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A Frost & Sullivan White Paper

Raising the Bar by Lowering the Dose:

No-compromise Digital Radiography Improves Image Quality and Keeps the Dose as Low as Reasonably Achievable: A Win-win Value Proposition for Providers and Patients

After closely tracking the US market's conversion from analog to computed radiography (CR) to digital radiography (DR), Frost & Sullivan has strengthened its conviction that best-of-breed image processing in DR can improve image quality, lower radiation dose, and improve workflows, all without a premium on the price tag.

While some of it is attributable to advances in flat-panel detector (FPD) technology, much of it actually has to do with image processing algorithms. That is where Agfa HealthCare shines with its MUSICA image processing software. MUSICA, short for multi-scale image contrast amplification, is the industry-leading, patented, proprietary image processing algorithm that the company has pioneered since the mid-1990s.

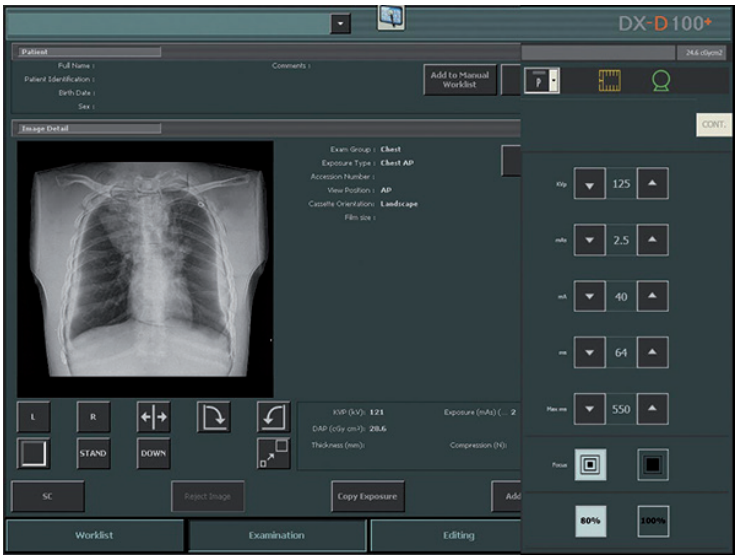
IMAGE ENHANCEMENT ALGORITHMS AS A MAJOR PRODUCT DIFFERENTIATOR

As the hardware components of radiography equipment, including flat-panel digital detectors, become increasingly commoditized, the true differentiator in imaging today is the sophisticated software that makes a DR system better able to meet complex user demands.

For Agfa HealthCare, image enhancement is performed through MUSICA. This advanced image processing solution is now in its third generation, and is the engine behind the crisp and detailed images produced by all Agfa radiography equipment.

MUSICA uses fractional multi-scaled processing and does not require the user's input to optimize output images. The algorithm decomposes the grayscale image into 12 frequency sub-bands that it can process individually allowing for each detail layer to be treated differently. Competing systems adjust fewer contrast levels requiring technologists to take additional time to manually tweak contrast, density, sharpness, and other factors. MUSICA automatically compares each pixel in an image to the group of adjacent pixels which allows it to boost the contrast without creating noise or artifacts. This active noise suppression makes a technologist's job easier and helps them to preserve the finer details in an image. Using this technology, Agfa systems are able to deliver excellent quality images at up to 60% lower radiation dose compared to conventional CR/DR. These claims are cleared by the US Food and Drug Administration (FDA) under the 510(k) pre-market process. Agfa customers also report they are able to reduce dose an additional 40% versus similar competitive DR systems they also currently have in use.

The Interface for Agfa's MUSICA Image Processing Solution Provides a More Efficient and Intuitive Way for Customers to Manage their Workflow



The Agfa DR acquisition workstation (NX Workstation) automatically applies MUSICA, thus making it very efficient and easy to use. In addition to improving image quality, the NX user interface makes dose management easy with a "traffic light" system that indicates whether image quality standards have been met. Technologists also have a "one-click" process for common studies, allowing them to quickly get an image into the PACS/RIS system. MUSICA allows customized settings for different radiologists, so it is not a one-size-fits-all solution. As a core component of every product across the DR portfolio, MUSICA constitutes a key competitive differentiator for Agfa today.

Frost & Sullivan's research evaluating the experience that Agfa DR customers have had with those systems compared to previous DR systems has found a significant improvement in their experience across a number of critical performance metrics.

Figure 1: Comparison of Previous DR System to Current Agfa DR System

THE MASSACHUSETTS GENERAL HOSPITAL'S EXPERIENCE WITH AGFA HEALTHCARE: IMAGE QUALITY AS THE DECIDING FACTOR

Massachusetts General Hospital (MGH) located in Boston is one of several leading U.S. institutions to have recognized the strong value proposition of Agfa's DR portfolio. From 2013 to 2015, MGH installed 10 portable DR (DX-D 100) and 12 fixed DR rooms (DX-D 600) from Agfa. MGH is an extremely busy hospital performing more than 300,000 radiography studies in 2015 with the support of 90 technologists across the enterprise. When their previous GE XRD DR systems were nearing end of life, the clinical operations team at the direction of the clinical directors for the department of radiology, asked Agfa, GE and other DR vendors to present their DR offerings and provide images taken from their equipment which were then imported into the hospital PACS where key radiologists could evaluate their relative image quality. The divisions of chest radiology and musculoskeletal opted to use Agfa. In addition, the pediatric division was interested in Agfa because of the lower radiation dose capabilities it could provide for its patients. The hospital was already using Agfa CR and picture archiving and communications systems (PACS) and expanding the relationship to include DR made sense.

PRIME HEALTHCARE'S COMMITMENT TO TECHNOLOGY EXCELLENCE PUTS AGFA HEALTHCARE DR AT THE FOREFRONT OF PATIENT CARE

With 42 hospitals spread across 14 states, Prime Healthcare Services (PHS) based in Ontario, California made a strategic decision to purchase 66 Agfa DX-D 100 portable DR units and three Agfa DR rooms to be used in emergency and outpatient departments throughout the system. Prime Healthcare's strong commitment to having the best technology available, and a need for greater efficiency in managing the approximately four million X-rays performed in the system, encouraged them to undertake a comprehensive evaluation of the available portable DR systems on the market. The system has grown rapidly through acquisitions integrating legacy systems of those facilities along the way, but historically most X-ray systems had been Siemens and portable Optima XR220s from GE Healthcare.

"We evaluated all of the available DR systems in the market, but chose Agfa for our portable and outpatient departments. Our radiologists really liked it and said it could reduce our radiation dosage by 50 to 60 percent, and that's especially important in pediatrics. Every company is talking low dose today, but Agfa was able to deliver beautiful images as well. The MUSICA image processing is absolutely great. Radiologists love it because they can see every detail which is particularly important with ICU patients, those with PICC lines and in chest X-rays. The difference in image quality between our older GE portable units and Agfa is day and night," said Seetha Reddy, Vice President of Radiology and Cardiology at Prime Healthcare.

In addition to excellent image quality, Reddy notes that the technologists using the system report the MUSICA interface is much easier to use allowing for fast post-processing and seamless PACS connectivity. "With our GE 220s our technologists had so many problems working with the software that in many cases they would opt to use our CR systems instead, and that added time to the case. Technologists had a difficult time manipulating the images after they were taken, sending them to the PACS and even time stamping them. With Agfa's MUSICA we have had no problems whatsoever," according to Reddy.

For hospitals considering upcoming DR investments, Reddy recommends they look for systems that provide ease-of-use, high image quality delivered by leading image processing software, and portable units with high-performance generators that can create a wireless radiography room in the event that staff requires it.

LOMA LINDA STANDARDIZING ON AGFA HEALTHCARE AS THE DR GOLD STANDARD: IMAGE QUALITY WITHOUT COMPROMISING ON EFFICIENCY AND DOSE

The image quality that MUSICA provides has been one of the most important contributors the success of a 15 year relationship between Agfa and 807-bed Loma Linda University Medical Center according to Roland Rhynus, the executive director of the radiology department. Most of the hospital's DR systems are Agfa today and it intends to standardize on the company long-term. "For other hospitals considering a DR purchase, I would recommend Agfa because of MUSICA 3," according to Rhynus. "You always want efficiency and the best image quality you can get from a system, and sometimes you have to compromise one for the other. But our experience and evidence with Agfa shows you don't have to compromise."

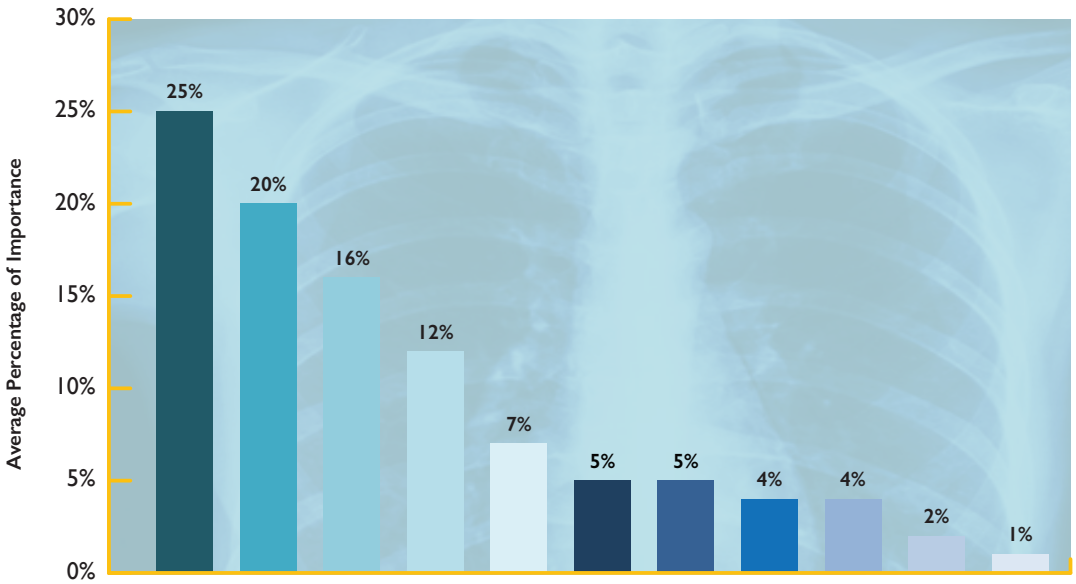
Loma Linda's radiologists have even been involved in the development of the third generation of the image processing software. "Our radiologists believe the excellent image quality of MUSICA brings more diagnostic value. When Agfa can bring us a solution that reduces cost, improves operational efficiency and makes our radiologists happy, then that makes sense for us," said Rhynus. "If we tried to take MUSICA away from our radiologists today, they would not be receptive to the idea."

Technologists at the hospital also enjoy the benefits of Agfa, reporting that the ease of use and image quality provided by MUSICA and the NX workstation helps to significantly improve their productivity. Rhynus reports that Agfa's tools for retrospective dose review are "exceptional," providing managers with the ability to evaluate the performance of individual technologists both during and after a procedure. This highly-detailed view, when combined with the dose calculation it provides, gives managers new tools to coach technologists on how collimation, technique and positioning can impact image quality and radiation dose. "The Agfa NX workstation is easy to use, logical and packed full of good information that helps us improve our process," said Rhynus.

IMAGE QUALITY HAS REAL CLINICAL AND OPERATIONAL IMPLICATIONS

Frost & Sullivan conducted interviews with radiology teams at hospitals using Agfa DR systems, and found that image quality and its ability to impact workflow and manage radiation dose were the leading reasons why they purchased the most recent DR systems they did. These factors significantly outweighed price, brand, and other variables under consideration.

Figure 2: Most Important Factors Considered in the Purchase of Most Recent DR System



THE THREE PILLARS OF DIGITAL RADIOGRAPHY'S VALUE PROPOSITION

DR has become the gold standard for general radiography imaging. Despite all the advances being made across various other imaging modalities, general radiography continues to account for between 40% and 45% of diagnostic imaging examinations performed by US imaging providers today.

Using DR efficiently in clinical practice hinges on three key elements:

1. Producing the highest possible image quality, which in the case of DR is a combination of high resolution, sharp detail, and high contrast, that can increase an interpreter's diagnostic confidence
2. Keeping radiation dose as low as reasonably achievable, in line with ALARA recommendations, Image Gently/ Image Wisely, and other guidelines
3. Achieving high workflow productivity to accommodate high patient volumes and staff availability as cost effectively as possible

The goal, then, is to achieve the right balance across all three items.

Susan Boulanger, director of imaging services at Signature Healthcare Brockton Hospital, Massachusetts, summarizes the outcome of these tradeoffs at her facility, which has replaced other long term vendor solutions in general radiography and installed three portable DX-D 100 DR systems and six fixed DR suites from Agfa. "The beauty of working with Agfa DR is better image quality without a sacrifice in patient dose. It's a win-win situation because we're getting better images and using lower dose," she says.

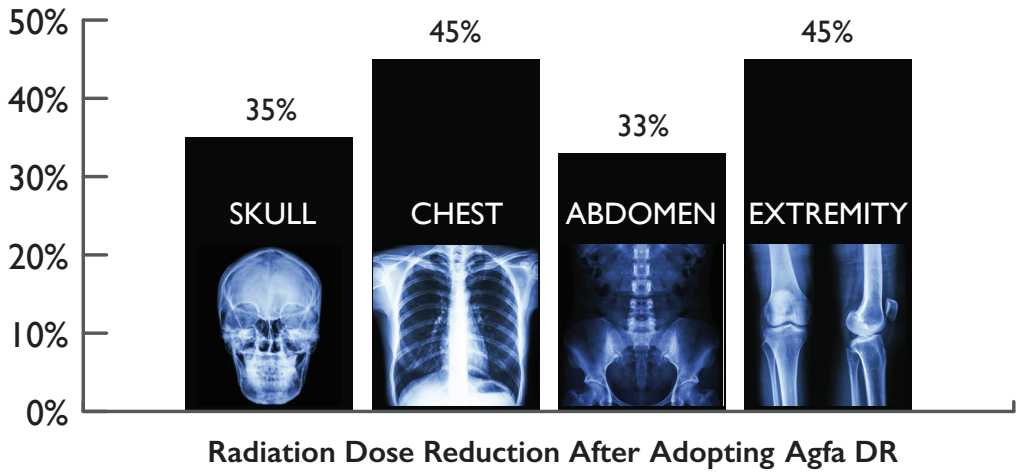
Boulanger agrees on the importance of high quality pediatric images: "Prior to Agfa our pediatric images weren't nearly as sharp. They were a bit washed out and not detailed enough. Since implementing Agfa, both radiologists and technologists agree on the benefits of redirecting the pediatric volume to the Agfa environment. In one of our [other radiology] rooms we avoid performing pediatric imaging whenever possible. Our radiologists simply will not read images that don't look like Agfa's."

Boulanger adds that the hospital's long-term plan will be to replace the majority of its radiology equipment with Agfa technology based on its "outstanding image quality." This investment is supported by the entire radiology team, including the facility's chief radiologist, Dr. Warren Salzman, who states that Agfa images remind him of film quality with a range of contrast that he does not see using other technology.

> *This emerging requirement for standardized high quality images puts at a definite advantage the vendors that offer consistent image look-and-feel across an entire fleet of fixed and mobile analog, computed and digital radiography (CR/DR) systems. In some cases, where hospitals have not yet standardized on a single radiography vendor, this can result in creative transitional approaches. Boulanger states: "Image quality, even on the portable DR by Agfa, is superior to what we were getting from our fixed GE Healthcare DR system to the point that we are now using the Agfa portable equipment inside the GE X-ray room."*

Frost & Sullivan's research with Agfa DR customers found that, on average, they reported a dose reduction of 35% to 45% compared to previous DR systems they were using, which included GE, Siemens, Philips, and Shimadzu.

Figure 3: Reported Reduction in Average Radiation Dosage After Replacing Competing System with Agfa HealthCare's Digital Radiography



FAR-REACHING IMPLICATIONS OF HIGHER DR IMAGE QUALITY

Image quality is sometimes considered subjective and a result of many variables such as X-ray exposure technique, the image acquisition system, image processing, and the display device used to reproduce the image. For this reason, most providers evaluating different DR systems run blind tests of sample images with their radiologists. Beyond just a "pretty" image, radiologists look for the incremental diagnostic insight that an added level of detail may provide.

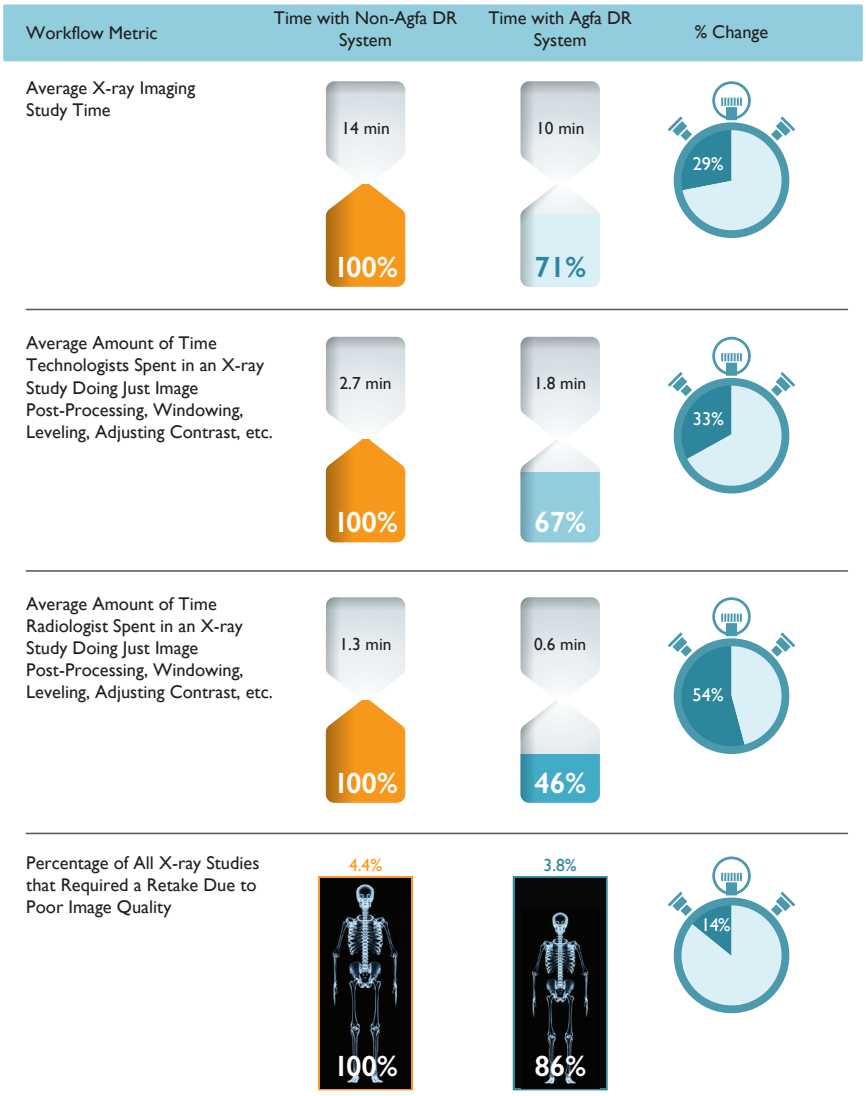
When using this consensus approach, the impact of individual subjectivity related to image quality is reduced as the power of the collective years of experience across the radiologist panel is leveraged.

For an imaging enterprise, higher DR image quality has a far-reaching impact:

- High image quality increases confidence in diagnostic interpretations and, in some cases, a lower rate of patient recalls for image retakes
- Reducing such redundancy takes costs out of the system, which is key under value- and outcomes-based reimbursement
- Excellent images yield higher technologist and radiologist satisfaction and can help retain and attract talent
- Achieving diagnoses more efficiently allows hospitals to move patients faster along their clinical care pathways, thereby generating system efficiencies

Agfa customers interviewed described how the excellent image quality and interface provided by MUSICA helped them to achieve significant workflow benefits in their operations. On average, respondents reported X-ray imaging study times 29% shorter, and technologists and radiologists spending 33% and 54% less time, respectively, on fine tuning their images for optimal reading. At an average salary of approximately $30,000 for the typical radiologic technologist, this translates into approximately $6,900 in additional productivity per technologist per year. While these hospitals indicated that technologist training and seniority have the greatest impact on the percentage of images that need to be retaken due to poor image quality and that that number has gone down significantly with the advent of DR, Agfa technology was still able to reduce that rate by 14% on average.

Figure 4: Agfa HealthCare MUSICA Has Significant Impact on Radiology Workflow



SEEKING CONSISTENT IMAGE QUALITY ACROSS A READING ENVIRONMENT

Realizing the huge potential that high DR image quality can have on the imaging and healthcare enterprise—especially under emerging payment models—more and more providers are seeking to standardize image quality across their organizations.

Removing disparities stemming from a multi-vendor radiography fleet means providers are able to:

- Streamline radiography protocols and build them into radiography equipment
- Improve technologists' mobility across the enterprise without a learning curve penalty
- Accelerate the development of a virtualized reading environment for radiologists
- Establish a strong relationship with the radiography vendor of choice

MEETING TODAY'S IMPERATIVES WHILE PREPARING FOR TOMORROW'S CHALLENGES

One of the fastest growing vendors in the highly competitive US DR equipment market, Agfa HealthCare has been adopted as the radiography vendor of choice by many US luminary hospitals since its introduction. Sales of the company's DR systems grew by more than 400% from 2000 to 2015. This is a significant testimony to Agfa's winning value proposition because these academic hospitals and premium imaging facilities are notoriously the most demanding customers and have the most advanced requirements.

Oregon Health & Science University (OHSU) located in Portland chose to begin replacing its existing portable radiography systems in 2012 with Agfa's DX-D 100 portable DR units. At the same time, it installed twelve Agfa DX-D Retrofit units into existing radiographic rooms. The facility performs over 130,000 radiography studies per year, so when it decided to upgrade to Agfa DR the fact that the image presentation remained consistent was very important. Chief Diagnostic Imaging Physicist Thomas M. Griglock, Ph.D., DABR reports the facility was able to decrease their average techniques thanks to the DR panel coupled with Agfa's MUSICA image processing algorithm. These changes have resulted in OHSU's patients receiving approximately 30 to 40 percent less radiation exposure. "We did a comparison of DR systems, and Agfa image processing is the best on the market. You can have a system that is great dose-wise, but if the image processing is no good, it is worthless. Image processing for general radiography is the most important part of the chain, and MUSICA has the most consistent image quality."

When talking to other physicists, Griglock recommends Agfa DR and believes the technical performance of the systems speaks for itself. "When people go out and get the full range of technical information on DR systems and have their physicists actually test them, 9 times out of 10, they will buy Agfa."

CONCLUSION

Radiography is the workhorse of every hospital's diagnostic services department, and poor image quality and inefficient workflows in this one critical area creates ripple effects across nearly every specialty in the facility. To stay competitive, hospitals must adopt a "best of breed" attitude toward this critical imaging modality and accept only the best for their patients. Compromising on a DR system with inferior image quality to secure a bundled contract for other unrelated products and services might appear to make short-term financial sense, but at the expense of improving the long-term efficiency of hospital operations and the delivery of patient care.

Achieving consistently high image quality while taking part in enterprise-level dose optimization and productivity enhancement efforts is the three-pronged key to success for hospital radiography services. In an increasingly competitive marketplace, using advanced DR image processing, such as Agfa HealthCare's, is no longer an optional feature to consider, but a new standard. Why would any hospital accept "good enough" image quality when excellent image quality is available at a competitive price?

ABOUT AGFA HEALTHCARE

Agfa HealthCare, a member of the Agfa-Gevaert Group, is a leading global provider of diagnostic imaging and healthcare IT solutions. The company has nearly a century of healthcare experience and has been a pioneer on the healthcare IT market since the early 1990's. Today Agfa HealthCare designs, develops and delivers state-of-the-art systems for capturing, managing and processing diagnostic images and clinical/administrative information for hospitals and healthcare facilities.

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