Purpose
During adaptive radiotherapy dose assessment, the estimated doses delivered to the parotid glands are often used as an indicator of how well the treatment delivery adheres to the planning objectives over a radiotherapy course. Uncertainties in the estimated parotid doses could result in the use of clinical resources for unnecessary replanning or the lack of a replan for a patient that could have benefitted from one. This study aims to establish a baseline dosimetric uncertainty of the parotid glands by examining two questions:
1) What is the inter-observer variability of physician-drawn parotid contours?
2) What is the dosimetric uncertainty of contours automatically generated from the physician-drawn contours using deformable image registration?

Materials/Methods
16 parotids with planned D_{50\%} values of 15-30 Gy were selected for review from 9 patients treated for head and neck carcinoma using helical IMRT. Each patient was re-imaged in the treatment position weekly using the same kVCT simulator. Parotid contours were drawn on the planning CT, a mid-treatment CT, and an end-of-treatment CT by three different clinicians resulting in a total of 144 parotid contour sets. The mid-treatment and end-of-treatment CTs were rigidly registered to the planning CT and dose distributions were recalculated on all image sets. The inter-observer variability was quantified using the relative standard deviation (RSD). The RSD is defined as the D_{50\%} standard deviation divided by the mean for each parotid. Deformable image registration (DIR) was then used to propagate each observer’s contours from the planning CT to the subsequent image sets. To evaluate the uncertainty of the automatically-generated parotid contours, DVHs were generated and the D_{50\%} endpoints of the automatic contours were compared to the contours drawn manually by each observer.

Results
The inter-observer overall mean RSD ± 1 SD was 9 ± 6% for the D_{50\%} of the parotids. The minimum and maximum D_{50\%} RSDs were 2% and 24%, respectively. Figure 1 shows the inter-observer contour variation for a typical patient.

Conclusions
The baseline inter-observer variation shows that the “true” parotid D_{50\%}, as defined by physician contours, is uncertain by an average of ±9%. If automatic contours were used in place of contours drawn manually by physicians, the D_{50\%} of the parotids in this dataset would be overestimated by 2%, on average. However, the uncertainty in the estimation of the parotid D_{50\%} using the automatic contours is on the same order of magnitude (±10%) as the inter-observer D_{50\%} variability (±9%) despite the fact that the automatic contours were only compared to the manual contours drawn by the same observer. Future research will explore the relationship between the uncertainty in the manual and automatic contours and attempt to analyze intra-observer dosimetric trends over the treatment course.