Abdominal Imaging and HCC Risk

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We have restricted our dataset to adult UCSF patients diagnosed with HCV who, prior to the start of follow up (ie. as of 12/31/14) had no cirrhosis and no HCC. (n = 1628) For those who had been in the system prior to 2015, historical data back to 2011 was used to calculate their FIB-4 score at the beinning of follow up (ie. by the end of 2014), for those who did not yet have those data, the FIB-4 score in 2014 was imputed using multiple imputation (m=5).

- **Sex**. This is a dichotomous variable, with two categories (male, female), as UCSF has not been capturing other gender categories within Epic.
- **Race**. This is a categorical variable, which we have recategorized into White, Black/African American, Latinx, and Other for ease of analysis.
- **SES**. We are using insurance type (Medi-Cal, or not Medi-Cal) as a marker of SES status, which is again a dichotomous variable.

The table below displays the demographic breakdown of the sample.

Demographic	Category	n	%
Sex	Male	897	55.1%
	Female	731	44.9%
	Black/African American	262	16.1%
	Latinx	217	13.3%
Race/ethnicity	White	818	50.2%
	Other	331	20.3%
	Unknown	NA	NA%
SES (Payor type)	Medi-Cal	288	17.7%
	Not Medi-Cal	1340	82.3%
TOTAL		1628	100%

Here, $Y(t)$ is an indicator variable describing whether or not the patient has been diagnosed with HCC by time t; as such, it deterministically jumps to 1 and remains there once an individual has become ill.

Causal Question: How would the counterfactual probability of getting HCC differ by the end of the 5 year follow up under an intervention to get abdominal imaging at least once a year every year for four years?

The target causal parameter is $\psi^F(\mathcal{P}_{U,X}) = E_{U,X}(Y_{\bar{a}=1(5)} - Y_{\bar{a}=0(5)})$

the average treatment effect on HCC diagnosis in year 5 assuming that all patients had abdominal imaging every year for the 4 prior years ($Y_{\bar{a}=1}$), compared to HCC outcomes in year 5 if all patients did NOT have

abdominal imaging at any time point during the preceding four years ($Y_{\bar{a}=0}$).

When testing our estimators against a simulation of 100,000 patients roughly matching the variable distribution of our observed dataset, here is how they performed:

	G-Comp	IPTW	TMLE
Bias	-0.00084	0.306642	-0.00333
Variance	0.00002	0.014691	0.00085
MSE	0.00002	0.10872	0.00086

Ultimately, implementing *ltmle* with *Super Learner* on our observed data produced the following estimates for the risk difference of developing HCC in year 5 when receiving abdominal imaging at least once per year for the 4 preceding years, compared to not receiving abdominal imaging during that time, when controlling for the number of hepatology or primary care visits, FIB-4 score, sex, race, and SES was:

G-Comp (95% CI)	IPTW (95% CI)	TMLE (95% CI)
1.116	1.116	1.146

Note that 95% CIs have not yet been computed in this draft but will be fixed.

If we use the G-computation estimate, this means that over the five years under study, patients with no cirrhosis at baseline were 1.1% less likely to develop HCC by year 5 when they had abdominal imaging each year for the 4 previous years, compared to patients who had no abdominal imaging, when controlling for liver cirrhosis, number of primary care or hepatology visits, sex, race, and SES. **This represents a number needed to treat (NNT) of 90**: for every 90 people who receive annual abdominal imaging despite no evidence of cirrhosis at baseline, 1 case of HCC could be prevented over 5 years.