

Supplementary Appendix

The Estimated Direct Medical Cost of Selected Sexually Transmitted Infections in the United States, 2008

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Chlamydia and Gonorrhea: Additional Information

Chlamydia cost per case varied depending on whether the incident case occurred in a man or woman; whether it was symptomatic or asymptomatic; whether it was treated or untreated; whether if treated it was treated in a public or private setting; and whether if treated it was treated in the base year (2008) or a subsequent year (Table).

To estimate the year of treatment, a simple Markov state transition model using weekly increments was constructed for chlamydia and gonorrhea using the durations of infection shown in the table. Incidence was assumed to be evenly distributed across the year for both symptomatic and asymptomatic cases. Cases were assumed to resolve at a constant rate ($1 / \text{duration}$). Cases treated in a subsequent year were discounted at 3% per year.

The overall cost and cost per case was calculated by multiplying the proportions in the table for each infection by the relevant costs.

Visit costs were included for treated symptomatic cases only.

Table

Variable	Chlamydia		Gonorrhea		Source
	Men	Women	Men	Women	
Probability of symptoms	0.20	0.20	0.50	0.25	1
Probability of treatment (symptomatic)	0.89	0.89	0.89	0.89	1,2
Probability of treatment (asymptomatic)	0.07	0.34	0.09	0.40	1,3
Duration in years, untreated [*]	0.5	1.0	N/A	N/A	1
Duration in years, treated (symptomatic) [*]	0.08	0.15	0.08	0.08	1
Duration in years, treated (asymptomatic) [*]	0.25	0.50	0.38	0.58	1
Probability of sequelae in untreated infection [†]	0.02	0.15	0.02	0.15	4,5
Probability of sequelae in treated asymptomatic infection ^{†‡}	0.00	0.08	0.00	0.08	4,5
Proportion of treated cases receiving	0.34	0.34	0.27	0.27	NETSS

	Chlamydia		Gonorrhea		Source
treatment via private physician					
Visit cost, private physician	\$117	\$110	\$183	\$122	6,7
Visit cost, not private physician	\$70	\$70	\$70	\$70	8,9
Treatment cost, private physician	\$46	\$39	\$97	\$86	6,7
Treatment cost, not private physician	\$45	\$45	\$51	\$56	8,10
Sequelae cost [†]	\$313	\$3202	\$313	\$3202	11,12

Notes

NETSS, National electronic telecommunications system for surveillance

*Duration of infection was not varied by treatment status for gonorrhea; the durations shown for asymptomatic and symptomatic infection were used for both treated and untreated cases

[†] Sequelae included were epididymitis in men and pelvic inflammatory disease (PID) in women

[‡] The sequelae rate was assumed to be zero for men and women in treated symptomatic cases

References (Chlamydia and Gonorrhea)

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7. Owusu-Edusei K, Jr., Gift TL, Chesson HW. Treatment cost of acute gonococcal infections: Estimates from employer-sponsored private insurance claims data in the United States, 2003-2007. *Sex Transm Dis* 2010;37:316-8.
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HBV Cost Estimates: Additional Information

HBV Table A: Summary of cost estimates

Study	base year	CPI adjustment to 2010 dollars	cost per case, unadjusted	cost per case, adjusted to 2010 dollars
Hu 2008	2003	1.307	\$2,222	\$2,904
Chesson 2004	2000	1.489	\$779	\$1,160
Jacobs 2003	2002	1.360	\$2,150	\$2,924
Pisu 2002	1998	1.604	\$1,354	\$2,172
average cost per case 2010 dollars				\$2,290
average cost per case 2010 dollars, excluding Chesson 2004 estimate				\$2,667

HBV Table B: Explanation of estimates obtained from Hu 2008

discounted Hep B medical costs without vaccination	\$1,414,526	Hu Table 3
discounted Hep B medical costs with vaccination	\$914,508	Hu Table 3
discounted Hep B medical costs averted by vaccination	\$500,018	row 1 minus row 2
cases of Hep B averted by vaccination	225	Hu Table 3
implied cost per case of Hep B	\$2,222	row 3 divided by row 4

base year	2003	Hu Table 2 (footnote)
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HBV Table C: Explanation of estimates obtained from Jacobs 2003

	No vaccination	Hep B vaccination	
Symptomatic HBV infections	1394	465	Table 2
Fraction of HBV infections that are symptomatic	0.411	0.411	Table 1
Total HBV infections	3391.727494	1131.386861	calculated as number of symptomatic infections divided by fraction of HBV infections that are symptomatic
Chronic HBV infections	214	70	Table 2
<i>Cost (in millions)</i>			
acute hep b treatment	2.43	0.75	Table 2
chronic hep b treatment	4.56	1.38	Table 2
total	6.99	2.13	sum of acute and chronic costs
HBV infections averted	2260.340633		calculated as difference in "no vaccination" and "Hep B vaccination" scenarios above
costs averted	4,860,000		calculated as difference in "no vaccination" and "Hep B vaccination" scenarios above
implied cost per case of HBV	\$2,150		calculated as HBV costs averted divided by HBV infections averted
base year	2002		see page 232, under "analytic methods"

HBV Table D: Explanation of estimates obtained from Pisu 2002

	Percent of all infections	cost	expected cost per case
Acute disease			
Asymptomatic infection	60.00%	\$0	\$0.00
Symptomatic/hospitalized/fulminant/death	0.13%	\$11,898	\$15.47
Symptomatic/hospitalized/fulminant/no death	0.06%	\$26,411	\$15.85
Symptomatic/hospitalized/not fulminant	4.60%	\$10,039	\$461.79
Symptomatic/not hospitalized	35.20%	\$338	\$118.98
Chronic liver disease			
CAH	0.225%	\$72,660	\$163.49
CPH	0.225%	\$44,560	\$100.26
CIRR	0.225%	\$177,450	\$399.26
HCC	0.225%	\$34,990	\$78.73
Total			\$1,353.82
base year	1998	see table 2 footnote	

Summary: Information below was taken from Table 2 of Pisu paper. Footnotes to Table 2 indicate that future costs were discounted, so no additional discounting was performed. The sum of the percent of infections is 99.99% (due to rounding) for the categories listed under "acute disease". The chronic costs are added to the costs of acute disease. In the source paper (Margolis 1995, reference 31 in Pisu), chronic disease could occur after asymptomatic infection or symptomatic infection; thus in our calculations the chronic costs and acute costs were treated as additive and not mutually exclusive.

CAH, chronic active hepatitis; CIRR, cirrhosis; CPH, chronic persistent hepatitis; HCC, hepatocellular carcinoma

References (HBV)

Pisu M, Meltzer MI, Lyerla R. Cost-effectiveness of hepatitis B vaccination of prison inmates. *Vaccine* 2002;21:312-21.

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DETAILS OF COST OF HPV ESTIMATE

CIN costs

CIN costs of \$0.816 billion were obtained from the Chesson HPV cost study [Chesson et al Vaccine 2012]. These costs were based on administrative and laboratory records of the Kaiser Permanente Northwest health plan [Insinga et al Am J Obstet Gynecol 2004], extrapolated to the U.S. general population. The annual \$0.8 billion cost of CIN is consistent with an estimate of \$0.7 billion obtained from a more recent analysis of medical claims data from a larger, more geographically diverse population [Henk HJ et al, J Low Genit Tract Dis 2010]. CIN costs were discounted 3 years according to the Chesson et al (2004) STD cost paper [Chesson et al, Perspect Sex Reprod Health 2004].

HPV Table 1: Cancer costs

Cost per case	Number of HPV-attributable cases	Cancer site	Total cost (millions)	Years discounted	Discounted cost (millions)
\$38,800	11,370	Cervix	\$441	23	\$223
\$23,600	1,560	Vulva	\$37	23	\$19
\$36,200	2,770	Anus & rectum (W)	\$100	23	\$51
\$43,200	1,450	Oropharynx(W)	\$63	23	\$32
\$27,100	460	Vagina	\$12	23	\$6
\$43,200	5,630	Oropharynx(M)	\$243	23	\$123
\$36,200	1,500	Anus & Rectum (M)	\$54	23	\$27
\$19,800	360	Penis	\$7	23	\$4

Cost per case estimates and number of HPV-attributable cases obtained from the Chesson HPV cost study. Cancer costs were assumed to occur 23 years after HPV infection, as in the original Chesson et al (2004) cost paper. A 3% annual discount rate was used. W and M denote cases in women and men, respectively.

HPV Table B: Genital warts and RRP costs

Cost component	Annual burden (millions)	Years discounted	Discounted costs: millions
Genital warts	\$288	0	\$288
Genital warts: Men (assumes half in men)			\$144
Genital warts: women (assumes half in women)			\$144
Juvenile-onset RRP: all attributable to HPV in women	\$123	5	\$106
Adult-onset RRP	\$48	3	\$44
Adult-onset RRP: men (assumes half in men)			\$22
Adult-onset RRP: women (assumes half in women)			\$22

RRP: recurrent respiratory papillomatosis. Genital warts costs were not discounted; in most patients, genital warts develop within 1 year of HPV infection (Winer JID 2005; 191:731-8). Juvenile-onset RRP costs were discounted 5 years: 1 year for pregnancy plus 4 years from birth to onset of RRP in child of infected mother [Chesson et al, Vaccine, 2008]. Adult-onset RRP costs were discounted 3 years as explained in main text. All genital wart and RRP costs were assumed to be attributable to HPV. All juvenile-onset RRP costs were assumed to be attributable to HPV in women.

HPV Table C: Total HPV incidence costs

Cost component	Annual cost (millions)
WOMEN	
CIN	\$747
Cancers	\$331
Genital warts	\$144
RRP	\$128
women total	\$1,350
MEN	
cancers	\$154
genital warts	\$144
RRP	\$22
men total	\$320
HPV total	\$1,670

HPV Table D: Cost per case estimates

Sex	Number of cases	Cost per case
female	7,060,844	\$191.15
male	7,076,249	\$45.22

References (HPV)

Chesson HW, Blandford JM, Gift TL, Tao GY, Irwin KL. The estimated direct medical cost of sexually transmitted diseases among American youth, 2000. *Perspectives on Sexual and Reproductive Health* 2004;36:11-9.

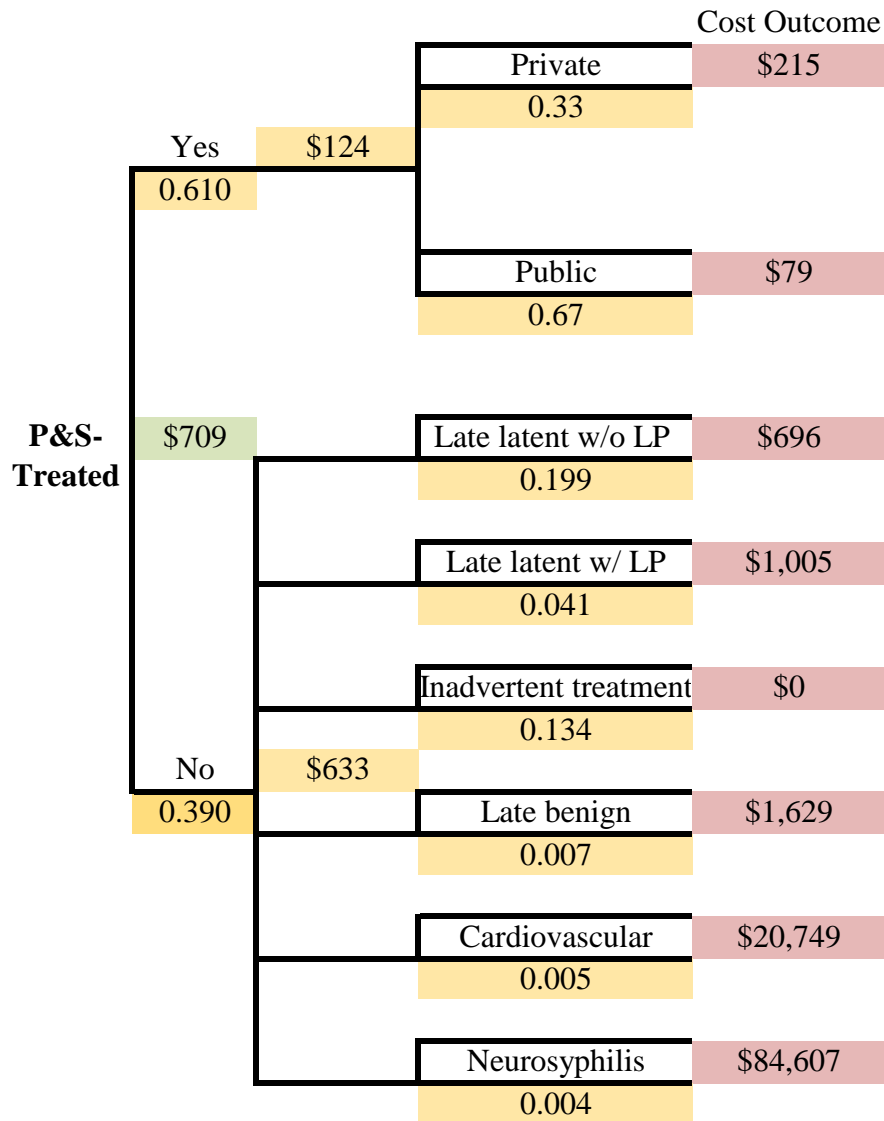
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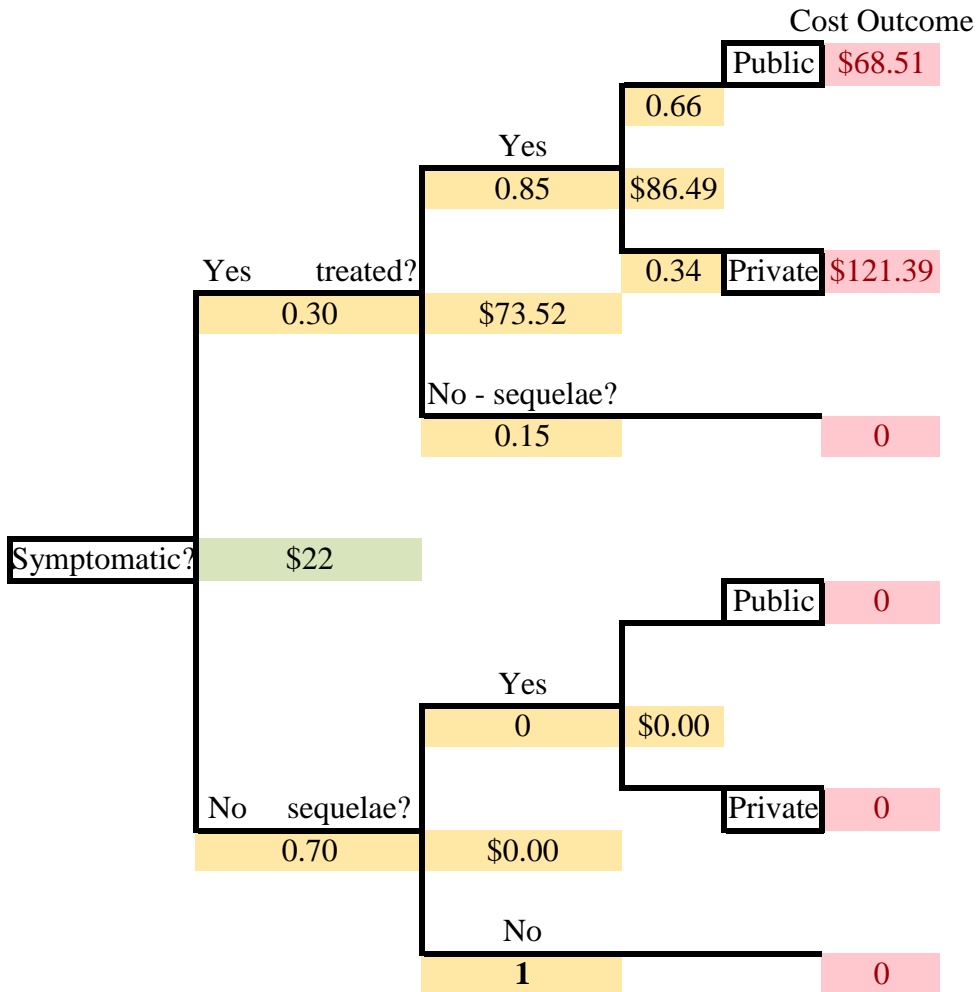
Syphilis: Based on 2004 decision tree probabilities (men & women)



Cost Adjustments

Source	Cost	CPI Adjustmen	2010 \$
Owusu-Edusei et al., 2009	194	1.106485042	214.66
Chesson et al., 2004	53	1.48940184	78.94
Chesson et al., 2004	467	1.48940184	695.55
Chesson et al., 2004	675	1.48940184	1005.35
Chesson et al., 2004	0	1.48940184	0.00
Chesson et al., 2004	1094	1.48940184	1629.41
Chesson et al., 2004	13931	1.48940184	20748.86
Chesson et al., 2004	56806	1.48940184	84606.96

Trichomoniasis: Based on 2004 method (men and women)



Cost Adjustments

Cost	Source	CPI Adjustment	2010 \$
\$46	Chesson et al., 2004	1.48940184	68.5125
\$101	Owusu-Edusei et al., 2009	1.201844059	121.3863

References (Syphilis and Trichomoniasis)

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- Owusu-Edusei K, Jr., Hoover KW, Tao G. Estimating the direct outpatient medical cost per episode of primary and secondary syphilis in the United States: insured population perspective, 2003-2007. *Sex Transm Dis* 2011;38:175-9.

Comparing current to previous (Chesson et al., 2004) Study

Infection	Gender	Method		Estimate (2010 US \$)		Comments
		Previous	Current	Previous	Current	
Chlamydia	Men	Expected cost - decision tree	Expected cost - Markov decision tree	30	30	Current estimate includes private sector costs, but does not include routine screening
	Women			363	364	
Gonorrhea	Men	Expected cost - decision tree	Expected cost - Markov decision tree	79	79	Current estimate includes private sector costs, but does not include routine screening
	Women			396	354	
HBV	Both	Published study	Imputed from recent published studies	1,160	2,667	Recent study includes cost of liver transplant
HIV	Both	Published study	Same	297,582	304,500	
HPV	Men	Based on annual burden of HPV- associated disease	Same	40	45	
	Women	Based on annual burden of HPV- associated disease	Same	1,829	191	Routine annual screening cost was not included in the current estimate
HSV-2	Men	Published study	Adjusted previous estimate	761	761	
	Women			621	621	
Syphilis	Both	Expected cost - decision tree	Same	661	709	Includes private sector cost
Trichomoniasis	Both	Expected cost - decision tree	Same	27	22	Includes private sector cost; lower probability of symptomatic infection in current estimate (30% vs. 40%)

With the exception of HSV-2, all current cost estimates include updated cost information not available at the time of the previous study.