Cost-Effectiveness of Influenza Vaccines

Considerations for Competing Resources

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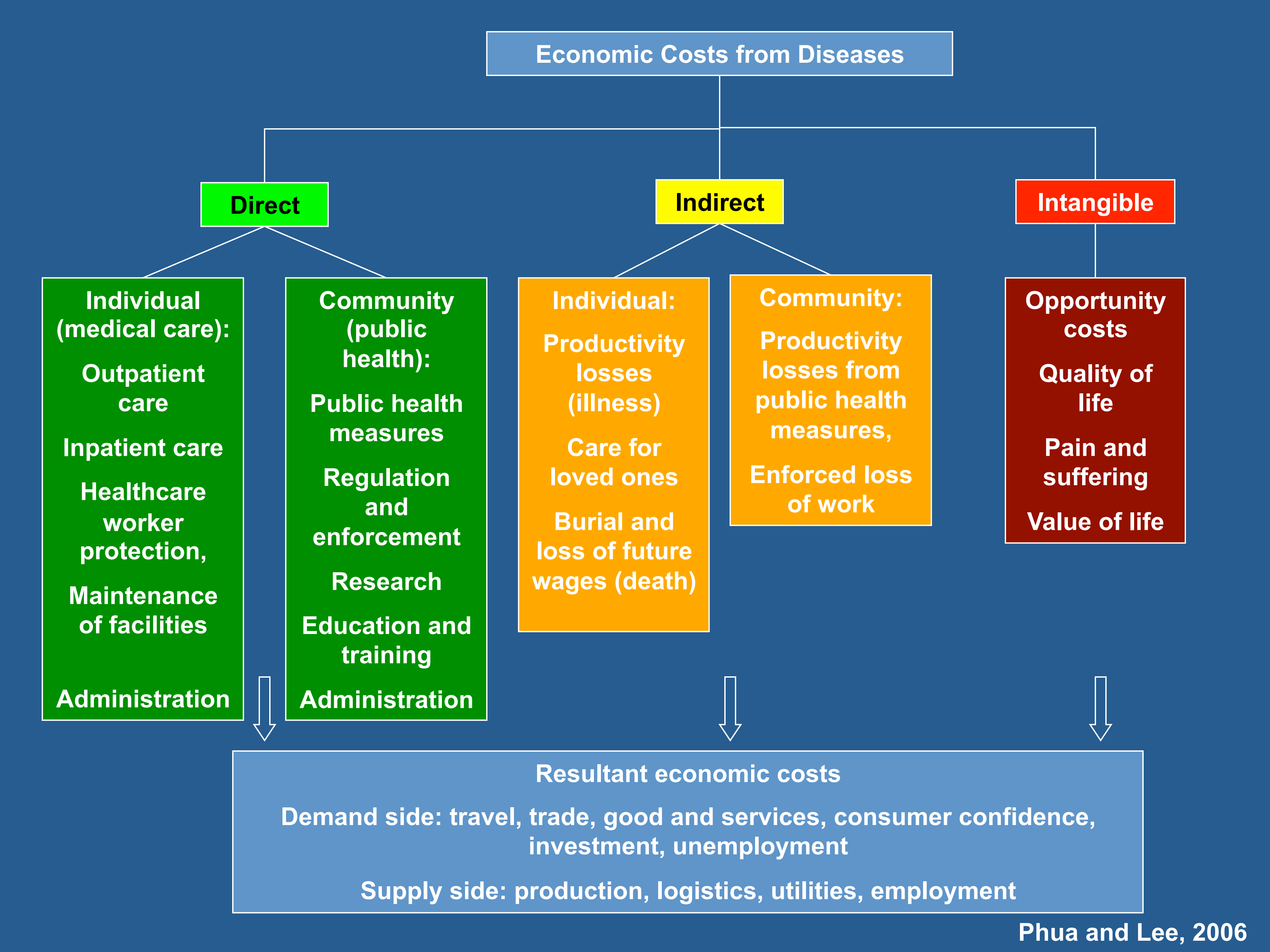
Economic Evaluation

- Access the impact of public health programs
- Determine their field effectiveness and cost-effectiveness
- Enables decision making with scare resources
- Combines economics, operations research, epidemiology, statistics, behavioral sciences, and more.



Economic Costs from Diseases
Direct
Indirect
Intangible
Individual (medical care):
Outpatient care
Inpatient care
Healthcare worker protection,
Maintenance of facilities
Administration
Community (public health):
Public health measures
Regulation and enforcement
Research
Education and training
Administration
Individual:
Productivity losses (illness)
Care for loved ones
Burial and loss of future wages (death)
Community:
Productivity losses from public health measures,
Enforced loss of work
Opportunity costs
Quality of life
Pain and suffering
Value of life
Resultant economic costs
Demand side: travel, trade, good and services, consumer confidence, investment, unemployment
Supply side: production, logistics, utilities, employment
Phua and Lee, 2006

Study Designs

- Methods for analysis
  - Cost-benefit
    - “Gold standard”
    - Common metric ($$)
    - Controversial issues
  - Cost-effectiveness
    - Costs assessed by health outcomes
    - Easily understood but needs interpretation
    - Common outcome needed
  - Cost-utility
    - Compare across outcomes through common metric
    - Quality Associated Life Years (QALY)
    - Subjective and population based

Cost-Effectiveness of Vaccines

- Clinical efficacy of vaccines not the only consideration

- Cost-effectiveness important due to competing resources
  - Global supply is limited
  - National resources are limited
  - Maximize use of scare resources

- Supply-induced demand
  - Vaccination uptake is often dependent on national policies including subsidies

Cost-Effectiveness of Vaccines

- Cost-effectiveness depends on factors IN THE LOCAL CONTEXT
  - Impact of disease
    - Spread and Clinical Severity
    - Changes for every epidemic
  - Efficacy of vaccine
    - To the actual circulating strain
  - Cost of vaccine
    - Cost to society
    - Cost to the individual

Table 2. Costs and outcomes for with changes in vaccine efficacy and strain mismatch (shown for vaccination within first stockpile)*†.

	Cost benefit (millions USD$)				
	Strain mismatch				
Vaccine Efficacy	**0.0**	**0.2**	**0.4**	**0.6**	**0.8**
0.2	103 (66, 128)	116 (87, 138)	126 (105, 142)	139 (124, 150)	151 (144, 157)
0.4	39 (−35, 90)	65 (9, 109)	86 (44, 118)	111 (81, 134)	135 (121, 147)
0.6	−24 (−136, 52)	14 (−70, 80)	46 (−17, 93)	83 (38, 118)	119 (98, 137)
0.8	−88 (−237, 14)	−37 (−149, 51)	5 (−78, 69)	56 (−4, 102)	104 (75, 127)
1.0	−152 (−338, −24)	−88 (−228, 22)	−35 (−139, 45)	28 (−47, 86)	88 (52, 117)
	Lives saved				
	Strain mismatch				
Vaccine Efficacy	**0.0**	**0.2**	**0.4**	**0.6**	**0.8**
0.2	82 (41, 138)	64 (32, 108)	50 (25, 85)	33 (17, 54)	16 (8, 26)
0.4	165 (82, 277)	129 (63,215 0	101 (51, 171)	65 (33, 109)	32 (17, 53)
0.6	247 (123, 415)	193 (95, 323)	151 (76,256)	98 (50, 163)	48 (25, 79)
0.8	330 (165, 553)	258 (127,431)	201 (102, 341)	130 (66, 218)	65 (33,105)
1.0	412 (206, 692)	322 (158, 539)	252 (127, 426)	163 (83, 272)	81 (42, 132)
	Cost per life saved (millions, USD$)				
	Strain m6ismatch				
Vaccine Efficacy	**0.0**	**0.2**	**0.4**	**0.6**	**0.8**
0.2	1.78 (0.86, 3.19)	2.42 (1.16, 4.37)	3.24 (1.62, 5.81)	5.23 (2.72, 9.05)	10.94 (5.85, 18.72)
0.4	0.63 (0.17, 1.23)	0.94 (0.37, 1.81)	1.34 (0.60, 2.45)	2.31 (1.15, 4.09)	5.10 (2.69, 8.80)
0.6	0.24 (−0.12, 0.64)	0.44 (0.04, 1.00)	0.71 (0.23, 1.41)	1.34 (0.60, 2.50)	3.15 (1.60, 5.52)
0.8	0.05 (−0.29, 0.36)	0.2 (−0.18, 0.61)	0.39 (0.01, 0.88)	0.85 (0.32, 1.71)	2.18 (1.08, 3.87)
1.0	−0.06 (−0.41, 0.21)	0.05 (−0.32, 0.39)	0.20 (−0.14, 0.58)	0.56 (0.12, 1.22)	1.59 (0.75, 2.85)

*Mean values are shown with 5th and 95th percentiles.
†All healthcare costs are in 2007 Singapore dollars.
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Lee et al, 2009

Table 3. Annual insurance premium for pandemic scenarios with changes in vaccine effectiveness and attack rate*†.

	Impending pandemic			
	Vaccine effectiveness			
Attack rate	**0.2**	**0.4**	**0.6**	**0.8**
0.1	6.02 (4.13, 8.33)	11.8 (8.03, 16.2)	17.9 (12.5, 24.3)	23.8 (16.4, 32.6)
0.3	18.1 (12.4, 25.0)	35.5 (24.1, 48.5)	53.8 (37.5, 72.7)	71.4 (49.3, 97.9)
0.5	30.1 (20.7, 41.7)	59.2 (40.2, 80.9)	89.6 (62.5, 121.2)	118.9 (82.2, 163.2)

Seasonal Influenza Vaccines

- Ontario, Canada universal influenza program was found to be cost-effective (Sander et al, 2000)

- Elderly
  - Multiple studies (USA, Canada, UK, France, Germany, The Netherlands, New Zealand, and Taiwan) found that vaccination is cost-effective and often cost saving (Nichol et al, 2003)

  - One vaccine campaign in Taiwan (Wang et al, 2002) reduced hospitalization and mortality
    - Savings up to 3x vaccination cost

Elderly

- A Polish study - vaccination had ICER of €6059/QALY compared to no vaccination (Brydak et al, 2012)

- A US study - high dose trivalent vaccine had ICER of $5299/QALY compared to standard trivalent vaccine (Chit et al, 2015)

- One Hong Kong study found no cost benefit (Fitzner et al, 2001)

Working Adults

- Some studies in USA, Canada, UK, France, and Brazil found that vaccination cost-effective (Nichol, 2003)

- Same study from Hong Kong - no cost savings (Fitzner et al, 2001)
- A US study in a manufacturing company - no cost savings in good or bad vaccine matching years (Bridges et al 2000)
- A study in Finland - no cost savings due to high vaccine delivery costs (Kumpulainen et al, 1997)
- Another study in the UK military - no cost savings
- A review paper of seven US studies - 1990 to 2010 in healthy adults found generally no cost saving (Gatwood et al, 2012)

Children

- Studies in USA and Argentina indicated cost-effective and often cost saving (Nichol, 2003)
- Zhao et al (2011) - AR in vaccinated Shanghai students was was 0.61% vs 1.76% (unvaccinated). The benefit-cost ratio was 2.24:1
- Yoo et al (2012) - school vaccination in New York cost-effective
  - Decreased transmission to household and decreased loss of productivity from caring for sick child
- Pitman et al (2013) - vaccinating 2-18 year olds in England and Wales was most cost-effective policy at uptake of 50%

Children

- One US study found that vaccinating earlier in the season in Oct and offering it until Dec saved costs and QALYs (Lee et al, 2010)

- A study from Hong Kong found not cost saving
  - Cost benefit ratio was HK$ 3.81 in costs for every HK$ 1 saved (Fitzner et al, 2001)

LAIV in Children

- Luce et al (2008) found LAIV had more cost savings compared to TIV due to reduction of burden of disease

- Tarride et al (2012) found LAIV to be the dominant strategy

- Damm et al (2015) found routine vaccination in Germany with LAIV (50% uptake) had an ICER of €1,228 per QALY compared with TIV

- Meeyai et al (2015) found vaccination with LAIV in Thailand was highly cost-effective, with ICER from 2,000 - 5,000 international dollars per DALY

High Risk Groups

- Pregnant women
  - Bregi et al (2010) - cost-effective in USA if flu prevalence is ≥7.5% and influenza-attributable mortality is ≥1.05%
  - Myers et al (2011) - $70,089 per QALY in US pregnant women from 6-42 weeks gestation
  - Ding et al (2012) - net benefit of $12.57 per vaccinated mother
    - If annual maternal AR is >2.8%
    - Vaccine efficacy is >47%
    - Acquisition and administration cost per dose are <$32.78.

High Risk Group

- Pregnant women & Health-care workers
  - Blommaert et al (Belgium, 2014) found that vaccination is cost-effective
  - For pregnant women (€6589 per QALY gained)
  - For health care workers (€24,096 per QALY gained)

Pandemic Vaccination

- US study on 2009 pandemic - early pandemic vaccination cost-saving (Khazeni et al, 2009)
- Another UK study - early availability and administration in 2009 will reduce morbidity and mortality (Baguelin et al, 2010)
  - Most cost-effective among high-risk individuals and children
- A study in Canada - mass vaccination during the 2009 pandemic was cost-effective (Sander et al, 2010)
- Pandemic prioritization
  - Miller et al (2008) – policies adjusted in real-time (eg. younger adults in 1918, and elderly for 1957/68)

Conclusions

- Likely cost-effective in elderly, children, high-risk groups
- Less so for general adult population
- Highly dependent on severity parameters incl. spread, virulence, impact

- More studies in other settings
  - Lower resourced countries
  - Urban versus rural regions