Cost-effectiveness of ART as prevention

Valentina Cambiano

Research Department of Infection and Population Health, University College London
Disclosure

I acted as a speaker at company-sponsor event for MSD.
HIV and MSM

In Europe, sex between men is still the predominant mode of HIV transmission. Men who have sex with men (MSM) are the only key population not to see a decline in new infections during the last decade: new diagnoses increased by 33% compared to 2004.
UK MSM treatment cascade – 2014

ART eligibility criteria for asymptomatic people living with HIV

Source: http://www.hivpolicywatch.org/
Number of patients starting ART by CD4 count at initiation: UK, 2010-2014

Definitions

Treatment as prevention (TasP):

“use of ART for people with diagnosed HIV with the aim of preventing HIV transmission to others rather than primarily for their own clinical benefit”

NHS

ART at diagnosis:
probability of 1 of initiating ART at diagnosis

ART at diagnosis – testing ++:
Testing is increased so that 90% are diagnosed by 1y from infection

NHS Clinical Commisioning Policy: TasP in HIV infected adults
HIV incidence: 15 years

Number of new infections per year

- base test rate
- ART at 350
- base test rate
- ART at diagnosis

% reduction in 2030
32%

Median across simulations
HIV incidence: 15 years

Number of new infections per year

Year

% reduction in 2030

32% ↓

54% ↓

80% ↓

Median across simulations
Questions to be addressed

• Would the offer of ART at diagnosis (without increasing HIV testing) be sufficient to reduce HIV incidence to <1/1000 among MSM in the UK when considering a long time frame (80 years)?

• What is the contribution of PrEP in the context of ART initiation at diagnosis?

• Is the offer of ART at diagnosis cost-effective?

• Is it cost-effective to introduce PrEP in addition to ART at diagnosis?
Definitions

ART at diagnosis:
Now: probability of 0.15 of initiating ART per 3 months for people with CD4>350

PrEP: introduction of PrEP in men who:
- have a negative HIV test at the current visit (involving a clinical risk assessment in a GUM clinic)
- had condomless anal intercourse in the previous three months
- had a negative HIV test in the preceding year

PrEP programme:
• ~ 3,500 MSM being initiated on PrEP by the end of the 1st year (2016)
• ~40,000 MSM ever initiated on PrEP by the end of 15th year (2030)
• ~17,000 MSM currently on PrEP in the 15th year (2030)
HIV Synthesis Model

- Individual based stochastic simulation model
- Each time model program is run it simulates a dataset of the experience of the entire MSM population in the UK

Variables in simulated data set:

<table>
<thead>
<tr>
<th>Whole adult MSM population</th>
<th>HIV positive MSM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>Time from infection</td>
</tr>
<tr>
<td>Condomless anal sex</td>
<td>CD4 count</td>
</tr>
<tr>
<td>Current STI</td>
<td>Viral load</td>
</tr>
<tr>
<td></td>
<td>Specific drugs</td>
</tr>
<tr>
<td></td>
<td>Currently on ART</td>
</tr>
<tr>
<td></td>
<td>Current adherence level</td>
</tr>
<tr>
<td></td>
<td>Drug resistance mutations ++</td>
</tr>
</tbody>
</table>
Model-based analysis of the UK epidemic in MSM

- Number of men diagnosed with HIV per year
- Number living with HIV (age 15-60)
- Number of deaths per year
- Number seen for care per year
- Proportion of men tested for HIV in past 5 years
- Median CD4 count at diagnosis
- Proportion diagnosed < 6 months from infection
- Number on ART
- Proportion of men having condomless anal sex in past year
Questions to be addressed

- Would the offer of ART at diagnosis (without increasing HIV testing) be sufficient to reduce HIV incidence to <1/1000 among MSM in the UK when considering a long time frame (80 years)?
  - Not in the lifetime frame
  - Yes, but in ~60 years
  - Yes, but in ~40 years
  - Yes, but in ~20 years
HIV incidence: 80 years

Median across simulations
Change in condomless sex (CLS)

Restricted to age 15-45
Median across simulations; CLS: condomless anal sex;
HIV incidence: contribution of PrEP

Mean across simulations; CLS: condomless anal sex;

36,600 (~30%) infections averted
Cost-effectiveness analysis (CEA)

- CEA is a form of economic evaluation that informs the choice of healthcare interventions/programmes
- Based upon comparative assessments of costs & health consequences

Choice

- ART at diagnosis
- ART only if CD4<350
Cost-effectiveness analysis (CEA)

• CEA is a form of economic evaluation that informs the choice of healthcare interventions/programmes
• Based upon comparative assessments of costs & health consequences
Why are we evaluating whether ART at diagnosis or PrEP is cost-effective?

- New interventions
  - Health gained
  - Additional Cost

- Budget constrained health care systems

- Interventions displaced or foregone
  - Health foregone
  - Resources released
Why are we evaluating whether ART for prevention or PrEP is cost-effective?

**Goal:** maximize health of the population

New interventions
- Health gained
- Additional Cost

Budget constrained health care systems

Interventions displaced or foregone
- Health foregone
- Resources released

Is the new intervention cost-effective?

Is the health gain from the new intervention likely to be greater than the health foregone?
Determining cost-effectiveness

1. Determine the **costs** of intervention and alternative scenarios

2. Measure and value **health outcomes** (HIV infections, deaths, life-years, Quality-adjusted life-years (QALYs))

3. **Compare** costs and health outcomes (to the reference scenario, usual care)

4. Calculate the ‘incremental cost-effectiveness ratio’ (ICER): the cost per QALY gained from an alternative.
5. Compare the ICER to a **threshold ICER** (sometimes called the cost-effectiveness threshold or willingness to pay threshold)

The threshold represents the **opportunity cost**, the value of the alternative that is foregone.

In the UK the threshold is estimated to be between £13,000 and £30,000 / QALY gained

Due to the overall budget constraint, if we adopt an intervention with ICER > threshold

--- more health is lost/foregone from the commitment of resources to that intervention than results from its provision
Questions to be addressed

• Would the offer of ART at diagnosis (without increasing in HIV testing) be sufficient to reduce HIV incidence to <1/1000 among MSM in the UK when considering a long time frame (80 years)?
  □ Not in the lifetime frame
  □ Yes, but in ~60 years
  □ Yes, but in ~40 years
  □ Yes, but in ~20 years

• Is the offer of ART at diagnosis cost-effective?
  □ No, not in a lifetime frame
  □ Yes, ICER below £13,000 per QALY gained
  □ Borderline cost-effective (ICER £13,000-30,000 per QALY gained)
  □ Yes, it is actually cost-saving
Incremental cost and QALY

- Incremental cost and QALY graph
  - ART at 350
  - ART at diagnosis
  - ART at diagnosis + PrEP
  - Cost-saving point
  - Increment in (discounted) cost (£million over lifetime)
  - Increment in (discounted) QALYs over lifetime
Incremental cost and QALY

- ART at 350
- ART at diagnosis
- ART at diagnosis + PrEP

Increment in (discounted) cost (£million over lifetime) vs. Increment in (discounted) QALYs over lifetime.
Incremental cost and QALY

Increment in (discounted) cost (£million over lifetime)

Increment in (discounted) QALYs over lifetime

- ART at 350
- ART at diagnosis
- ART at diagnosis + PrEP

COST-SAVING
## Cost-effectiveness of PrEP and timeframe

<table>
<thead>
<tr>
<th>Reduction in the cost of ARVs*</th>
<th>10%</th>
<th>20%</th>
<th>30%</th>
<th>40%</th>
<th>50%</th>
<th>60%</th>
<th>70%</th>
<th>80%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current cost of ARV</td>
<td><img src="image" alt="Legend" /></td>
<td><img src="image" alt="Legend" /></td>
<td><img src="image" alt="Legend" /></td>
<td><img src="image" alt="Legend" /></td>
<td><img src="image" alt="Legend" /></td>
<td><img src="image" alt="Legend" /></td>
<td><img src="image" alt="Legend" /></td>
<td><img src="image" alt="Legend" /></td>
</tr>
</tbody>
</table>

- **Cost-saving** (leading to a health benefit and saving in cost);
- **Cost-effective** (ICER below £13,000 / QALY gained);
- **Border-line cost-effective** (ICER between £13,000-£30,000 / QALY gained);
- **Not cost-effective** (ICER above £30,000 / QALY gained);
Comments and other issues

- It is a mathematical model not an oracle!

- We have not formally assessed the contribution of ART at diagnosis and PrEP among heterosexuals in the UK, but their impact is likely to be significantly lower due to the lower HIV incidence

- ART & PrEP coverage in MSM visiting from abroad who have sex in the UK has not been taken into account
Summary and conclusions

- Would the offer of ART at diagnosis (without increasing HIV testing) be sufficient to reduce HIV incidence to <1/1000 among MSM in the UK?
  
  Our model suggests that this is the case but it will take ~ 40 years

- What is the contribution of PrEP in the context of ART initiation at diagnosis?
  
  A PrEP programme of 17,000 at full scale could prevent ~30% of HIV infections among MSM, in the context of offer of ART at diagnosis

- Is the offer of ART at diagnosis cost-effective?
  
  Our model suggests that it is not only cost-effective but cost-saving

- Is it cost-effective to introduce PrEP in addition to ART at diagnosis?
  
  Our model suggests it will be in 40 years time at current ARV cost or in 20 years if the cost of ARVs is reduced by 80% from 2019

- A moderate increase in CLS could lead to a substantial increase in HIV incidence even in the context of ART at diagnosis
Thank you very much to:

Andrew Phillips
Alec Miners
David Dunn
Sheena McCormack
KohJun Ong
Noel Gill
Anthony Nardone
Monica Desai
Nigel Field
Graham Hart

Jens D Lundgren
Simon Collins
Valerie Delpech

Gus Cairns
Alison Rodger
Fumiyo Nakagawa
Legion computing cluster
(Legion@UCL)

Fiona Lampe
Fumiyo Nakagawa
Alison Brown
Daniela De Angelis
Jonathan Elford
Anne Johnson

…and you for your attention!