Purpose: Direct addition of doses between plans with different fractionation fails to provide accurate dose-response information to anticipate clinical outcome. To combine different fractionation patterns, first-order biological model correction for dose-rate must be included. Moreover, 3-D isoeffect patterns of the combined doses must be displayed so that overlap area to elegant volumes can be avoided. The linear quadratic (LQ) model and biologically effective dose (BED) method were used to produce a combined plan in equivalent 2 Gy fractions (EQD2) for radiosurgery and conventional 3D radiotherapy.

Methods: For patients with multiple courses of radiotherapy, dose distributions of the prior and boost treatment plans were converted to BED. The fraction size specified by the prescription was applied globally for each BED calculation. $\alpha/\beta$ ratio of 10 and 2.5 was used for early and late effect, respectively. Image registration with CT or MR was performed for initial and boost plans. The registration information was applied to dose distributions to obtain the composite EQD2.

Results: As a demonstration of this method, two patients were selected who had combined treatments from substantially different modalities. A patient with liver cancer initially received radiotherapy of 30 Gy/10 Fx and re-irradiation with CyberKnife radiosurgery (15 Gy/1 Fx). The combined plan showed that the PTV received EQD2 of 63.8 Gy. Another patient had brain metastasis treated with GammaKnife of 18 Gy (50% isodose) followed by conventional 3D whole brain radiation of 30 Gy/10 Fx. The minimal combined tumor EQD2 was 74.5 Gy. Early and late calculated responses showed that all critical organ doses were within tolerance.

Conclusions: For patients receiving radiation with different fractionation schemes, combined isoeffective dose distributions were calculated and displayed. In both cases, crucial information regarding 3-D dose distributions assisted the physicians in determining whether tolerance limits of overlap areas of retreated critical structures were preserved.