Impact of providing ART to Medicare ineligibles

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This document summarises a simple methodolgy to calculate the impact of providing anti-retroviral therapy (ART) for free to people living with HIV (PLHIV) in Australia who are medicare ineligible. This analysis uses data from the Australian HIV Obserbvational Database Temporary Residents Access Study (ATRAS) [1].The R code for these calculations is available in the associated Rmarkdown file.

This document is written in dynamic format using R markdown v2 within R studio 0.98.1056 (using R version 3.1.2). Plots are created using the package ggplot2. Further details are available in the associated R markdown file which also contains the R code to produce all the results when the markdown is run. Code blocks have been supressed in the output document.

### Methodogy

This section summarises the methodology used for the calculations. A simple mathematical model is used to caluclate the change in population size over time and the number of new infections in partners of medicare ineligible people. Model details, assumptions and input parameters are described below.

#### Demographics

For this analysis we consider a population of PLHIV who are medicare ineligible with the characteristics of people in ATRAS [1]. The overall population is split into heterosexual males and females, and males who are gay, bisexual or men who have sex with men (GBM). We assume females do not engage in sex work and the population does not include people who inject drugs (PWID). The porportion of people in each of these populations is based on ATRAS data and assumed to be constant over time. This comparmentalisation of the population is used to distinguish the risk of HIV infection rather than treatment coverage and adherence.

The number of medicare ineligibles can change over time with people becoming eligible for medicare provided ART and new temporary residents entering the population. This movement is represented by a constant rate (which is positive for a growing population and negative for a declining population). In ATRAS aproximately 20% of people become medicare eligible and leave the population each year, this would be lower bound on the rate of population change. Letting equal the total population size in year , the number of medicare ineligible people in the population is then given by

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#### Clinical characteristics

The main aim of this analysis is to investigate the impact on HIV transmission of providing all medicare ineligible people in ATRAS with ART. For the calculations we simply consider the proportion of the population taking ART and the proportion of those on ART with viral suppression. Both of these inputs can change over time based on the ATRAS data. We do not consider different proportions for each population group (BUT WE CAN IF ATRAS HAS THIS DATA). The most recent data value is used for future projections.

#### HIV transmission to partners

HIV transmission occurs through sexual intercourse between medicare ineligibles and their sexual partners. We assume initiating ART does not change sexual behaviour and the number of partnerships, sexual acts per partnership, and the level of condom use is similar to the overall Medicare eligible population in Australia. We also do not consider onward transmission from newly infected partners. As the sexual behaviour for the ART and non-ART population is the same, we use a simple risk equation model with behavioural parameters set to reflect the overall annual risk of transmission rather than incorporating different partnership types and more complex sexual behaviours.

Key assumptions:

* All sexual partners are HIV negative.
* Homogeneous mixing is assumed which means partnerships are not maintained from year to year.
* HIV transmission only occurs through sexual intercourse.
* There is no difference in sexual behaviour between those on and off ART. Hence, the only factor affecting HIV transmission is ART use and viral suppression.
* Those with unsuppressed virus have the same transmission risk as those not taking ART.
* Females and males have the same number of partners, sexual acts, and condom use on average.
* Females and males have the same sexual behaviour as males and females in the general heterosexual population in Australia.
* Behavioural and transmission parameters are assumed constant over time.
* GBM are exclusively homesexual.

#### Costs associated with ART provision

Our analysis includes an estimate of the annual cost of providing ART, care and support to Medicare ineligibles and their partners who become infected. We obtained estimates of these costs using previous work for Australian settings [2]. By summing all costs associated with providing ART to Medicare ineligibles and the average 'lifetime' cost of providing care and support to PLHIV for their infected partners, we estimate the cost per infection averted.

#### Parameter table

Table 1 lists all input parameters and their values and ranges.

**Table 1** - Calculation input parameters. Note parameter values and ranges are simple placeholders at the moment. References also need to be found and inserted.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Description | Value | Range | Endnote justification |
| **Demographic parameters** |  |  |  |
|  | Overall population size in initial year (2014) | 450 | [400 - 500] | 1 |
|  | Rate of entry into population | 1 /yr | [0.98 - 1.02] | 1 |
|  | Proportion population female | 0.25 | [0.2 - 0.3] | 1 |
|  | Proportion population male | 0.23 | [0.2 - 0.3] | 1 |
|  | Proprtion population GBM |  | Depends on and values | 1 |
| **Clinical parameters** |  |  |  |
|  | Proportion of population taking ART | ATRAS data | Multiplicative factor [0.95 - 1.05] | 2 |
|  | Proportion of population taking ART | ATRAS data | Multiplicative factor [0.95 - 1.05] | 2 |
| **HIV behavioural parameters** |  |  |  |
|  | Annual number of heterosexual acts between females and males | 80 | [60 - 100] | 3 |
|  | Proportion of heterosexual acts protected with a condom | 0.225 | [0.15 - 0.3] | 4 |
|  | Annual number of sexual acts with other GBM | 40 | [20 - 60] | 5 |
|  | Proportion of GBM acts protected with a condom | 0.575 | [0.5 - 0.65] | 6 |
| **HIV transmission paramaters** |  |  |  |
|  | Per act transmission probability from females to males | 410^{-4} | [10^{-4} - 0.0014] | 7 |
|  | Per act transmission probability from males to females | 810^{-4} | [610^{-4} - 0.0011] | 7 |
|  | Per act transmission probability between GBM | 0.014 | [0.01 - 0.019] | 8 |
|  | Efficacy of condoms | 0.9 | [0.8 - 0.975] | 9 |
|  | Efficacy of ART in preventing HIV transmission if virus is suppressed | 0.7 | [0.5 - 0.9] | 10 |
| **Healthcare costs** |  |  |  |
|  | Average annual healthcare for cost for PLHIV | 0 | [0 - 0] | 11 |
|  | Avergae annual cost of providing ART | 0 | [0 - 0] | 11 |
|  | Average lifetime cost of providing healthcare (including ART) post infection | 0 | [0 - 0] | 12 |

1. [1]

2.  
3. The Second Australian Study of Health and Relationships reported heterosexual men had an average of 1.4 partners in the previous year (95% CI: 1.3-1.4; median 1) and heterosexual women had an average of 0.98 partners in the previous year (95% CI: 0.95-1; median 1) [3]. Seventy four percent of all respondents were in a regular partnership (equal to 89% of those sexually active). On average those in a regular pertnership had vaginal intercourse 1.42 times per week (95% CI: 1.34-1.50). This gives a range of 0.95 x 0.9 x 1.34 x 52 = 59.6 to 1.4 x 0.9 x 1.5 x 52 = 98.3 heterosexual acts per year.Based on this data and calculations we assume a range of [60 - 100] acts per year. 4. The Second Australian Study of Health and Relationships reported 25.5% and 21.1% of men and women respectively used a condom during most recent sexual encounter involving vaginal sex [4]. Based on this data we assume a range of [15 - 30]%.

1. The Second Australian Study of Health and Relationships reported homosexual men had an average of 6.8 partners in the previous year (95% CI: 5.1-8.5; median 3). Twenty eight percent of homosexual men were in a regular homosexual relationship which we assume 1-2 acts anal intercourse per week with the remaining partnerships being casual with 1-2 acts of anal intercourse per partnership. In terms of sexual acts this data suggests an estimate 0.28 x 2 x 52 = 30 regular acts per year and 6.5 x 2 = 13 casual acts per year - assuming 2 acts of anal intercourse per week for regular partnerships and 2 acts of anal intercourse per casual partner. Based on this data and calculations we assume a range of [20 - 60].
2. The Second Australian Study of Health and Relationships reported 56.7% and 58.9% men engaging in homosexual behaviour used a condom when they last engaged in insertive and receptive anal sex, respectively. Based on this data we assume a range of [50 - 65]%.

8.  
9.  
10.  
11.

#### Calculations for new infections and costs

The overall number of new infections per year is calculated by summing the number of new infections caused by each population group; i.e.,

where is the given year.

Letting the index represent one of the populations groups (and droping for the time being), the probability of HIV transmission without ART is given by

or

For , the number of acts and condom use are equal and given by the index . Similarly we can incorporate the prevention effects of treatment and suppressed virus. For a given population,

as ineffective treatment (resulting in unsuppressed virus) has the same transmission probability as no treatment. After some algebra this gives

Adding all the population terms together and substituting in the equation for gives (after some algebra) the overall risk equation for the number of new infections in a given year ,

The cumulative number of new infections in partners of medicare ineligibles over years is then equal to

The total cost of providing ART and healthcare to Medicare ineligibles and infected partners is then given by

### Results

Results amd figures will be generated once final methodology is finalized.

### Discussion

### References

1. Petoumenos K (2013) The australian hIV observational database temporary residents access study (aTRAS): one year follow-up.

2. Schneider K, Gray RT, Wilson DP (2014) A cost-effectiveness analysis of hIV pre-exposure prophylaxis for men who have sex with men in australia. Clinical infectious diseases 58: 1027–1034.

3. Rissel C, Badcock PB, Smith AM, Richters J, Visser RO de, et al. (2014) Heterosexual experience and recent heterosexual encounters among australian adults: the second australian study of health and relationships. Sexual health 11: 416–426.

4. Visser RO de, Badcock PB, Rissel C, Richters J, Smith AM, et al. (2014) Safer sex and condom use: findings from the second australian study of health and relationships. Sexual health 11: 495–504.