Chapter 6

Conclusions
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Electronic portal imaging devices have been examined since the early 1980’s as alternatives to film megavoltage imaging. Although commercial EPIDs have been available since the early 1990’s, it is recognized that the widespread clinical use of these systems is still to be realized. Commercially available systems were developed to provide the best image quality with the lowest possible noise contribution to achieve higher accurate and reliable radiation treatment dose delivery. Great advances have been made in the technical development and clinical use of electronic portal imaging system devices. Since amorphous silicon flat panel imagers became commercially available in 2000, an increase on their clinical and physical usability for several QA applications is noticeable.

Acceptance testing and commissioning programs based on imaging system performance were performed together with improvements on linear accelerators technologies to achieve higher conformity and confidence levels for a safe and high quality treatment delivery. Quality control tests have been developed to meet the stated specifications and establish baseline parameters for future quality control programs, new trend analysis and upgrades for the widespread of portal imaging technology.

Analyzing physical images is a complicated multivariate technique related to the contrast, resolution and noise properties of imaging systems. The factors affecting these components are basically independent of each other, but the final outcomes are interrelated. The problem can be stated as a given black box (the system) in which we shall determine its transfer characteristics, so that the output resulting from any possible input, can be predicted uniquely.

Physical and clinical decisions have always a certain degree of inaccuracy and subjectivity, which should be measured, quantified and documented. The quality assurance of a specific parameter should be carried out with minimum external noise sources which normally act as confounding variables that can influence the final statement.

Currently available phantoms (QC-3V) analyse small EPID areas and therefore cannot provide an efficient QA analysis for clinical applications since they can miss clustered areas with poor clinical image quality. The end-of-life is associated with clustered artefacts that coincide with structures in clinical images which can influence the accuracy of image matching procedures.

New approaches for EPIDs quality control were investigated to obtain feasible and reliable quantification of the image quality in the time trend, by looking into non standard and non documented methods and applications.

The first results of our study suggest that evaluation of the new approaches could be correlated in time with imaging system degradation as the panel gets damaged by the incident radiation. Both the Subpanel Image Noise (SIN) technique and the Non Average Pixel (NAP) response revealed higher correlation of measurements than the QC-3V based parameters, compatible with a decrease on image quality by artefacts detection and therefore the end of life.
When talking about the end-of-life the exact moment is always a big constraint as subjective clinical evaluation is a controversial analysis due to higher degree of disagreement between different observers.

EPIDs life line is still an unpredictable task, as large number of noise sources in any portal imaging system could be influenced by energy absorption noise, noise added by the imaging system and noise in the human visual system. Nevertheless the imaging system underlying process is changing day-by-day and the noise properties become less statistically dependent which make this non-stationary process a candidate for a discrete analysis in time.

We can conclude that for larger EPID matrix areas, compatible with field sizes of around $15 \times 15$ cm$^2$ at the isocenter (almost clinical situations), the prediction of the end-of-life was followed by $\sim 2.5\%$ non-average pixels increase and an overall subpanel SNR reduction by less than 35, accompanied by a reduction of 80% of clinical positive appreciation.

These new approaches have been shown to be practical for detector panel damage quantification by correlating physical parameters to the clinical usability.

Reference values for EPIDs life line and the end-of-line, should be clearly demonstrated with further investigations with individual EPID measurements in time. Since a great number of external variables such as: dose rate; beam energy; frame acquisition rate; integrated frames per image; attenuation levels; etc. add different contributions for spatial resolution and signal-to-noise ratio properties, the quantification of the non average pixel response and subpanel image noise should be reported and well documented for a future EPID acceptance tests and commissioning.