracy as it eliminates a manual process and yet one more area for potential errors. Increased automation is particularly important as industry price competition demands radiologist productivity improvements.

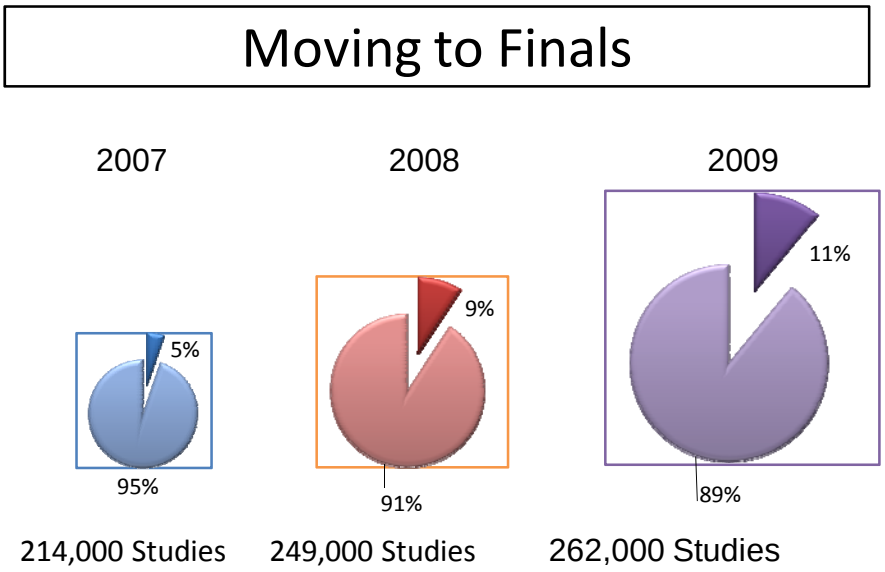

Fig. 12. Increasing proportion of exams are finals vs. preliminary studies.

Teleradiology has been a commercially viable business for fewer than ten years. It is impossible to predict what the business will look like in five years, but some trends are very obvious for both IOC and the teleradiology industry in general. In 2010, IOC has expanded its ability to deliver subspecialty reads, especially breast MRI exams. It has also become a full daytime operation in response to the needs of some existing customers. In addition, it is investigating the possibilities of providing support for 3D image interpretation and a significant expansion in wireless handheld imaging applications. In a recent survey of 71 healthcare professionals conducted by Software Advice, nearly 50% of responders expressed a desire to be able to view medical imaging on their smartphones, making this the top-rated desired capability for the future.[2] Only approximately 12% of those surveyed are currently able to access medical imaging in this manner. IOC fully expects to be involved in image repositories, electronic medical

records, and possibly even to provide the business model for other telemedicine applications such as telepathology, teledermatology, and personalized medicine.

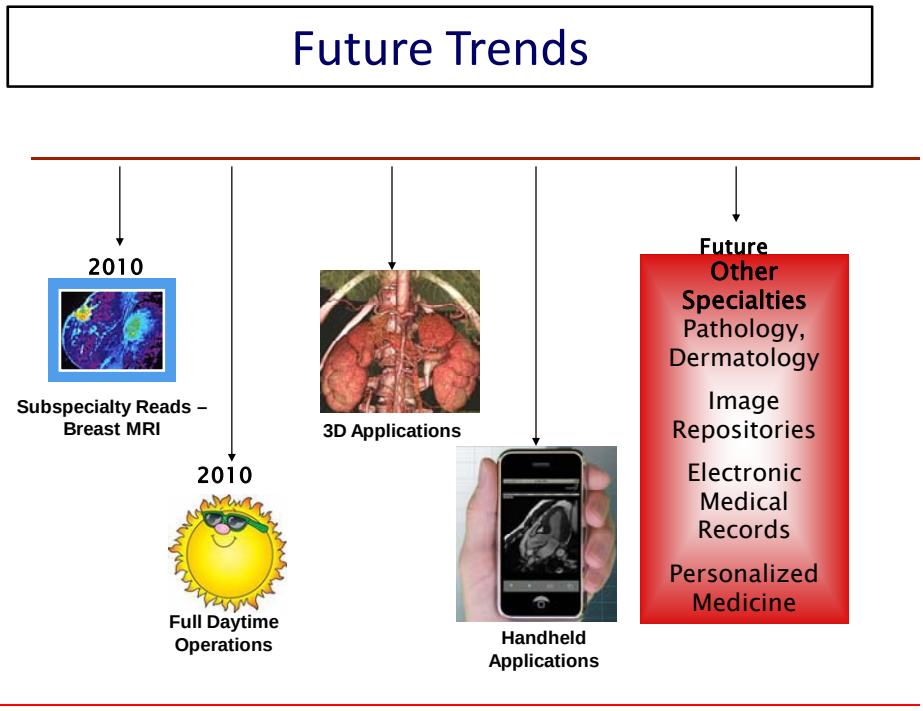

Fig. 13. Future trends for teleradiology.

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2. Thorman C. Survey results: which smartphone will own the healthcare market? http://www.softwareadvice.com/articles/medical/smartphone-survey-results-1073009.

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