

Cost-effectiveness of hepatitis C treatment: The Indian Scenario

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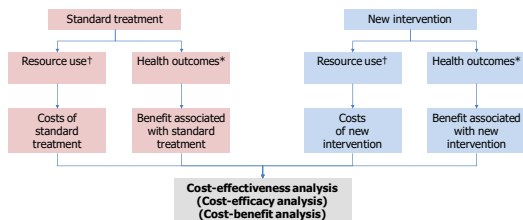
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HCV infection in India

- Disease burden: 6 to 7 million viremic cases (0.5-0.6% of population), mainly genotype 3
- Generic DAAs available at low cost since 2015
 - NS5b inhibitor: Sofosbuvir
 - NS5a inhibitors: Daclatasvir, ledipasvir, (velpatasvir)
- However, number of persons treated still low (except in some areas)
- Cost-effectiveness data for generic HCV DAAs not available
- Could DAA-based treatment for HCV be cost-saving?
- If yes, how long does it take for this treatment to be cost-effective or cost saving?

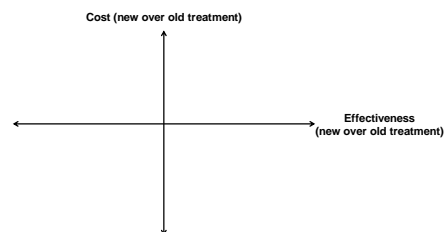
Such data may allow a broader use of treatment

Cost-effectiveness evaluation

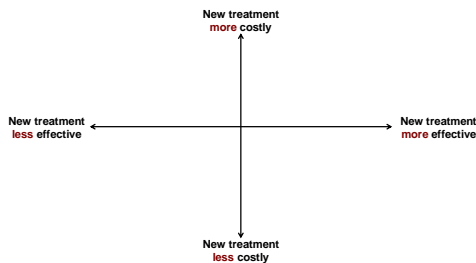


† Healthcare costs ± indirect costs ± loss of wages
 * Benefits as physical quantities (e.g. life span, cases prevented), QALY, DALY, monetary value

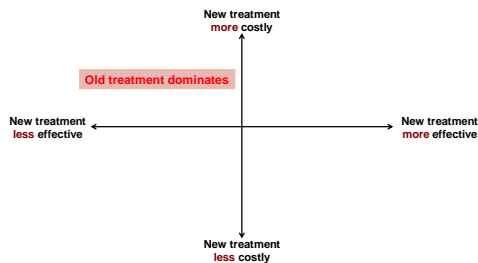
Incremental cost-effectiveness plane



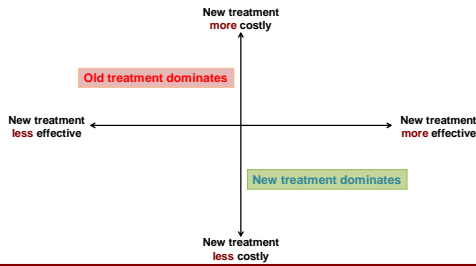
Incremental cost-effectiveness plane



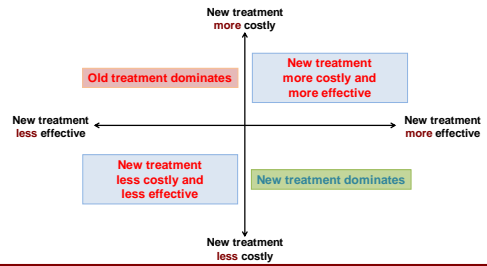
Incremental cost-effectiveness plane



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Incremental cost-effectiveness plane



Cost-effectiveness analysis

- Incremental cost-effectiveness ratio (ICER)
- Defined as

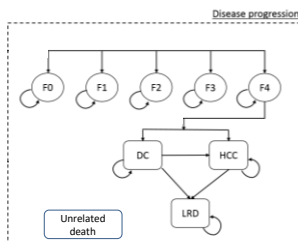
$$= \frac{\Delta C}{\Delta E} = \frac{\text{Change in cost}}{\text{Change in effect}} = \frac{\text{Cost new treatment} - \text{cost current treatment}}{\text{Effect new treatment} - \text{effect current treatment}}$$
- Represents: extra money spent per unit gain
- Lower values better

Methods

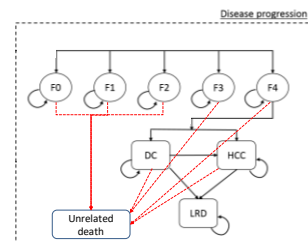
- Used a Markov state-transition model: MATCH (Markov-based Analyses of Treatments for Chronic Hepatitis C)
- Modified for India
- Base cases:

HCV infected persons in India	
- Age	35 years
- M:F (%)	58 : 42
- Genotype 1:3:4 (%)	32.0 : 63.4 : 4.6
- F0:F1:F2:F3:F4 (%)	18 : 25 : 22 : 22 : 13
- Excluded	HBV/HIV coinfection, kidney disease, multi-transfused, or prior failed treatment

HCV: Disease progression model



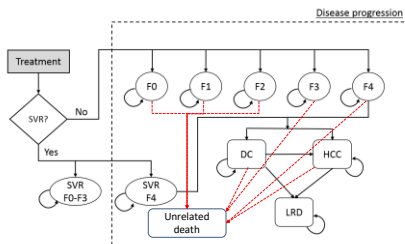
HCV: Disease progression model



Adapted from: Chhatwal J, et al. Annals Intern Med 2015; 162: 397-406.

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HCV: Disease progression model



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Assumptions: Treatment regimens

HCV genotype	METAVIR fibrosis stage	Treatment drugs	Treatment duration (weeks)	Sustained virological response (%)	Treatment discontinuation (%)
G1	F0-F3	SOF + LDV	12	98.1	1
	F4	SOF + LDV	12	93.2	1
G3	F0-F3	SOF + DCV	12	97.0	0
	F4	SOF + DCV	24	86.0	2
G4	F0-F4	SOF + LDV	12	95.0	1

Alshai N et al. *NEJM* 2014; 370: 1889-98.
Nelson DR et al. *Hepatology* 2015; 61: 1127-35.
Weitz et al. *Gut* 2016.

Assumptions: Medical costs

Item	Cost Indian Rupees (US\$)	Range
Pre-treatment workup (genotyping, fibrosis, others)	8,000 (119)	0.5 to 2.0 fold
DAA's (Sof+Dac/Ldv) cost for 4 weeks	6700 (100)	1.0 to 9.0 fold
Tests during and after treatment	6,000 (89)	0.5 to 2.0 fold
Annual cost of tests and drugs		
F0-F3	2000 (30)	0.5 to 2.0 fold
Compensated cirrhosis	10,000 (149)	0.5 to 2.0 fold
Decompensated cirrhosis/HCC	40,000 (596)	0.5 to 2.0 fold

Assumptions

Quality of life weights	State	Baseline	Range
	F0-F3	0.93	0.84-0.99
Compensated Cirrhosis	0.90	0.81-0.99	
Decompen Cirrhosis	0.80	0.57-0.99	
HCC	0.79	0.54-0.99	
Post-SVR	1.00	0.92-1.00	

Perspective	Health payer
Discount rate	3% (for both costs and QALY)
Horizon	Life-time
Number of iterations	10,000
Sensitivity analyses	One-way, probabilistic multi-variate

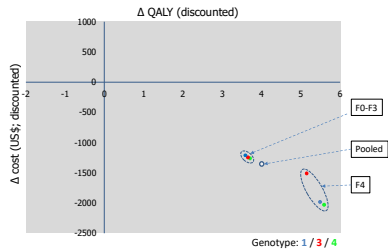
Results

Patient group	Life Years			Quality-adjusted Life Years (Discounted*)		
	No treatment	With DAA-based treatment	Increase in LYs	No treatment	With DAA-based treatment	Increase in QALY
Non-cirrhosis (F0-F3)						
Genotype 1	30.25	37.92	7.677	15.05	18.75	3.71
3	30.25	37.82	7.572	15.05	18.71	3.66
4	30.25	37.70	7.452	15.05	18.65	3.60
All F0-F3	30.25	37.85	7.600	15.05	18.72	3.67
Cirrhosis (F4)						
Genotype 1	19.16	30.28	11.115	10.37	15.86	5.49
3	19.16	29.65	10.487	10.37	15.51	5.15
4	19.16	30.51	11.350	10.37	15.97	5.60
All F4	19.16	29.89	10.728	10.37	15.65	5.28
All patients	28.76	36.78	8.020	14.42	18.31	3.89

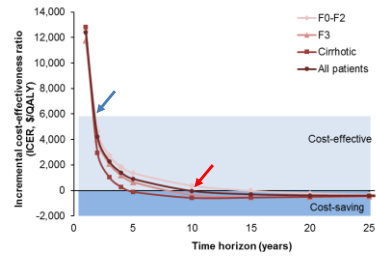
Results: Change in healthcare expenditure

Patient group	Total life-time cost (discounted)		
	No treatment (US\$)	With DAA-based treatment (US\$)	Difference in cost (US\$)
Non-cirrhosis (F0-F3)			
Genotype 1	1,803	536	-1,267
Genotype 3	1,803	558	-1,245
Genotype 4	1,803	590	-1,212
All F0-F3	1,803	553	-1,250
Cirrhosis (F4)			
Genotype 1	3,182	1,192	-1,990
Genotype 3	3,182	1,672	-1,510
Genotype 4	3,182	1,152	-2,030
All F4	3,182	1,494	-1,688
All patients	1,988	679	-1,309

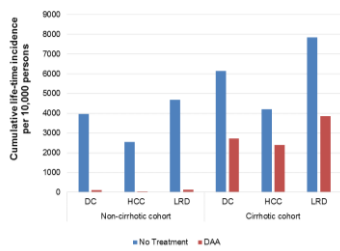
Results: Incremental cost-effectiveness ratios



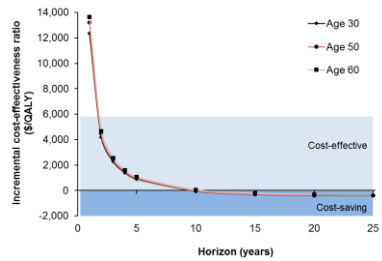
DAA HCV treatment: ICER over time



DAA treatment: Reduction in liver events



DAA HCV treatment: ICER over time with age



Sensitivity analysis: Age at treatment

Age (y)	Cost (US\$)		QALYs		Incremental QALYs	ICER (\$/QALY)
	No treatment	DAA	No treatment	DAA		
20	2284	700	16.26	21.91	5.65	Cost-saving
25	2207	694	15.78	20.86	5.08	Cost-saving
30	2108	687	15.14	19.64	4.49	Cost-saving
35 (base)	1988	679	14.42	18.31	3.89	Cost-saving
40	1847	669	13.54	16.83	3.29	Cost-saving
50	1495	646	11.47	13.73	2.27	Cost-saving
60	1090	617	8.94	10.34	1.40	Cost-saving
70	711	586	6.27	7.04	0.77	Cost-saving

Sensitivity analysis: Cost of treatment

Drug cost (per 4 wk)	Cost (US\$)		QALYs		Incremental QALYs	ICER (\$/QALY)
	No treatment	DAA	No treatment	DAA		
\$100* (base case)	1988	679	14.42	18.31	3.89	Cost-saving
\$300	1988	1325	14.42	18.31	3.89	Cost-saving
\$600	1988	2295	14.42	18.31	3.89	79
\$900	1988	3265	14.42	18.31	3.89	329

Conclusions

- Treatment with 'generic' DAAs at prices in India
 - Improves patient outcomes (life-span, QALY, DALY)
 - Is cost-effective within 2 years of treatment
 - Is cost-saving within ~10 years of treatment
 - These benefits are seen
 - Irrespective of patient age
 - On different sensitivity analysis
 - Earlier in patients with cirrhosis (5 y) than in those with lesser stages of fibrosis
 - HCV treatment should be a priority from both public health and economic perspectives in areas with drug availability at such prices
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