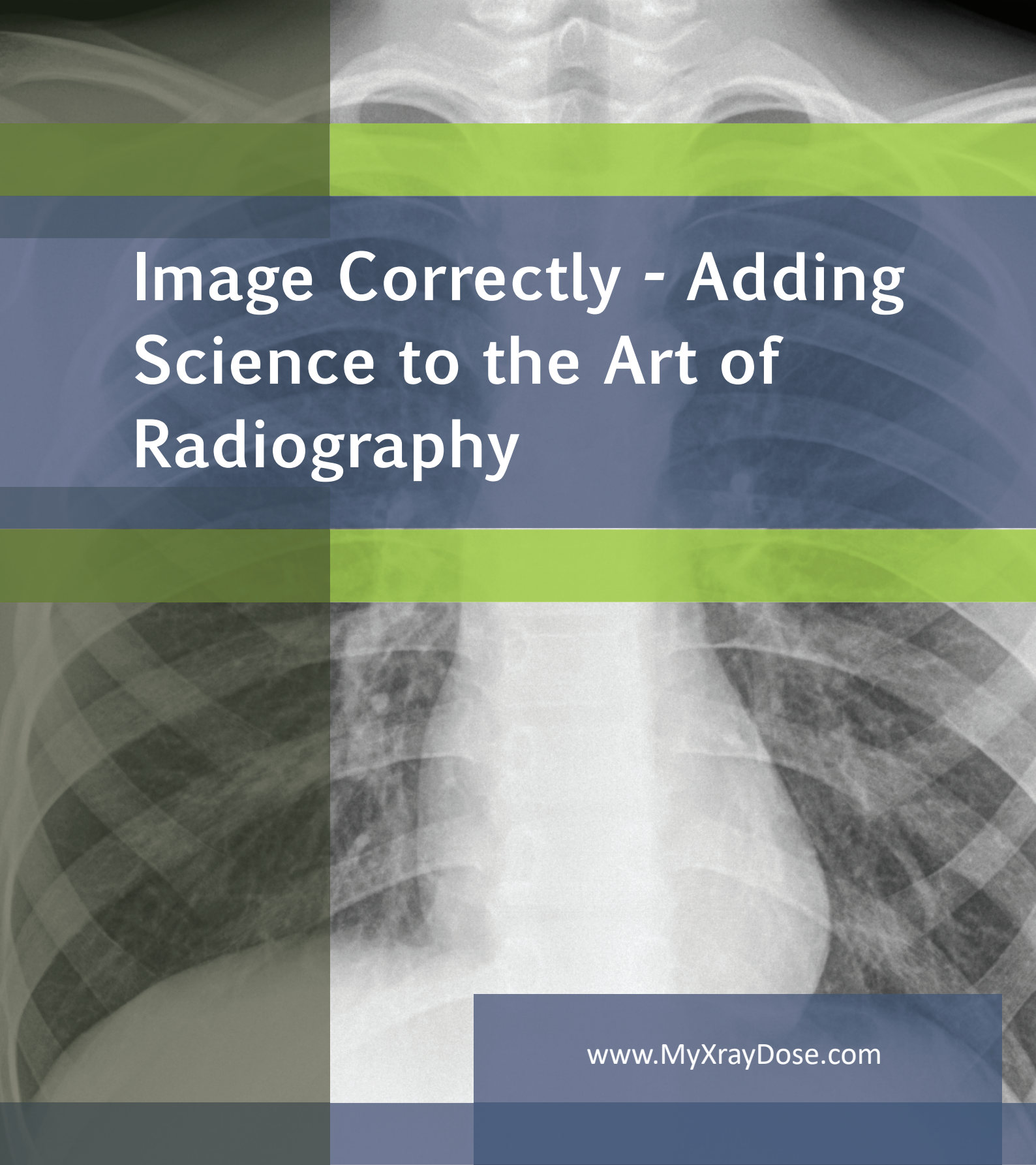
Image Correctly - Adding Science to the Art of Radiography



www.MyXrayDose.com

myxraydose

Published by MyXrayDose Ltd Aug 2019

White paper

Image Correctly - Adding Science to the Art of Radiography

Executive Summary

The core business of a radiology service is to provide accurate consistent diagnoses for the lowest risk to patients. Radiology is a science but continues to depend on subjective methods to refine imaging techniques. This is a fundamentally flawed process resulting in unintentional diagnostic variability which may contribute to poor clinical outcomes for some patients. Combining computer analysis of image quality with a cloud based reporting service, objective image quality and patient x-ray dose goals can be set and monitored. These same objective goals can then be applied across the whole of radiology providing a path to consistent organization and industry-wide diagnostic quality for the lowest x-ray dose to patients.

> *"Appropriate patient care will only follow the correct diagnosis. Get the diagnoses wrong and poor clinical outcomes will almost certainly follow."*

Introduction

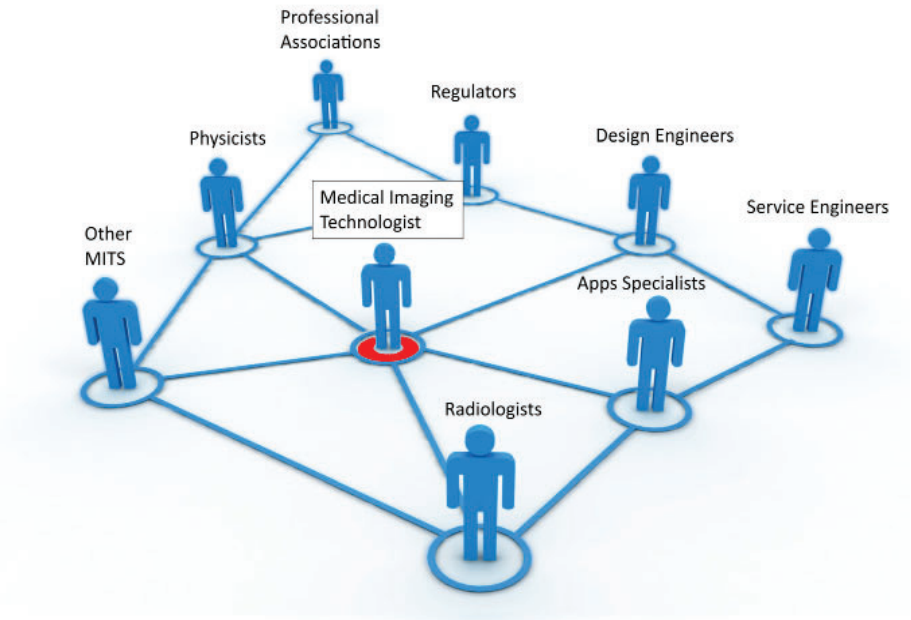
Image Gently and ***Image Wisely***[1] are two excellent initiatives designed to reduce patient x-ray dose through ensuring appropriate radiology referrals and x-ray technique optimization. The difficulty when trying to optimize techniques is exactly how do you know you are imaging correctly and achieving an adequate diagnostic standard? Appropriate patient care will only follow the correct diagnosis. Get the diagnoses wrong and poor clinical outcomes will almost certainly follow. Apart from the human costs, misdiagnoses from inadequate imaging represents a wasted use of radiology services and a flow on effect of wasting other healthcare resources from inappropriate clinical management.

The Shortcoming in visual perception & language when defining imaging requirements

Radiology is a science involving the detection of pathologies. But the process of refining imaging technique protocols is treated more like an art. The applications experts, design engineers, imaging technologists and other radiology professionals will in conjunction with radiologists make subjective judgments about the adequacy of the imaging. This will appear to be validated as pathologies are seen on images and it is then presumed the current practice is adequate. This process is however fundamentally flawed and leads to significant variability in diagnostic image quality for the same sized patient for the same clinical indication across the national fleet of x-ray equipment.

For the edge cases, where the pathology is near the limit of what we expect to see, the difference in image quality may also give rise to a different diagnosis depending on which equipment the patient is imaged with. The difference in image quality is often simply a difference in imaging technique and not because of limitations of the x-ray equipment and so can be correct at little to no cost.

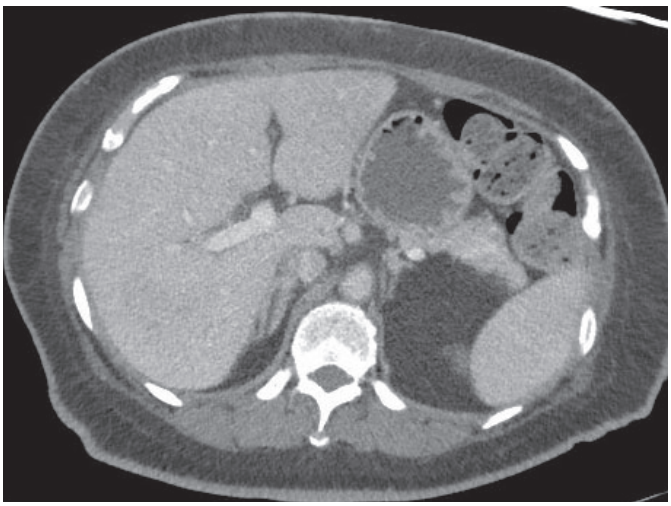
[1] *Image Gently and Image Wisely are registered trademarks of the Image Gently Alliance and the American College of Radiology*



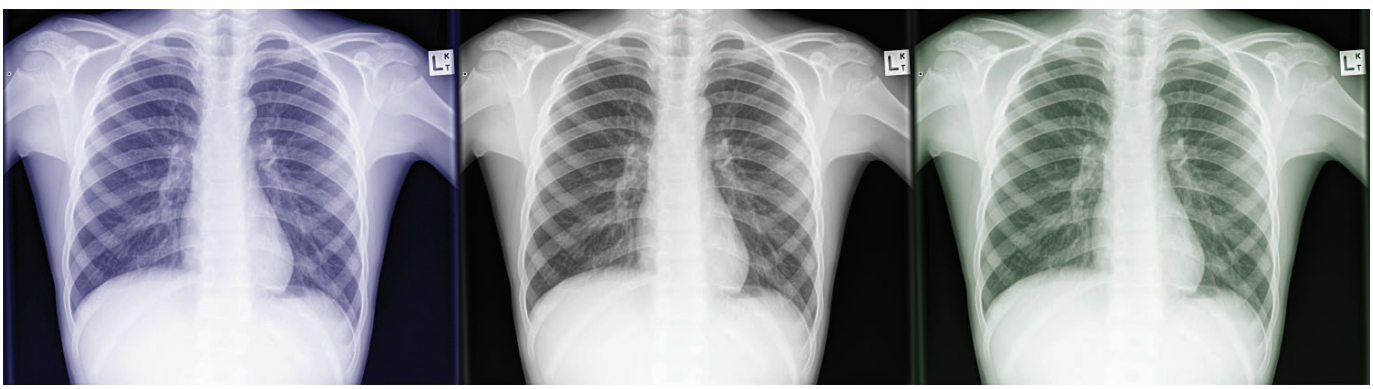
The process of refining radiology techniques is largely subjective with influence from a number of different observers with different expectations that can influence the standard of imaging

The root of this flaw is the fact that our visual perception is not equipped with adequate specificity to assess attributes such as image noise and then predict the influence it will have on the conspicuity of lesions. Compare this with color specificity where from year to year and observer to observer, we (except for the color blind) will all agree if a familiar image such as the chest x-rays below have a slightly green or purple tint.

Associated with the visual specificity to color is a vast language to describe the different colors and their hues. Color specificity can be understood at a physiological level from the spectral specificity inherent in the retinal cones. The same cannot be said for the visual perception of noise. Show a Radiologist a Liver CT and ask them to describe the noise quantity and characteristics in the image. Very limited language is available to describe the amount of noise or its characteristics. “Looks OK”, “about right”, “probably too much”, … Yet we often ask our imaging professionals to make a call as to whether the image noise is sufficiently low to be able to detect pathologies of interest. It simply isn’t possible for a human observer to achieve this reliably and accurately using a routine clinical image. This process is being repeated many times over through radiology as techniques are set up and refined, with the inevitable resultant variability.



For example, is the noise in the above CT image sufficiently low to be able to detect a 10 mm hepatocellular carcinoma with a contrast of 10 Hounsfield units above the normal liver? Maybe, maybe not, but the honest answer is you can’t tell by looking at this single image.



Descriptions of color are specific and consistent between observers. The same isn’t true for other attributes that affect the visibility of pathologies such as image noise characteristics.

The problem is more subtle than this, even if a carcinoma was visible, its size may appear to change with changing image noise as more or less of its margins become obscured by different noise levels. This apparent change in size is important and could have a significant impact on the diagnosis and ongoing management of the patient.

The Missing Tools for Defining Image Quality

Attempts have been made to introduce more science into defining the required image quality by running carefully constructed experiments such as Receiver Operating Characteristics (ROC) studies. These are impractically large, mathematically complex, ethically problematic and difficult to run across the large number of modalities, makes, models, protocols, patient sizes, clinical indications, involving a group of Radiologists in a time-poor radiology service. The industry's response has been a tendency to avoid the issues and claim the radiologist will know and complain when the imaging is not adequate. From experience, the most likely time a Radiologist will complain is when either the imaging has moved so far from adequate that it is clear that the features needed to be visualized won't be seen, or more likely an image of the required quality for the same sized patient arrives and a side by side comparison reveals significant inadequacies in the other set of images.

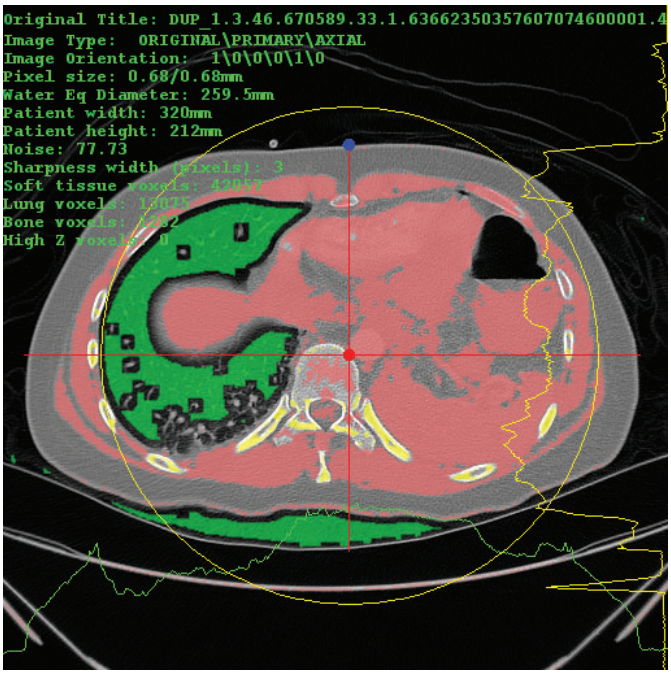
So how does a Medical Imaging Technologist win in this situation? On the one hand, we are concerned about x-ray dose and can measure this with great precision; on the other hand, we want to ensure our patients get an accurate reliable diagnosis but don't have adequate visual specificity to be able to determine whether we are achieving consistent diagnostic quality. If that wasn't causing a big enough problem, increasingly equipment includes software controlled settings that are obscure and complex. For example, what is the difference between "Strong" and "Very strong" tube current adaptation in terms of how it will affect a CT image for different sized patients? Add to this the image processing options and proprietary algorithms that are run over the image before presentation and it all starts to feel like it's too hard to treat the refining of radiology imaging protocols as anything other than a subjective art and hope that time will prove what we are doing is right.

But radiology is a science and there is too much at stake to let the vagaries of subjective assessment be used to set imaging performance. The chance of detecting pathologies in a noisy image can be described mathematically, and the presence and appearance of pathologies can be described by a radiologist so some of the key elements exist to find an objective solution to setting consistent image quality in clinical practice.

Where would you even begin? The multiple variations in different modalities and study types with their own specific image quality requirements and a range of patient sizes makes objectively assessing image quality a very large task in even a small radiology service. Add to this the many thousands of patients that will be x-rayed in a year, with patients queuing up in the waiting room. Whatever approach is used to help manage this issue needs to fit seamlessly and effortlessly into the normal radiology work flow.

It's a difficult problem to solve. We need methods to extend visual perception, a language to accurately describe the image quality characteristics in a way that relates to a radiologist's perception, the technology to do this across all imaging modalities, studies and patient sizes, a way of defining the expected image quality characteristics, a process that integrates effortlessly into a busy working radiology practice, and the tools to find the root causes of any imaging or dose issues that have been identified. This all needs to be achieved without losing sight of the objective of keeping patient x-ray doses as low as we can.

The good news is this problem can be solved with computerized image analysis and cloud-based analytical and reporting services.



Quantitative analysis of radiology images can be used to accurately extract image quality attributes such as image noise and resolution. These can then be used to benchmark the image quality against typical industry values or predefined targets for specific radiology study types.

First Do No Harm

There are approaches to optimization being made that only manage the x-ray dose side of the problem. The potential for causing more harm than good to patients from dose reduction inadvertently compromising the adequacy of the diagnostic image is too large to ignore. The optimization problem needs to be flipped the right way up and the question of whether the image quality is of an adequate standard answered first before trying to identify ways to minimize patient dose.

Putting diagnostic adequacy first is consistent with the central national and international radiation protection documents. The principle of optimization of patient dose begins by stating that achieving adequate diagnostic quality is the primary objective and that dose minimization is secondary to this. A statement that is unfairly left to the reader to try and implement without the methods or ability to do in a working radiology service.

The Solution

At www.MyXrayDose.com we have developed a set of software tools that fits seamlessly into the normal radiology work flow for accurately measuring and managing the quality of clinical images. Patient dose monitoring has been combined with this to provide a full set of data for finding opportunities to minimize patient dose. We are proud to be the first to provide a cloud-based service to bring quantitative tools to radiology professionals to help solve the problem of achieving consistent diagnostic quality and also x-ray dose optimization in a working radiology service.

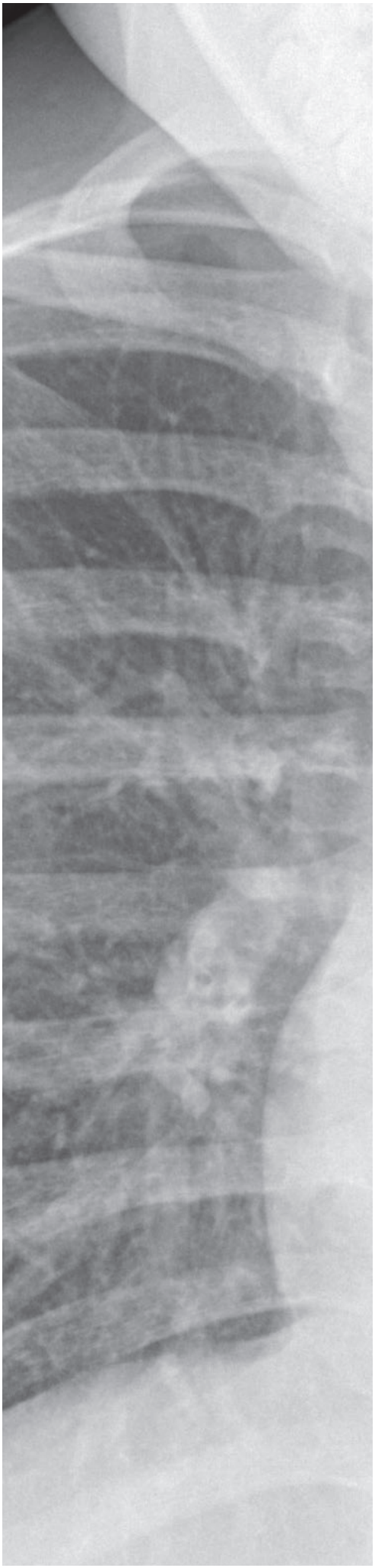
If you want to learn more about how the MyXrayDose service could help raise the standard of your radiology practice, contact us and we would be happy to show you how to take the consistency and diagnostic accuracy of your radiology service to the next level.

How to get started

Please contact us

by email at **Enquiry@MyXrayDose.com**

or through our website at: **www.MyXrayDose.com/contact/**



About www.MyXrayDose.com

Where we are

www.MyXrayDose.com has been developed by a company that specializes in producing software tools to support and improve the practice of medical imaging professionals. The services we offer live in the Cloud and are available internationally.

Software & services we provide

- **www.MyXrayDose.com** is our flagship service for the quantitative analysis and management of clinical image quality and patient dose.
- **LesionSim** - For the advanced users or those involved in applied imaging research we have developed clinical imaging simulation tools to run virtual clinical trials of imaging techniques. This allows the prospective simulation and refining of clinical protocols without the need to irradiate patients to confirm optimal imaging techniques.
- **ViewIQ** is a software application for calibrating medical image displays to DICOM Part 14 standards for optimal clinical image viewing

Who our customers are

Our customers range from multi-modality comprehensive radiology service providers to single x-ray system practices in public and private organizations. Our service is available internationally.