

Purpose: To evaluate and identify safety system concerns and possible failure modes for a multimodality, linear accelerator (linac) – magnetic resonance imager (MRI) - brachytherapy, radiotherapy system.

Methods: A Delphi process is applied to investigate the safety system concerns and possible failure modes in a linac-MRI-brachytherapy system. Well established, for instance in the automotive or airline industries, system, design and process failure modes effect analysis can be applied to the design of a multimodality radiation therapy system.

Results: Safety design, systems, processes and culture in radiation therapy is of great importance. When implementing new technologies a review of the necessary staff and patient safety may be necessary. To address patient and staff safety concerns a thoughtful design process must be implemented when an MRI is present or near a linac or a brachytherapy system. Each input into a patient specific process map, such as consent, screening, immobilization, planning, image guidance and machine movement coordination must be analyzed for safety and failure modes concerns. Numerous items have been identified as potential failure modes, these items have been classified into the following nine categories: screening, motion, interlocks, imaging, treatment delivery, dosimetry, plan adaptation, mechanical and miscellaneous. A broad range of failure modes have been identified some of these include and range from non-compatible in-room finishing to linac performance degradation under repeated small magnetic field influences to improper patient screening and the possibility of machine collisions.

Conclusions: An abridged list of suggestions resulting from our safety systems analysis includes a rigorous staff educational and training program, the evaluation of current quality assurance devices used for mechanical and dosimetric tests, an interlocked computerized system for machine translations and rotations, machine servicing protocols and both fire and patient emergency protocols.