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Introduction

- Electronic portal imaging devices (EPID) can be used for transit in vivo dosimetry (IVD) (Fig 1a).
- **Major limitation** of amorphous Silicon EPID detectors for usage IVD: non-linear detector response to water equivalent dose [1,2].
- **Possible solution**: deep learning (DL) model, to obtain portal dose (PD) from EPID images (Fig 1b) [3].
- **This work**: assess the sensitivity of our DL framework to detect different dose errors and to compare various metrics (Fig 1c).
- Useful for the development of inhouse DL-based alert system.

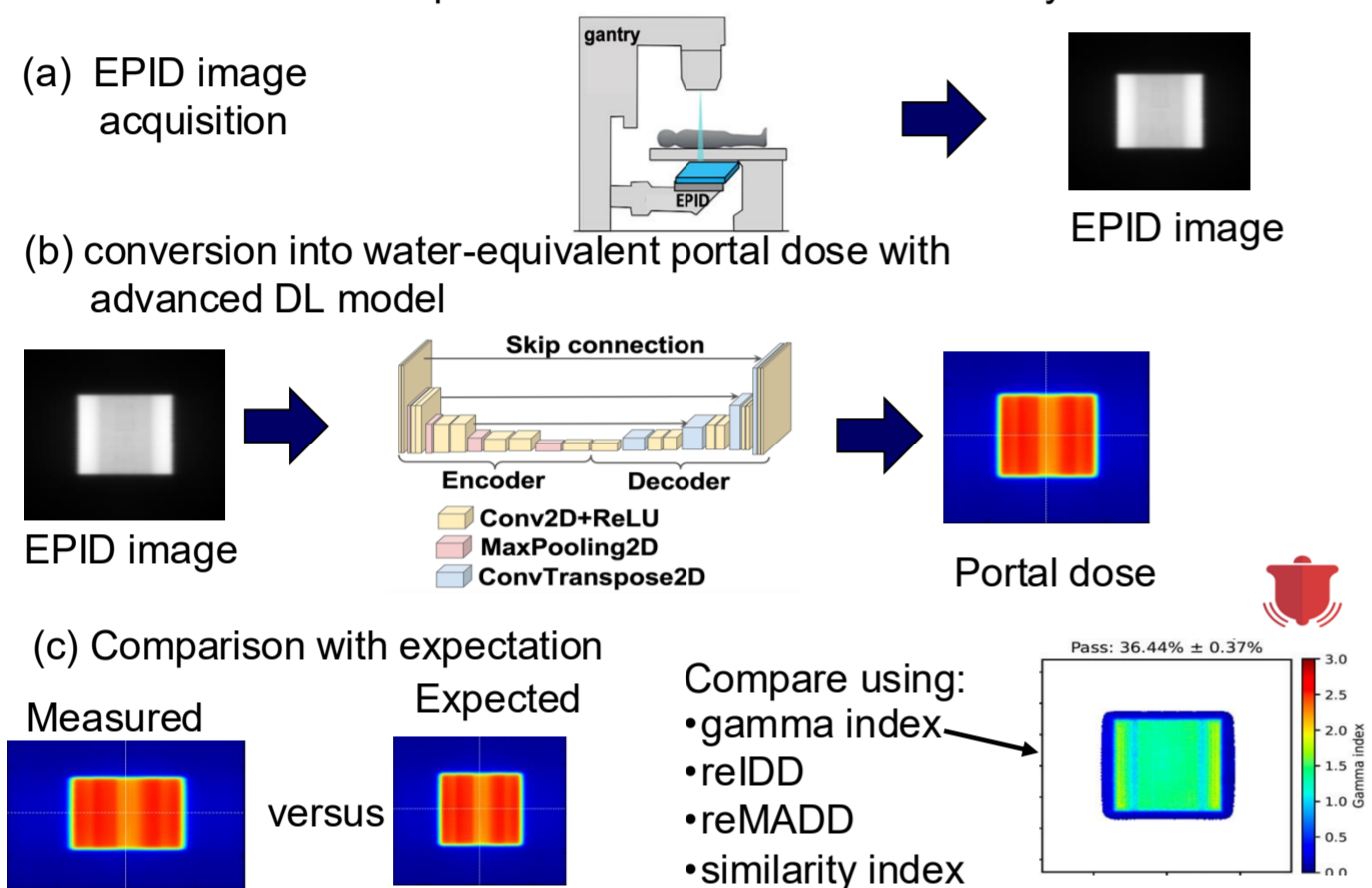
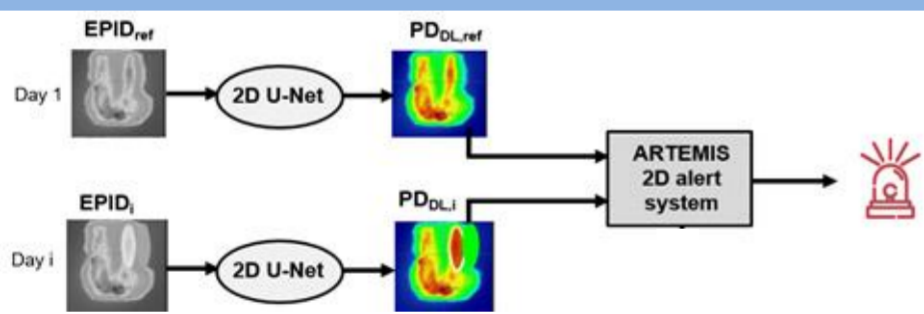


Figure 1. (a) EPID image acquisition, (b) DL model converts EPID into portal dose, (c) assessment of sensitivity of framework to error detection

Research objective

To evaluate the applicability of our DL model within an in-vivo alert system for radiotherapy. Specifically, this study focuses on quantifying the sensitivity of the system in detecting different types of treatment errors.



Materials & Methods

- We performed irradiations of various commercial + non-commercial radiotherapy phantoms (Fig 2a) and fields, using the Elekta Versa HD Linac at the Carreggi University Hospital.
- Acquired EPID images without errors (reference, 1c) and with controlled treatment errors (Fig 1c) and converted into portal dose (PD) images.
- Various alert metrics for 2D analysis: gamma index, relative mean absolute dose difference (ReMADD), integral dose difference (IDD), Root Mean Square Error (RMSE), and more.
- Systematic comparison of metrics.

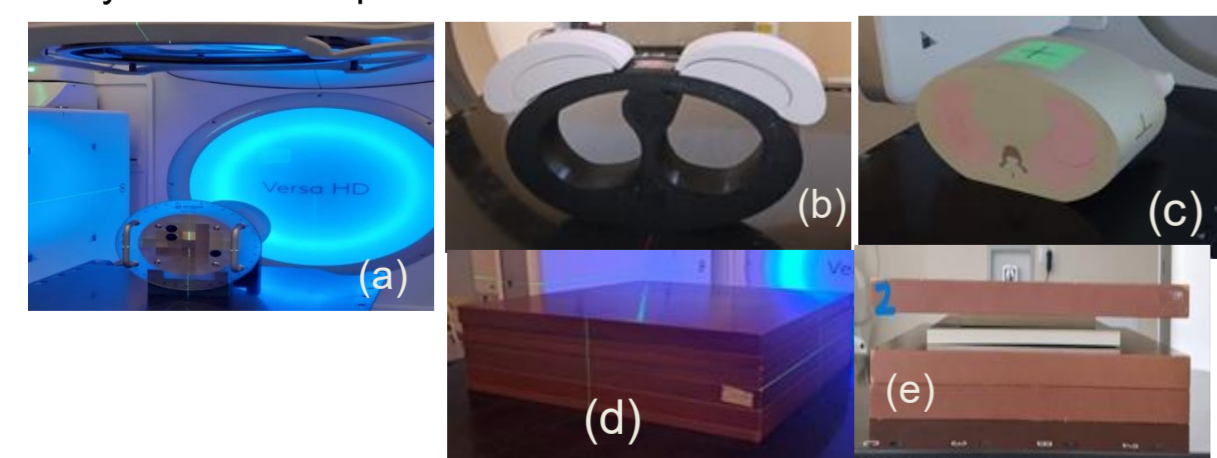


Figure 2. Phantoms irradiated in our study: Multiplug (a), Customized INFN breast phantom (b), CIRS (c), solid water (d), inhomogeneous phantom (e).

Results

- DL-based framework sensitive to dose delivery errors.
- Gamma index alone not always enough to detect errors, particularly when using narrow fields.
- Example: when irradiating a CIRS phantom with 1x15 cm² field, gamma passing rate (GPR) was 95%, while there was 5% excess in monitor units (Fig 3 a). Combining with other metrics can help in error detection (Fig 3 b, c and d).
- Sensitivity improves if more than one metrics is used.

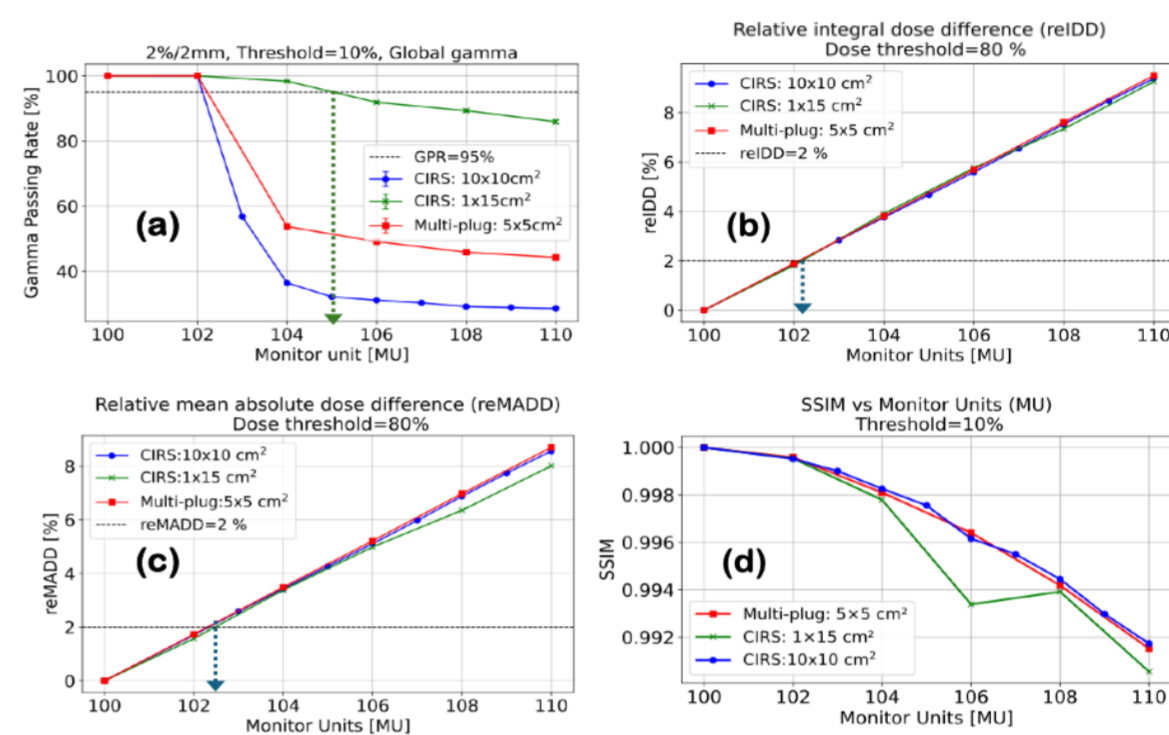


Figure 3. Example of metrics for comparison of DL-generated portal dose images: gamma index (a), integral dose deviation (b), relative mean absolute dose difference (c), and similarity index (d), when comparing a PD acquired while there was an excess in monitoring units with the reference.

Conclusions

In the 2D EPID-based alert systems, it is important to apply various metrics, rather than to be limited to a single metric such as gamma passing rate (GPR). Using a combination of metrics is important to detect serious treatment errors and to estimate the error source.

DL framework developed to transform EPID into dose images	Avoids complex EPID calibration and correction	Detection of errors with alert system including different metrics	Potential for real-time in-vivo dosimetry for increasing patient care quality
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ARTEMIS: Artificial Intelligence in RadioTherapy with EPID Monitoring System

InTrEPID: In vivo 3D dosimetry in radiotherapy Treatments with EPID

References

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