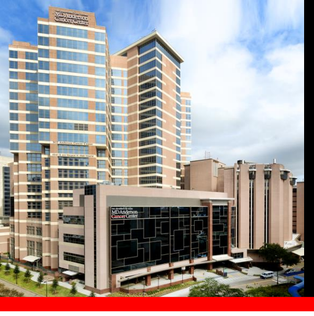

Predicting Tumor-Related Liver Failure in Unresectable Intrahepatic Cholangiocarcinoma Patients through the Development of an Imaging-Based Deep Learning Neural Network Model

Arie Van Wieren BS, Brian De MD[1], David Fuentes PhD[2], Milind Javle MD[3], and Eugene J. Koay MD PhD[1]

[1]Department of Radiation Oncology, The University of Texas MD Anderson Cancer Center, Houston, TX, USA
[2]Department of Imaging Physics, The University of Texas MD Anderson Cancer Center, Houston, TX, USA
[3]Department of Gastrointestinal Medical Oncology, The University of Texas MD Anderson Cancer Center, Houston, TX, USA

THE UNIVERSITY OF TEXAS MD Anderson Cancer Center
Making Cancer History®

Background

Intrahepatic cholangiocarcinoma (iCCA) is an uncommon, aggressive bile duct cancer. Two-thirds of iCCA tumors are surgically unresectable at diagnosis and prognosis for these patients is poor, with median survival time of 2.5-7.5 months in absence of treatment.[1] More than half of unresectable iCCA patients die from tumor-related liver failure (TRLF), a result of the tumor invading and disrupting the nearby parenchyma, vasculature, or bile ducts.[2]

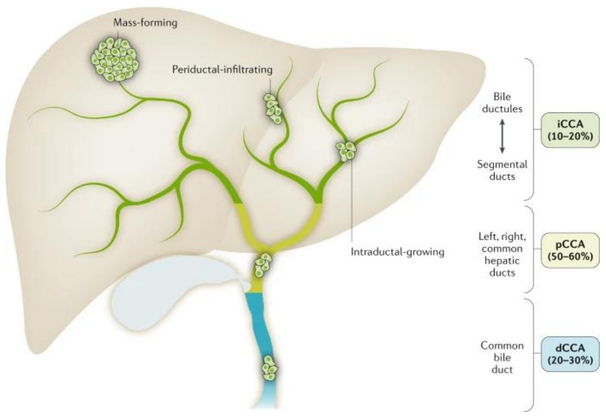

Figure 1. iCCA is a malignancy that arises in the periphery of the second-order bile ducts.[3]

Ablative radiotherapy (ART) has been shown to effectively mitigate TRLF and improve survival, but fewer than 1 in 6 iCCA patients likely to develop TRLF receive this treatment.[4] This stems from the difficulty of prospectively identifying this subgroup of patients. To enable automated identification of iCCA patients likely to develop TRLF, we are developing a model applying the predictive ability of deep convolutional neural networks (CNNs) to an institutional database and pretreatment computed tomography (CT) scans for patients with unresectable iCCA. We predict that intratumoral and peritumoral imaging features of iCCA along with clinicopathologic features can be used by a CNN to accurately predict TRLF.

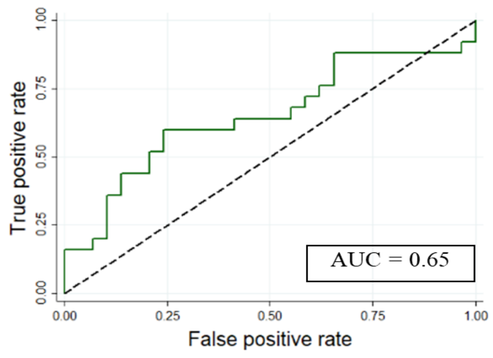

Figure 2. Receiver operating characteristic curve of logistic prediction model for TRLF using pretreatment clinical characteristics. Clinical characteristics alone are inadequate to predict TRLF.

Methods

We will construct a large institutional database that includes manually segmented CT scans, molecular data, and treatment data to train, validate, and test a CNN that can accurately predict whether a patient will develop TRLF. To construct an institutional database for training of the CNN, we will review records of 700+ patients with iCCA.

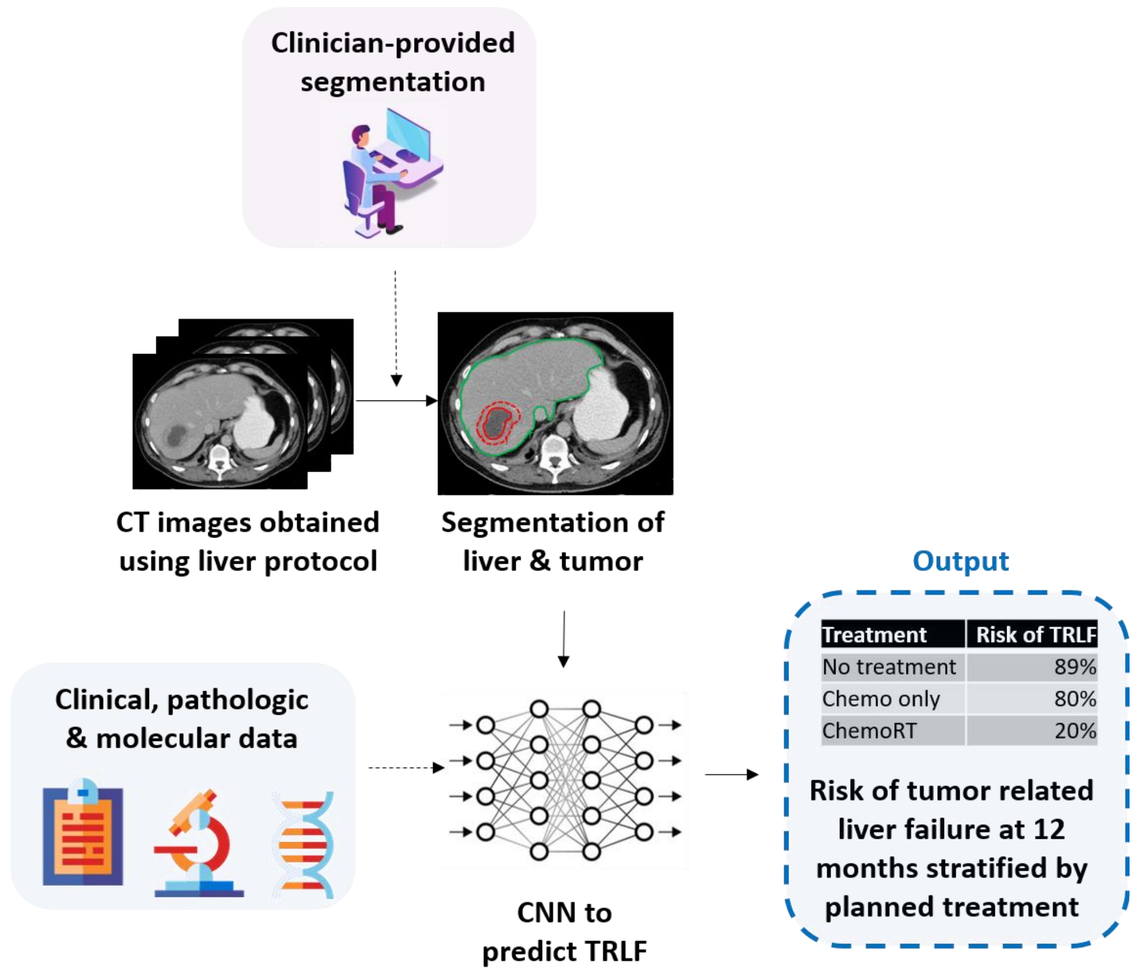

Figure 3. Workflow displaying how segmented liver protocol CT images and clinical, pathologic, and molecular data will be utilized by a CNN to provide risk of TRLF at 12 months.

Results

Currently, we have analyzed 175 patients who underwent radiotherapy for unresectable iCCA at MD Anderson from 2002-2021. TRLF was found to be the cause of death in 13 of 83 patients with a known cause of death.

Table 1. Median age, tumor size, radiotherapy treatment conditions, and overall survival.

	Median	Range
Age (years)	66	25-89
Tumor Size (cm)	7.3	1.7-18.4
Radiotherapy dose (Gy)	67.5	33-100
Fractions	15	33-100
BED10 (Gy)	98	44-144
Overall Survival (months from diagnosis)	23.9	1.9-163
Overall Survival (months from radiotherapy)	13.7	0.6-153.5

Table 2. Percentage of patients by American Joint Committee on Cancer 8th Edition Stage at start of radiotherapy.

American Joint Committee on Cancer 8th Edition Stage	
Stage I	12%
Stage II	22%
Stage III	37%
Stage IV	29%

Table 3. Overall Survival at one year following radiotherapy.

	Overall Survival [95% CI] at 1 year following radiotherapy
All patients (n=175)	73% [65-81%]

Table 4. Percentage of patients by tumor location.

Tumor location in liver	Percentage of Patients
Centrally	71%
Peripherally	29%

Table 5. Most common mutations in iCCA patients with molecular testing.

Gene	Percentage of Patients with Mutation
IDH1	24%
TP53	21%
ARID1A	21%
FGFR2	13%
BAP1	12%
IDH2	12%
PIK3CA	11%

Conclusions

Our preliminary data indicate a range of outcomes for patients and variables that may be useful to develop a CNN to predict TRLF. Looking forward, we will expand on our efforts to annotate patient data as well as manually segment CT scans of these patients for training of the CNN models.

References

1) Park et al. Gut LIver. 2009;3(4):298-305
2) Koay et al. Hepatobiliary Surg Nutr. 2017;6(2):105-116
3) Banales et al. Nat Rev Gastroenterol Hepatol. 2020;17(9):557-588
4) Tao et al. J Clin Oncol. 2016;34(3):219-226