Purpose:The global cost burden of radiotherapy is $5 billion annually, with vault design, construction and linacs being major components. To maintain state-of-the-art technologies and simultaneously reduce costs, we propose a novel mini linac system utilizing a vertically mounted fixed beam 6MV linac, a rotating couch, and IGRT. The aim of this study was to design and quantify the building size, concrete requirements and cost of the proposed mini linac system compared with conventional systems (6MV gantry mounted linacs in average vault size) and compact linacs (6MV gantry mounted in small vault).

Methods:The inner vault footprint was calculated based on the equipment configuration in the room and the necessary treatment and clearance distances. Utilizing shielding equations, we determined the necessary thicknesses of barriers in the mini system vault, and the amount of concrete required. In determining cost estimates of linac systems/vaults, values were obtained from the literature and shielding specialists. We compared the vault footprint and the total costs of linac systems/vaults.

Results:The proposed mini system vault footprint is 20m2 compared to 85m2 and 110m2 for compact systems and conventional systems respectively. The mini system only requires secondary shielding. Parametric studies revealed that leakage radiation was dominant, thus allowing the use of an ultra low leakage ratio mini linac. We determined that the amount of concrete required in the shielding of the mini system is 50m3 compared with 150m3 and 216m3 for the compact and conventional vaults respectively. The total costs of the proposed mini system and vault was estimated at US$1,200,000, which was lower than the compact and conventional linacs/vaults, US$1,500,000 and US$3,000,000 respectively.

Conclusions:We are able to substantially reduce the cost of high quality radiotherapy using a vertically mounted 6MV fixed beam mini linac housed in small vault.