# HIV testing: increasing uptake among people who may have undiagnosed HIV

## Evidence review on:
## The most cost effective ways to increase the uptake of HIV testing to reduce undiagnosed HIV among people who may have been exposed to it

*Internal Guideline Development Team:*
*Chris Carmona (Senior Technical Analyst), Diana O'Rourke (Technical Analyst), Stephen Robinson (Assistant Technical Analyst)*

*February 2015*

*National Institute for Health and Care Excellence*

**Contents**


1. Introduction ..... 1
2. Methods ..... 1
   2.1. Review question ..... 1
   2.2. Searching, screening, quality assessment and data extraction ..... 1
3. Results ..... 2
   3.1. Flow of literature through the review ..... 2
   3.2. Characteristics of the included studies ..... 4
      3.2.1. What interventions to increase opportunity for, and uptake of, HIV testing are cost effective? ..... 4
   3.3. Study findings ..... 9
4. Discussion ..... 18
   4.1. Strengths and limitations of the review ..... 18
   4.2. Applicability ..... 18
   4.3. Gaps in the evidence ..... 18
5. Included Studies ..... 19
6. Appendix 1 Evidence Tables ..... 20
7. Appendix 2 Quality of included studies ..... 41
8. Appendix 3 Quality Appraisal checklist ..... 43

# 1. Introduction

In September 2014 it was agreed that NICE's guidelines on HIV testing in black Africans and HIV testing in men who have sex with men (MSM) (PH33 and PH34) should be partially updated and combined into one piece of guidance to take account of new evidence relating to indicator conditions, changes in the law relating to home testing and self-sampling, and to reflect changes in commissioning responsibilities for HIV testing. It was agreed that the partial update would combine the recommendations in PH33 and PH34 into generic recommendations and, where appropriate, make specific recommendations for high risk population groups and consider potential changes to indicator conditions and home testing and sampling.

This evidence review has been conducted to support the update of PH33 and PH34 and will focus on the effectiveness of interventions which increase awareness of the benefits of, the opportunity for and uptake of HIV testing. The review will also examine new evidence relating to interventions aimed at improving the uptake of HIV testing among all people who may have undiagnosed HIV. The evidence reviews for PH33 and PH34 will also be considered as part of the overall evidence base.

# 2. Methods

This review was conducted according to the methods guidance set out in 'Developing NICE guidelines: the manual' (October 2014).

## 2.1. Review question

**Review question 1c:** What are the most cost effective ways to increase the uptake of HIV testing to reduce undiagnosed HIV among people who may have been exposed to it?

## 2.2. Searching, screening, quality assessment and data extraction

A single systematic search of relevant databases and websites was conducted from 1996 (the start date for the searches for PH33 and PH34) to May 2015 to identify relevant evidence for this review (see Appendix 5: Reviews 1a and 1b).

The protocols outline the methods for the review, including the search protocols and methods for data screening, quality assessment and synthesis.

All references from the database searches were screened on title and abstract against the criteria set out in the protocols. A random sample of 10% of titles and abstracts was screened by two reviewers independently, with differences resolved by discussion. Agreement at this stage was 93.4%. Full-text screening was carried out by two reviewers independently on 10% of papers. Agreement at this stage was 100%. Reasons for exclusion at full paper stage were recorded (see Appendix 4: Reviews 1a and 1b).

Any studies which were included in PH33 and PH34 have been excluded from this evidence review. There may be some studies which were excluded by PH33 and PH34 which have been included in this review, for example, those covering the more general population or other at-risk groups.

Each included study was data extracted by one reviewer, with all data checked in detail by a second reviewer. Any differences were resolved by discussion.

Included studies were rated individually to indicate their quality, based on assessment using a checklist. Each included study was assessed by one reviewer and checked by another. Any differences in quality grading were resolved by discussion. The tool used to assess the quality of studies is included in Appendix 3 and a summary of the QA results of all included studies is included in Appendix 2. The quality ratings used were:

++ All or most of the checklist criteria have been fulfilled, and where they have not been fulfilled the conclusions are very unlikely to alter.

+ Some of the checklist criteria have been fulfilled, and where they have not been fulfilled, or are not adequately described, the conclusions are unlikely to alter.

– Few or no checklist criteria have been fulfilled and the conclusions are likely or very likely to alter.

# 3. Results

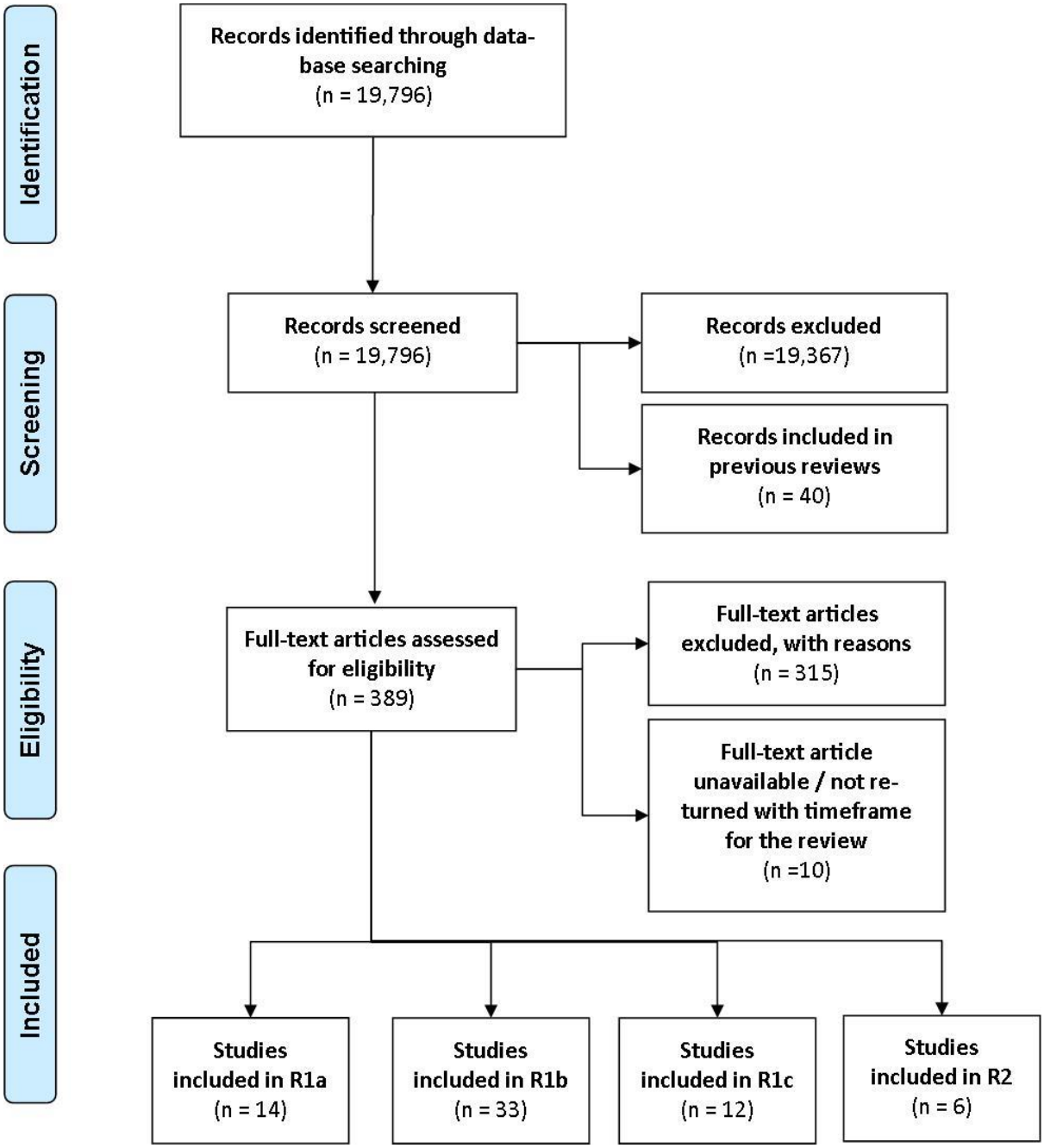
## 3.1. Flow of literature through the review

12 studies were included in review 1c. Figure 1 below shows the flow of literature through the review. A brief summary of reasons for exclusion at full text is included in the table below.

| Reason | Number |
|---|---|
| Did not meet the study type criteria | 106 |
| Conference abstract | 96 |
| Not UK based qualitative study | 50 |
| Not about HIV test uptake | 20 |
| No specific intervention | 15 |
| Outcomes not relevant | 14 |
| Out of scope | 9 |
| Not English language | 3 |
| Other | 2 |

*Figure 1. Flow of literature through the review*[1]

(note: 1 paper is included in two reviews causing the total to be 390 full text studies)




[1] R1a: What interventions to increase awareness of the benefits of HIV testing and details of local testing services among the general public and healthcare workers are the most effective?
R1b: What interventions to increase opportunity for, and uptake of, HIV testing are the most effective?
R1c: What are the most cost effective ways to increase the uptake of HIV testing to reduce undiagnosed HIV among people who may have been exposed to it?
R2: What factors help or hinder the uptake of HIV testing among people who may have undiagnosed HIV, and how can the barriers be overcome?

## 3.2. Characteristics of the included studies

Full details of the included studies are given in the evidence tables in Appendix 1. Table 3.2.1 below shows in which country the studies were conducted, and provides a brief summary of the interventions, populations and settings investigated in these studies.

*3.2.1. What interventions to increase opportunity for, and uptake of, HIV testing are cost effective?*

| First author, year | Design | Country | Setting / Population | Intervention/ comparator | Perspective | Time horizon | Underlying prevalence of HIV | Outcomes | QA rating |
|---|---|---|---|---|---|---|---|---|---|
| **Types of test** | | | | | | | | | |
| **Rapid vs. traditional tests** | | | | | | | | | |
| Ekwueme et al 2003 | Cost analysis | USA | People attending for HIV testing, HIV testing sites | 1. conventional testing (2 week return for results)<br>2. rapid one-step testing (same day results)<br>3. rapid two-step testing (same day likely positive return in 2 weeks) | Provider and societal perspective | No extended time period observed. | - | Incremental costs for implementing the test protocols | + |
| Farnham et al 1996 | Cost-effectiveness analysis (CEA) | USA | People attending for HIV testing, HIV testing sites | 1. conventional testing<br>2. rapid testing | Societal perspective | No extended time period observed. | - | Cost effectiveness ratios for: HIV-infected individuals who correctly learn their serostatus; infected and uninfected individuals who correctly learn their serostatus | + |
| Stevinson et al 2011 | Retrospective CEA | USA | People attending for HIV testing, HIV | 1. conventional testing<br>2. rapid testing | - | No extended time period observed. | - | Incremental cost of the rapid testing protocol per additional | + |

| First author, year | Design | Country | Setting / Population | Intervention/ comparator | Perspective | Time horizon | Underlying prevalence of HIV | Outcomes | QA rating |
|---|---|---|---|---|---|---|---|---|---|
| | | | testing sites | | | | | positive person notified/per day earlier notification | |
| **Targeted vs. universal testing** | | | | | | | | | |
| Long et al 2014 | CEA | UK | All adults vs, specific high risk groups | 1. annual universal screening (all adults)<br>2. annual targeted (MSM, PWID, migrants from HIV endemic countries) | Societal perspective | Prevalence and incidence of 10 years and lifetime QALYs accrued to the population | HIV prevalence among UK residents:<br>• People from HIV-endemic countries: Men 2.5%; Women 5.0%]<br>• People who inject drugs (men and women) 1.2%<br>• MSM 5.0%<br>• All others: Men 0.033%; Women 0.033% | Quality adjusted Life-Year (QALYs); Cost per QALY | ++ |
| Phillips et al 2000 | CEA | USA | New patient visits, Primary care practices | 1. routine testing (universal)<br>2. risk factor targeted testing | Societal perspective | - | Population seroprevalence of 0.15% | Incremental cost per infection identified; Cost per QALY gained | ++ |
| **Traditional (targeted plus return i.e. western blot) vs Screening vs Rapid** | | | | | | | | | |
| Sanders et al 2010 | CEA | USA | Primary care patients with | 1. conventional testing<br>2. nurse initiated routine | The perspective of a perfect insurer was | Patients were followed for their lifetime | Prevalence of undiagnosed HIV was 0.398% | QALYs; Costs per QALY | + |

| First author, year | Design | Country | Setting / Population | Intervention/ comparator | Perspective | Time horizon | Underlying prevalence of HIV | Outcomes | QA rating |
|---|---|---|---|---|---|---|---|---|---|
| | | | unknown HIV status | conventional testing<br>3. nurse initiated routine rapid testing | used, which uses costs to the insurer and patient, and corresponds to what most studies term a societal perspective. | | | | |
| Farnham et al 2008 | Cost analysis | USA | People attending for HIV testing or people attending ED, HIV testing sites & ED | 1. conventional testing<br>2. rapid testing<br>3. routine testing/screening | Provider perspective | No extended time period observed. | HIV prevalence of 1% | Cost per HIV infected patient notified and per patients costs of receiving results | + |
| **Screening/universal testing** | | | | | | | | | |
| Hutchinson et al 2011 | Cost comparison | USA | ED Screening | 1. ED staff screening<br>2. hired staff screening<br>3. Hybrid model (ED & hired staff screening) | Provider perspective | No extended time period observed. | HIV prevalence of 1% | Cost per new HIV infection identified | + |
| **Opt in vs opt out testing** | | | | | | | | | |
| Haukoos et al 2013 | Prospective cohort study | USA | Patients attending ED | 1. Opt-in offered based on a diagnostic approach by physicians<br>2. opt out at registration testing. | ED/hospital perspective | No extended time period observed. | - | Total annualized costs for the programs; cost-effectiveness ratios for each programme for identifying patients with newly-diagnosed HIV | + |

| First author, year | Design | Country | Setting / Population | Intervention/ comparator | Perspective | Time horizon | Underlying prevalence of HIV | Outcomes | QA rating |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | infection; cost per additional new infection identified (ICER) | |
| **Indicator-based testing** | | | | | | | | | |
| Juusola et al 2011 | CEA | USA | | 1. Symptom-based viral load (VL) testing<br>2. Adding VL testing to the annual screening protocol<br>3. Expanding screening coverage<br>4. Expanding screening coverage in combination with symptom-based testing | Societal perspective | Total health-related costs for individuals were calculated for a 20-year time frame. | HIV prevalence in the MSM population of 8.5% | QALYs; Incremental cost-effectiveness ratio (ICER) per QALY gained | ++ |
| **Changes in service delivery** | | | | | | | | | |
| **Electronic reminders** | | | | | | | | | |
| Chan et al 2014 | Cost analysis | USA | Users of a Veterans Healthcare clinic | 1. Traditional re/post-test counselling<br>2. Counselling and new clinical reminder system<br>3. Only clinical reminders | Payer-perspective | - | Prevalence of undiagnosed HIV was 0.4% | Total annual costs of each option and cost per new diagnosis | + |
| **Settings where tests can be carried out** | | | | | | | | | |
| **Substance abuse clinic (off-site versus on site testing)** | | | | | | | | | |
| Schackman et al 2013 | CEA | USA | Community based substance abuse clinic | 1. off-site testing referral<br>2. on-site rapid testing with | Societal perspective | Modelled from entry until death | Prevalence of undiagnosed HIV was 0.4% | Incremental cost-effectiveness ratio (ICER) per | ++ |

| First author, year | Design | Country | Setting / Population | Intervention/ comparator | Perspective | Time horizon | Underlying prevalence of HIV | Outcomes | QA rating |
|---|---|---|---|---|---|---|---|---|---|
| | | | | information only<br>3. on-site rapid testing with counselling | | | | QALY | |

## 3.3. Study findings

12 studies were included in review 1c. Overall, the quality of the studies was good, with 4 of the studies graded [++] and 8 studies graded [+]. (see Table 3.2.1).

Studies were grouped by the intervention the study tested:

**Types of test**

- Traditional vs. Rapid Testing (3 studies)
- Targeted versus Universal (2 studies)
- Traditional (targeted plus return for results) vs. Screening vs. Rapid testing (2 studies)
- Universal testing (1 study)
- Opt in versus opt out testing (1 study)
- Indicator-based testing (1 study)

**Changes in service delivery**

- Electronic reminders (1 study)

**Settings where tests can be carried out**

- Substance abuse clinic (off site versus on site testing) (1 study)

**Types of test**

***Rapid vs. traditional tests***

Ekwueme et al. 2003 (Cost analysis [+]) developed a cost analysis model to calculate the economic costs associated with three HIV counselling and testing (CT) protocols for a hypothetical client in a publicly funded HIV clinic: a standard protocol including conventional testing and a 2 week return for results; a one-step rapid protocol with same day results; and a two-step rapid protocol with same day results and confirmatory testing for positive results with a 2 week return for results. CT costs were estimated from the provider perspective (the cost of the intervention including all costs incurred by the CT programme) and the societal perspective (all provider costs plus costs incurred by the clients, such as transportation expenses and 'opportunity costs' associated with their time).

The results of the cost analysis are presented in the tables below:

<u>Provider perspective</u>

| | Cost per person tested ($) | | Cost per person notified ($) | |
|---|---|---|---|---|
| Protocol | HIV + | HIV - | HIV + | HIV - |
| 1. conventional testing (2 week return for results) | 58.14 | 18.39 | 81.94 | 25.66 |
| 2. rapid one-step testing (same day results) | 32.95 | 20.28 | 33.54 | 20.80 |
| 3. rapid two-step testing (same day likely positive return in 2 weeks) | 82.10 | 22.26 | 85.56 | 22.79 |

Societal perspective

| | Cost per person tested ($) | | Cost per person notified ($) | |
|---|---|---|---|---|
| Protocol | HIV + | HIV - | HIV + | HIV - |
| 1. conventional testing (2 week return for results) | 98.71 | 55.59 | 133.65 | 77.50 |
| 2. rapid one-step testing (same day results) | 62.20 | 44.11 | 63.94 | 45.78 |
| 3. rapid two-step testing (same day likely positive return in 2 weeks) | 133.76 | 46.71 | 139.20 | 48.40 |

The results of the cost analysis were generally consistent between the societal and provider perspectives although differed depending on HIV status of the client. For HIV-positive clients, the cost per person tested and the cost per person notified were greatest for the 2-step rapid protocol and smallest for the 1-step rapid protocol. For HIV-negative clients, conventional testing was the most expensive and the 1-step protocol the least expensive, with one exception: from the provider perspective, the cost per person tested was greatest for the 2-step rapid protocol and least for the standard protocol. Overall, the 1-step rapid protocol was generally the least expensive of the three protocols.

Farnham et al. 1996 (CEA [+]) developed a decision model to compare the costs and effectiveness of a streamlined CT procedure using a rapid screening test with a conventional CT procedure. Two outcomes were included in the basic analysis: only HIV-infected individuals correctly learning their serostatus (Outcome 1); and infected and uninfected individuals correctly learning their serostatus (Outcome 2). The results indicated that the rapid CT procedure is generally a more cost-effective alternative to the conventional CT procedure (outcome 1: cost-effectiveness ratios of $940 for the rapid procedure vs $1165 for the conventional procedure; outcome 2: cost-effectiveness ratios of $37 for the rapid procedure vs $68 for the conventional procedure per client informed). However, further analysis indicated that in HIV-infected individuals only, if information regarding a positive result from the rapid screening test is not given to clients at the initial visit before a confirmatory test is performed, the rapid procedure is not more cost-effective than the current procedure (incremental cost effectiveness ratios of $1,172 for the rapid procedure vs $1,165 for the conventional procedure).

Stevinson et al. 2011 (retrospective CEA [+]) compared the cost effectiveness of a rapid testing algorithm (RTA) (using a second different rapid test to verify the preliminary positive, with same day notification and referral) with a standard algorithm (using a single rapid test followed, when positive, by a Western Blot (WB) for confirmation and requiring a second visit for receipt of results). In 2008, utilising the traditional testing protocol, 215 of 247 clients with a positive rapid HIV test were confirmed positive by WB. Of those with positive test results, 90.9% were notified and 9.1% did not return for a second visit to receive their results. There was a lag of 11.4 days until notification of confirmed positive results. In 2009, utilising the RTA, 152 of 170 clients with one positive rapid test had a confirmatory second positive test and were notified on the same day.

Per positive test, the incremental cost effectiveness ratio (ICER) of the RTA compared to the standard algorithm was $30.46 per additional percent notified ($24.31 per day earlier notification) and $4.85 per additional percent notified ($3.87 per day earlier notification) modelled with elimination of the WB. Calculated for the 170 positives in 2009, this represents a potential saving of $14.68 (16%) per positive person with the RTA.

***Evidence statement 1: cost-effectiveness of rapid versus traditional testing strategies in HIV testing site settings***

There is moderate evidence from 3 US studies (a cost analysis [+][1], a CEA [+][2] and a retrospective CEA[+][3]) which showed that rapid same day testing protocols with same day results offer economic advantages over testing protocols that require confirmatory testing with a second return date for results. One study found that a 1-step rapid protocol with same day's results was more cost effective in terms of both the cost per person tested and the cost per person notified than a conventional protocol (2 week return for results) and 2-step rapid protocol with delayed results (per HIV+ tested: $62.20 vs $98.71 and $133.76 respectively; per HIV+ notified $63.94 vs $133.65 and $139.20 respectively [societal perspective])[1]. The results of a second study indicated that a rapid counselling and testing (CT) procedure is generally more cost-effective than conventional CT (cost-effectiveness ratios of $940 for the rapid procedure vs $1165 for the conventional procedure per HIV-infected client correctly counselled and tested; cost-effectiveness ratios of $37 for the rapid procedure vs $68 for the conventional procedure per client informed, regardless of serostatus)[2]. A third study reported that, per positive test, the incremental cost effectiveness ratio (ICER) of a rapid testing algorithm (RTA) compared to the standard algorithm was $30.46 per additional percent notified ($24.31 per day earlier notification) and $4.85 per additional percent notified ($3.87 per day earlier notification) modelled with elimination of the Western Blot. Overall, there was also a potential saving of $14.68 per HIV-positive person with the RTA[3].

Applicability: The evidence is only partially applicable to HIV testing in the UK because all the studies were undertaken in the USA.


1. Eweume et al. 2003 [+]
2. Farnham et al. 1996 [+]
3. Stevinson et al. 2010 [+]


***Targeted vs. universal testing***

Long et al 2014 (CEA [++]) estimated the effectiveness and cost-effectiveness of HIV testing in the United Kingdom (UK), where 25% of people living with HIV are estimated to be undiagnosed.

Using a dynamic compartmental model to analyse strategies to expand HIV testing and treatment in the UK, with particular focus on men who have sex with men (MSM), people who inject drugs (PWID), and individuals from HIV endemic countries, they estimated HIV prevalence, incidence, quality-adjusted life years (QALYs), and health care costs over 10 years, and cost-effectiveness.

Annual HIV testing of all adults could avert 5% of new infections, even with no behaviour change following HIV diagnosis because of earlier ART initiation, or up to 18% if risky behaviour is halved. This strategy costs £67,000–£106,000/QALY gained. Providing annual testing only to MSM, PWID, and people from HIV-endemic countries, and one-time testing for all other adults, prevents 4–15% of infections, requires a quarter as many tests to diagnose each PLHIV, and costs £17,500/QALY gained. Augmenting this program with increased ART access could add 145,000 QALYs to the population over 10 years, at £26,800/QALY gained.

The authors conclude that annual HIV testing of key populations in the UK is very cost-effective. Additional one-time testing of all other adults could identify the majority of

undiagnosed PLHIV. These findings are potentially relevant to other low-prevalence, high-income countries.

Phillips et al 2000 (CEA [++]) estimated the cost-effectiveness of approaches to expanded HIV counselling and testing in primary care practices in the USA.

They examined two approaches: (i) requesting all patients to complete an HIV-risk screening instrument, with counselling as well as testing offered only to patients disclosing risk factors (`risk histories' option); and (ii) routine offering of voluntary testing to all patients, with consent obtained but no pre-test counselling (`routine testing').

A decision analytical approach was used to examine the incremental costs and effectiveness of each approach. The analysis is from a societal perspective. Costs and effectiveness were discounted at 3% (range 0±10%).The primary outcome was the cost per infection identified. They also examined: (i) the costs and numbers of infections averted if individuals change their risk behaviours; and (ii) the additional years of life and quality-adjusted life years (QALY) gained as a result of earlier HIV testing and treatment for infected individuals.

Their results imply that routine voluntary testing is the most cost-effective approach to identifying infected individuals at an incremental cost of US$4200 per infection identified. Although using risk histories is more costly and less effective than routine testing, it becomes similarly cost-effective using plausible ranges for sensitivity analyses. If at least 10% of HIV positive individuals change their behaviour, both routine testing and using risk histories would save money. If testing identifies infected individuals one year earlier than they otherwise would have been diagnosed, routine testing would cost US$22, 000 per QALY gained.

The authors conclude that routine testing is the most cost-effective approach to identifying new HIV infections. However, using risk histories may be similarly cost-effective under various assumptions. Both routine testing and using risk histories are more cost effective than current practices.

***Evidence statement 2: cost-effectiveness of targeted versus universal testing strategies***

There is strong evidence from two studies[1,2] that universal testing differs dependent on the strategy adopted. An annual strategy of testing all adults costs £67,000–£106,000/QALY gained; whilst annual testing of identified high-risk groups, and one-time testing for all other adults, costs £17,500/QALY gained[1]. Universal/routine testing is the most cost-effective approach to identifying infected individuals in primary care setting when testing new patients at an incremental cost of US$4200 per infection identified compared with the use of a risk histories approach; if testing identifies infected individuals one year earlier than they would otherwise have been diagnosed, routine testing would cost US$22,000 per QALY gained[2].

Applicability: One study was undertaken in the USA where different universal testing strategies are recommended than in the UK. However there is one UK study[1] that is directly applicable.

1. Long et al. 2014 [++]
2. Phillips & Fernyak 2000 [++]

***Traditional (targeted plus return for results) vs. Screening vs. Rapid testing***

Farnham et al. 2008 (Cost analysis [+]) undertook a study to estimate the costs of rapid and conventional HIV testing in the following scenarios: sexually transmitted disease (STD) clinic counselling and testing (CT); STD clinic screening, and; Emergency department (ED) screening. Overall, the costs of the rapid testing procedure were higher than those of conventional testing because of more expensive test kits and, for patients who tested positive, the need for additional specimen collection and post-test counselling during both the initial and return visits. However, the cost per HIV-infected patient receiving test results was lower for the rapid test (STD CT = $2,925; STD Screening = $1,868; ED-screening = $ 1638) compared with conventional testing in all scenarios (STD CT = $4,334; STD Screening = $1,995; ED-screening = $1,807).

Sanders et al. 2010 (CEA [+]) performed a cost-effectiveness analysis based on a Markov model to examine the cost of 3 intervention models for HIV counselling and testing (CT) in primary care patients with unknown HIV status:

- Model A - traditional HIV CT;
- Model B - nurse-initiated routine screening with traditional HIV CT;
- Model C - nurse-initiated routine screening with rapid HIV testing and streamlined counselling.

Model A resulted in per-patient lifetime discounted costs of $48,650 and benefits of 16.271 QALYs ($2,990/QALY). Model B increased lifetime costs by $53 and benefits by 0.0013 QALYs (corresponding to 0.48 quality-adjusted life days). Model C cost $66 more than Model A with an increase of 0.0018 QALYs (0.66 quality adjusted life days) and an incremental cost-effectiveness of $36,390/QALY. When the benefit reduced HIV transmission was included, Model C cost $10,660/QALY relative to Model A.

***Evidence statement 3: cost-effectiveness of traditional testing compared with rapid testing and targeted versus universal testing strategies***

There was moderate evidence from 2 US studies (1 (Cost analysis [+])[1]; 1 CEA [+][2]) which compared screening and targeted testing using both traditional return for results and same day rapid result protocols. In 1 of the studies the rapid testing protocol was more expensive than conventional testing, but lowered the cost of HIV infected patients receiving their results (STD CT = $2,925; STD Screening =$1,868; ED-screen = $ 1638) compared with conventional testing in all scenarios (STD CT = $4,334; STD Screening =$1,995; ED-screen = $1,807)[1]. This was further supported when comparing rapid testing with same day results through a nurse initiated protocol versus traditional targeted and nurse initiated universal testing with a return for results scenario. When transmission reductions were included with rapid same day results, the nurse-initiated protocol with rapid testing cost $10,660/QALY relative to the traditional protocol with return for results scenario.

Applicability: The evidence is only partially applicable to HIV testing in the UK because both the studies were undertaken in the USA.

1. Farnham et al 2008
2. Sander et al (2010)

### *Universal testing*

Hutchinson et al, 2011 (Cost comparison [+]) compared the costs and outcomes of a model that used a US hospital's Emergency Department (ED) staff to conduct screening with a supplemental staff model that used non-ED staff hired to conduct screening and a hypothetical hybrid model that combined aspects of both approaches using a decision analytic model to estimate the cost per HIV-infected patient identified using alternative ED testing models.

The cost per new HIV infection identified was $3,319, $2,084 and $1,850 under the supplemental, existing staff and hybrid models, respectively. Assuming an annual ED census of 50,000 patients, the existing staff model identified 29 more HIV infections than the supplemental model and the hybrid model identified 76 more infections than the existing staff model.

They conclude that a hybrid model should be favoured over either a supplemental staff or existing staff model in terms of cost per outcome achieved.

**Evidence statement 4: cost-effectiveness of different methods for implementing a universal testing program in an Emergency Department**

There is moderate evidence from one study[1] that a hybrid model ($1,850) of using existing staff plus some additional staffing resource in an emergency department to deliver universal screening was more cost effective than either additional staff ($3,319) or existing staff model only ($2,084) per new HIV infection identified[1].

Applicability: This study was undertaken in the USA which has a different screening policy in emergency departments than in the UK

1. Hutchinson et al. 2011 [+]

### *Opt in vs. opt out testing*

Haukoos et al. 2013 (Prospective cohort study [+]) compared the programmatic costs of non-targeted opt-out rapid HIV screening with physician-directed diagnostic rapid HIV testing in an urban emergency department (ED). Over 16 months, non-targeted rapid HIV screening (intervention) and diagnostic rapid HIV testing (control) were alternated in 4-month time blocks. During the intervention phase, patients were offered HIV testing using an opt-out approach during registration; during the control phase, physicians used a diagnostic approach to offer HIV testing to patients. Total annualised costs for non-targeted opt-out screening and diagnostic testing were $148,977 and $31,355 respectively. The cost-effectiveness ratio (CER) of non-targeted opt-out screening for identifying patients with newly-diagnosed HIV infection was $9,932, whereas the CER of diagnostic testing was $7,839. Compared to diagnostic HIV testing, non-targeted opt-out HIV screening identified 11 additional newly diagnosed HIV infections at a cost of $10,693 per additional new infection identified.

***Evidence statement 5: Cost-effectiveness of opt-out testing strategies in emergency departments***

There is moderate evidence from 1 cost-effectiveness study from the USA [+] that non-targeted opt-out screening strategies are more cost effective than physician-directed diagnostic testing. Whilst non-targeted opt-out screening is more costly on average per new

HIV diagnosis ($9,932) than the diagnostic approach ($7,839), the non-targeted strategy resulted in a greater proportion accepting and completing testing and identified 11 more undiagnosed infections at an incremental cost of $10,693 per additional infection[1].

Applicability: This study took place in the USA which has a different emergency department screening policy than in the UK.

1. Haukoos et al. 2013 [+]

***Indicator-based testing***

Juusola et al. 2011 (CEA [++]) evaluated 3 HIV testing strategies in men who have sex with men (MSM) in the US: viral load (VL) testing for individuals with influenza-like illness (ILI); expanded antibody screening coverage to 90% of MSM; expanded screening with antibody and VL testing. HIV prevalence, incidence, QALYs and healthcare costs were estimated over a 20-year time horizon.

The results showed that expanding antibody screening coverage from 67% to 90% annually reduces new infections by 2.8% and is cost-effective, with an incremental cost-effectiveness ratio (ICER) of $12,582 per QALY gained compared to the status quo over the 20-year time horizon. Adding symptom based VL testing to current antibody screening rates of 67% is more expensive than expanded antibody screening, but is more effective, reducing new infections by 4.2%, and costing $22,786 per QALY gained relative to the status quo. Combining expanded antibody screening with symptom-based VL testing reduces infections by 5.7% and costs $29,923 per QALY gained compared to expanded antibody screening alone or $20,013 relative to the status quo. Expanded screening with both antibody and VL tests, in combination with symptom-based VL testing, is the most effective strategy, reducing infections by 7.2% over 20-years, however, it costs $105,398 per QALY gained compared to expanded screening with symptom-based testing.

***Evidence statement 6: Cost-effectiveness of symptom-based testing and expanded screening strategies***

There is moderate evidence from 1 cost effectiveness analysis [++][1] that strategies involving expanding antibody screening coverage to 90% of MSM and viral load (VL) testing for individuals with influenza-like illness (ILI) are both effective and cost effective over a 20-year time horizon. Expanding screening coverage to 90% reduces new infections by 2.8% and costs $12,582 per QALY gained compared to the status quo. However, symptom-based VL testing alone, without expanding antibody testing, reduces new infections by 4.2%, and costs $22,786 per QALY gained relative to the status quo. Combining expanded antibody screening with symptom-based VL testing reduces infections by 5.7% and costs $29,923 per QALY gained compared to expanded antibody screening alone or $20,013 relative to the status quo.

Applicability: The evidence is only partially applicable to HIV testing in the UK because the study was undertaken in the USA.

1. Juusola et al. 2011 [++]

**Changes in service delivery**

***Electronic reminders***

Chan et al 2014 (Cost analysis [+]) estimated the cost and health outcomes associated with a new HIV testing strategy that utilised routine clinical reminders in Veterans Health clinics in the US.

They conducted an economic analysis of

1) Traditional pretest/posttest counselling (Strategy A);
2) Counselling and a new electronic clinical reminders system (Strategy B); and
3) Electronic clinical reminder only (Strategy C)

A payer-perspective decision model was used to calculate the 1-year budget impact of the three HIV testing strategies. Parameter values were obtained from the literature, including patients' probability of accepting test, and costs associated with HIV testing procedures. De-identified patient data, including total population screened and number of new HIV cases, were collected from one clinic in Los Angeles, California, from August 2004 to December 2011. Annual total costs and costs per new case were calculated on the basis of parameter values and patient data. Sensitivity analyses were conducted to evaluate the robustness of the critical variable on costs.

Strategy B had the lowest annual cost of $81,726 over 1 year compared with $109,208 for Strategy A. Strategy C had the highest annual cost at $243,564, however, the number of HIV tests performed and the number of new diagnoses was higher than for the other two strategies (16,172 tests and 17 new diagnoses vs. 1,906 tests and 12 diagnoses for Strategy A, and 3,858 tests and 19 new diagnoses for Strategy B). In addition, Strategy C had the lowest cost per case ($57.69) and cost per non-case ($14.88) compared to Strategy A and Strategy B (A: cost per case $120.93 and cost per non-case $56.80; B: cost per case $77.32 and cost per non-case $20.38). .

The authors conclude that a clinical reminder system can reduce the cost per case identified and promote better performance of HIV testing compared with traditional HIV testing. The fundamental decision model can be used for hospital facilities outside the Veteran Affairs adopting a similar program for improving the HIV testing rate.

**Evidence statement 7: Cost-effectiveness of a clinical reminder system in a veterans' clinic**

There is moderate evidence from one cost analysis study[1] that the total cost of the clinical reminder system with pretest counseling was $81,726 over 1 year compared with $109,208 for traditional HIV testing[1] and $243,564 for the clinical reminder system alone. Whilst the clinical reminder system alone had the highest annual cost, it can reduce the cost per cases identified and promote better performance of HIV testing compared with traditional HIV testing.

Applicability: this study was undertaken in the USA who have different system arrangements for veterans and offer specific clinics; this approach may not be transferable to the UK.

1. Chan et al. 2014 [+]

**Settings where tests can be carried out**

***Substance abuse clinic (off-site versus on site testing)***

Schackman et al 2013 (CEA [++]) measured the cost-effectiveness of three HIV testing strategies evaluated in a randomized trial conducted in 12 community-based substance abuse treatment programs in the US in 2009:

- off-site testing referral;
- on-site rapid testing with information only;
- on-site rapid testing with risk reduction counselling.

Data from the trial included patient demographics, prior testing history, test acceptance and receipt of results, undiagnosed HIV prevalence (0.4%) and program costs. The Cost Effectiveness of Preventing AIDS Complications (CEPAC) computer simulation model was used to project life expectancy, lifetime costs, and quality-adjusted life years (QALYs) for HIV infected individuals modelled from entry in to the model until death. Incremental cost-effectiveness ratios (2009 US $/QALY) were calculated after adding costs of testing HIV-uninfected individuals; costs and QALYs were discounted at 3% annually.

Referral for off-site testing is less efficient (dominated) compared to offering on-site testing with information only. The cost-effectiveness ratio for on-site testing with information only compared to no intervention is $60,300/QALY in the base case, or $76,300/QALY with 0.1% undiagnosed HIV prevalence. HIV risk-reduction counselling costs $36 per person more without additional benefit.

The authors conclude that a strategy of on-site rapid HIV testing offer with information only in substance abuse treatment programs increases life expectancy at a cost-effectiveness ratio <$100,000/QALY.

**Evidence statement 8: Cost-effectiveness of on-site HIV testing in substance misuse treatment centres.**

There is strong evidence from one cost-effectiveness analysis[1] that the cost-effectiveness ratio from 12 community-based substance abuse treatment programs assessing on-site testing with information only (no counselling) compared with no intervention is $60,300/QALY in the base case, or $76,300/QALY with 0.1% undiagnosed HIV prevalence. HIV risk-reduction counselling costs $36 per person more without additional benefit. A strategy of on-site rapid HIV testing offer with information only in substance abuse treatment programs increases life expectancy at a cost-effectiveness ratio <$100,000/QALY. Both strategies were more effective and cost effective than referral for off-site testing.

Applicability: The evidence is only partially applicable to HIV testing in the UK because the study was undertaken in the USA.

1. Schackman et al 2013 [++]

# 4. Discussion

## 4.1. Strengths and limitations of the review

Overall, the quality of the studies was good, with 4 of the studies graded [++] and 8 studies graded [+].

Several limitations are seen across the studies including, studies not taking account in their analysis the longer terms effects of HIV counselling and testing, costs not being discounted, and appropriate incremental analysis not undertaken. Further detail of the strengths and weaknesses of individual studies can be found in the evidence tables (Appendix 4).

## 4.2. Applicability

As noted in the evidence statements, most evidence for the review is from the USA, with only 1 study based in the UK. This may limit the applicability of some findings to the context of HIV testing in the UK due to differences in costs/funding which may not be transferable to a UK context.

## 4.3. Gaps in the evidence

We set out to find evidence on the cost effectiveness of interventions which increase awareness, the offer and uptake of HIV testing. No specific evidence was found in relation to the following areas:

- Interventions which increase awareness of HIV testing e.g. mass media campaigns, social media, one-to-one information provision, opportunistic information provision, group-based information provision
- Increasing the number of tests offered in primary care and other settings outside sexual health services
- Home-based testing/sampling

## 5. Included Studies


1. Chan, K., Hernandez, L., Yang, H., Bidwell Goetz, M (2014). Comparative cost analysis of clinical reminder for HIV testing at the veterans affairs healthcare system. Value in Health 17 p.334-339
2. Ekwueme, Donatus U., Pinkerton, Steven D., Holtgrave, David R., Branson, Bernard M., Anderson, Branson Carpenter Constantine Critchfield Dittus Dobilet Doll Evans Farnham Farnham Gold Gorsky Howe Irwin Kallenborn Kassier Kassler Kassler Kassler Keenan Kelen Koblavi-Deme Levin McKcnna Phillips Respess Rotheram-Borus Spencer Steiler Sweat Tao Toomey Wilkinson Woehrle Wykoff (2003) Cost Comparison of Three HIV Counseling and Testing Technologies. American journal of preventive medicine. 25 p.112-121
3. Farnham, P. G., Gorsky, R. D., Holtgrave, D. R., Jones, W. K., Guinan, M. E. (1996) Counseling and testing for HIV prevention: Costs, effects, and cost- effectiveness of more rapid screening tests. Public Health Reports111 p.44-53.
4. Farnham, Paul G., Hutchinson, Angela B., Sansom, Stephanie L., Branson, Bernard M. (2008). Comparing the costs of HIV screening strategies and technologies in health-care settings. Public health reports 123 Suppl 3 p.51-62
5. Haukoos, J. S., Campbell, J. D., Conroy, A. A., Hopkins, E., Bucossi, M. M., Sasson, C., Al-Tayyib, A. A., Thrun, M. W (2013). Programmatic cost evaluation of nontargeted opt-out rapid HIV screening in the emergency department PloS one 8
6. Hutchinson, Angela B., Farnham, Paul G., Lyss, Sheryl B., White, Douglas A. E., Sansom, Stephanie L., Branson, Bernard M. (2011). Emergency department HIV screening with rapid tests: a cost comparison of alternative models. AIDS education and prevention 23 p.58-69
7. Juusola, Jessie L., Brandeau, Margaret L., Long, Elisa F., Owens, Douglas K., Bendavid, Eran, The cost-effectiveness of symptom-based testing and routine screening for acute HIV infection in men who have sex with men in the USA, AIDS (London, England), 25, 1779-87, 2011
8. Long, Elisa F., Mandalia, Roshni, Mandalia, Sundhiya, Alistar, Sabina S., Beck, Eduard J., Brandeau, Margaret L. (2014). Expanded HIV testing in low-prevalence, high-income countries: a cost-effectiveness analysis for the United Kingdom PloS one 9 p.e95735
9. Phillips, K. A., Fernyak, S. (2000). The cost-effectiveness of expanded HIV counselling and testing in primary care settings: a first look. AIDS 14 p.2159-69
10. Sanders, G. D., Anaya, H. D., Asch, S., Hoang, T., Golden, J. F., Bayoumi, A. M., Owens, D. K. (2010). Cost-effectiveness of strategies to improve HIV testing and receipt of results: economic analysis of a randomized controlled trial. Journal of general internal medicine 25 p.556-63
11. Schackman, B. R., Metsch, L. R., Colfax, G. N., Leff, J. A., Wong, A., Scott, C. A., Feaster, D. J., Gooden, L., Matheson, T., Haynes, L. F., Paltiel, A. D., Walensky, R. P. (2013). The cost-effectiveness of rapid HIV testing in substance abuse treatment: results of a randomized trial. Drug and alcohol dependence 128 p.90-7.
12. Stevinson, Kendall, Martin,Eugene G., Marcella,Stephen, Paul,Sindy M. (2011). Cost effectiveness analysis of the New Jersey rapid testing algorithm for HIV testing in publicly funded testing sites. Journal of clinical virology 52 Suppl 1 p.S29-S33

# 6. Appendix 1 Evidence Tables

***What interventions to increase opportunity for, and uptake of, HIV testing are cost effective?***

<table>
<tr><th>Study details</th><th>Inclusion / Exclusion criteria</th><th>Population</th><th>Intervention / Comparison</th><th>Method of analysis</th><th>Results</th><th>Notes</th></tr>
<tr>
<td>Full citation<br>Chan, K., Hernandez, L., Yang, H., Bidwell Goetz, M., Comparative cost analysis of clinical reminder for HIV testing at the veterans affairs healthcare system, Value in Health, 17, 334-339, 2014<br><br>Quality score<br><br>+<br><br>Study type<br><br>Cost analysis<br><br>Aim of the study<br><br>To estimate the cost and health outcomes associated with a new HIV testing strategy that utilises routine-based clinical reminders in the Veterans Affairs healthcare system.</td>
<td>Inclusion criteria<br><br>N/A<br><br>Exclusion criteria<br><br>N/A</td>
<td>Number of participants<br><br>N/A<br><br>Participant characteristics<br><br>N/A</td>
<td>Intervention / Comparison<br><br>The authors conducted an economic analysis of traditional pretest/post-test counselling and a new clinical reminders system only clinical reminder in the veterans’ healthcare system.</td>
<td>Method of analysis<br>A payer-perspective decision model was conducted to calculate the 1-year budget impact of three HIV testing strategies. Parameter values were obtained from the literature, including patients’ probability of accepting test, and costs associated with HIV testing procedures. Deidentified patient data, including total population screened and number of new HIV cases, were collected from one clinic in Los Angeles, California. Annual total costs and costs per new case were calculated on the basis of parameter values and patient data. Sensitivity analyses were conducted to evaluate the robustness of the critical variable on costs.</td>
<td>Primary outcomes
<table>
<tr><th></th><th>Strategy 1</th><th>Strategy 2</th><th>Strategy 3</th></tr>
<tr><td>Population screened</td><td>1,906</td><td>3,858</td><td>16,172</td></tr>
<tr><td>New diagnoses</td><td>12</td><td>19</td><td>17</td></tr>
<tr><td>Cases identified with CD4<200</td><td>3</td><td>9</td><td>14</td></tr>
<tr><td>Estimated annual cost</td><td>$109,208.98</td><td>$81,726.57</td><td>$243,564.29</td></tr>
</table>
The total cost of the clinical reminder system with pretest counselling was $81,726 over 1 year compared with $109,208 for traditional HIV testing. Under a clinical reminder system with no pretest counselling, the number of HIV tests performed and the number of new diagnoses increased for that year. In addition, cost per new diagnosis was the lowest.</td>
<td>Limitations identified by author<br><br>Costs were calculated under the assumption that the provider already has an electronic medical records system in place. Data were collected from patients of a veteran hospital who may have different characteristics than do non-VA patient populations. Another limitation is that strategies 1, 2 and 3 were introduced sequentially at different times and that as a consequence the population being offered HIV testing differed; that is, the highest risk patients were subject to being offered HIV testing before the implementation of strategy 3, which might then partially explain the lower rates of new case finding when strategy 3 was used. Also, the actual hourly wages of physicians and nurses in VA hospitals may not be the same as extracted from the BLS database, the HIV prevalence rate</td>
</tr>
</table>

<table>
<tr>
<th>Study details</th>
<th>Inclusion / Exclusion criteria</th>
<th>Population</th>
<th>Intervention / Comparison</th>
<th>Method of analysis</th>
<th>Results</th>
<th>Notes</th>
</tr>
<tr>
<td>Location and setting<br><br>Veterans Afffairs healthcare system, US<br><br>Length of follow up<br><br>N/A<br><br>Source of funding<br><br>None</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>in VA hospital areas in this study may be quite different from that in other areas, or physician and nurse time for counselling may vary across hospitals.<br><br>Limitations identified by review team<br><br>US study so costs may not be transferable. No cost utility analysis.</td>
</tr>
<tr>
<td>Full citation<br>Ekwueme, Donatus U., Pinkerton, Steven D., Holtgrave, David R., Branson, Bernard M., Anderson, Branson Carpenter Constantine Critchfield Dittus Dobilet Doll Evans Farnham Farnham Gold Gorsky Howe Irwin Kallenborn Kassier Kassler Kassler Kassler Keenan Kelen Koblavi-Deme Levin McKcnna Phillips Respess Rotheram-Borus Spencer Steiler Sweat Tao Toomey Wilkinson</td>
<td>Inclusion criteria<br><br>n/a<br><br>Exclusion criteria<br><br>n/a</td>
<td>Number of participants<br><br>n/a<br><br>Participant characteristics<br><br>n/a</td>
<td>Intervention / Comparison<br><br>1. Conventional testing (2 week return for results)<br><br>2. Rapid one-step testing (same day results)<br><br>3. Rapid two-step testing (same day results for negative tests; likely positive test results at initial testing confirmed through additional testing and a 2 week return for results)</td>
<td>Method of analysis<br><br>A cost-analysis model was developed to calculate the intervention costs associated with providing HIV counselling & testing services using the standard conventional testing protocol and the 2-step and 1-step rapid test protocols. Counselling and testing costs were estimated from the provider perspective (the cost of the intervention included all costs</td>
<td>Primary outcomes<br><br>Provider perspective<br><br>
<table>
<tr><td></td><td colspan="2">Cost per person tested ($)</td><td colspan="2">Cost per person notified ($)</td></tr>
<tr><td>Protocol</td><td>HIV +</td><td>HIV -</td><td>HIV +</td><td>HIV -</td></tr>
<tr><td>1. conventional testing (2 week return for results)</td><td>58.14</td><td>18.39</td><td>81.94</td><td>25.66</td></tr>
<tr><td>2. rapid one-step testing (same day results)</td><td>32.95</td><td>20.28</td><td>33.54</td><td>20.80</td></tr>
<tr><td>3. rapid two-step testing (same day likely positive return in 2 weeks)</td><td>82.10</td><td>22.26</td><td>85.56</td><td>22.79</td></tr>
</table>
</td>
<td>Limitations identified by author<br><br>The study was limited by the availability of data for the input variables and by variability in some extant estimates. Also, the study did not include overhead costs, such as rent and utilities for operating an HIV clinic, or capital costs for computers and maintenance of facilities. The intervention costs estimated in this study were only incremental costs (i.e. costs needed to implement these testing technologies in an already existing programme) and did not</td>
</tr>
</table>

<table>
<tr>
<th>Study details</th>
<th>Inclusion / Exclusion criteria</th>
<th>Population</th>
<th>Intervention / Comparison</th>
<th>Method of analysis</th>
<th>Results</th>
<th>Notes</th>
</tr>
<tr>
<td>Woehrle Wykoff, Cost Comparison of Three HIV Counseling and Testing Technologies, American journal of preventive medicine, 25, 112-121, 2003<br><br>Quality score<br><br>+<br><br>Study type<br><br>Cost analysis<br><br>Aim of the study<br><br>To estimate and compare the economic costs associated with 3 HIV counselling & testing protocols: the standard protocol and the 1-step and 2-step rapid protocols.<br><br>Location and setting<br><br>A hypothetical client in a publicly funded HIV clinic</td>
<td></td>
<td></td>
<td></td>
<td>incurred by the counselling and testing programme including all materials and staff salary and compensation) and the societal perspective (all provider costs plus costs incurred by the clients, such as transportation expenses and 'opportunity costs' associated with their time).</td>
<td>Societal perspective<br><br>
<table>
<tr><td></td><td colspan="2">Cost per person tested ($)</td><td colspan="2">Cost per person notified ($)</td></tr>
<tr><td>Protocol</td><td>HIV +</td><td>HIV -</td><td>HIV +</td><td>HIV -</td></tr>
<tr><td>1. conventional testing (2 week return for results)</td><td>98.71</td><td>55.59</td><td>133.65</td><td>77.50</td></tr>
<tr><td>2. rapid one-step testing (same day results)</td><td>62.20</td><td>44.11</td><td>63.94</td><td>45.78</td></tr>
<tr><td>3. rapid two-step testing (same day likely positive return in 2 weeks)</td><td>133.76</td><td>46.71</td><td>139.20</td><td>48.40</td></tr>
</table>
<br>The results were generally consistent between the societal and provider perspectives although differed depending on HIV status of the client. For HIV-positive clients, the cost per person tested and the cost per person notified were greatest for the 2-step rapid protocol and smallest for the 1-step rapid protocol. For HIV-negative clients, the standard protocol was the most expensive and the 1-step protocol the least expensive, with one exception: from the provider perspective, the cost per person tested was greatest for the 2-step rapid protocol and least for the standard protocol. Overall, the 1-step rapid protocol was generally the least expensive of the three protocols.</td>
<td>take into account the potential overhead and capital costs necessarily associated with the larger number of clinic visits necessary for the 2-step protocol. Further, potential "psychological costs" that may occur as a result of a client being informed of a preliminary false-positive test in the 2-step rapid protocol were not take into account.</td>
</tr>
</table>

| Study details | Inclusion / Exclusion criteria | Population | Intervention / Comparison | Method of analysis | Results | Notes |
|---|---|---|---|---|---|---|
| **Length of follow up**<br><br>n/a<br><br>**Source of funding**<br><br>The author was supported, in part, by a grant from the National Institute of Mental Health (K02-MH01919 and P30-MH52776) | | | | | | |
| **Full citation**<br>Farnham, P. G., Gorsky, R. D., Holtgrave, D. R., Jones, W. K., Guinan, M. E., Counseling and testing for HIV prevention: Costs, effects, and cost-effectiveness of more rapid screening tests, Public Health Reports, 111, 44-53, 1996<br><br>**Quality score**<br><br>+<br><br>**Study type** | **Inclusion criteria**<br><br>n/a<br><br>**Exclusion criteria**<br><br>n/a | **Number of participants**<br><br>n/a<br><br>**Participant characteristics**<br><br>n/a | **Intervention / Comparison**<br><br>Intervention:<br>A streamlined counselling and testing procedure using a rapid HIV screening test<br><br>Comparison: Conventional testing including offer of counselling and testing; pretest counselling; blood sample; on- or off-site laboratory testing; repeat testing for positive samples; and post-test counselling. | **Method of analysis**<br><br>A decision model was developed based on a societal perspective, including all costs and effects incurred by both providers and clients. The analysis was developed from the perspective of adding one or the other testing procedure to an existing clinic or provider not presently offering HIV CT. | **Primary outcomes**<br><br>HIV-infected individuals only who correctly learn their serostatus,: there was a cost-effectiveness ratio for the traditional procedure of $1165 per HIV-infected client correctly counselled and tested and a ratio of $940 for the rapid procedure.<br><br>HIV-infected and uninfected individuals who correctly learn their serostatus: there was a cost-effectiveness ratio for the traditional procedure of $68 per client informed and a ratio of $37 for the rapid procedure.<br><br>The results of the analysis indicated that the rapid HIV counselling and testing procedure is generally more cost effective than the current procedure. | **Limitations identified by author**<br><br>The study does not deal with confidentiality or other ethical issues surrounding HIV counselling and testing or with measuring the quality of the counselling sessions. In addition, this study does not look at long-term impacts on behaviour of HIV C/T, which should not differ under the two procedures examined here. The precise long-term effects of HIV counselling and testing appear to vary by population and warrant further study. Such concerns must be weighed carefully in |

| Study details | Inclusion / Exclusion criteria | Population | Intervention / Comparison | Method of analysis | Results | Notes |
|---|---|---|---|---|---|---|
| Cost-effectiveness analysis<br><br>**Aim of the study**<br><br>To compare the the costs and effectiveness of a streamlined counseling and testing (CT) procedure using the rapid screening test with the current CT procedure.<br><br>**Location and setting**<br><br>n/a<br><br>**Length of follow up**<br><br>n/a<br><br>**Source of funding**<br><br>Not reported | | | | | | addition to the results of this analysis when choosing between the two testing procedures. |
| **Full citation**<br>Farnham, Paul G., Hutchinson, Angela B., Sansom, | **Inclusion criteria**<br><br>n/a | **Number of participants** | **Intervention / Comparison** | **Method of analysis**<br><br>Actual costs were | **Primary outcomes**<br><br>**Per-patient cost of conventional and rapid HIV** | **Limitations identified by author** |

<table>
<tr>
<th>Study details</th>
<th>Inclusion / Exclusion criteria</th>
<th>Population</th>
<th>Intervention / Comparison</th>
<th>Method of analysis</th>
<th>Results</th>
<th>Notes</th>
</tr>
<tr>
<td>Stephanie L., Branson, Bernard M., Comparing the costs of HIV screening strategies and technologies in health-care settings, Public health reports (Washington, D.C. : 1974), 123 Suppl 3, 51-62, 2008<br><br>Quality score<br><br>+<br><br>Study type<br><br>Cost analysis<br><br>Aim of the study<br><br>To estimate the costs of conventional and rapid HIV testing to illustrate the differences among testing strategies and technologies.<br><br>Location and setting<br><br>STD clinics and emergency departments (EDs)</td>
<td>Exclusion criteria<br><br>n/a</td>
<td>n/a<br><br>Participant characteristics<br><br>n/a</td>
<td>The study estimated the costs of rapid and conventional HIV testing in the following scenarios:<br><br>1. Sexually transmitted disease (STD) clinic counselling and testing (CT);<br>2. STD clinic screening;<br>3. Emergency department (ED) screening.</td>
<td>estimated from the provider perspective. Input variables, including costs and probabilities of patients completing various parts of the testing process, were derived from both the literature and various CDC-funded HIV counselling and testing projects. The study includes values for provider time as well as costs of materials and test kits used. Sensitivity analysis was performed on the input cost and probability variables affecting the cost per HIV infected patient receiving test results.</td>
<td>testing procedures in three scenarios (in 2006 dollars)<br><br>
<table>
<tr><td></td><td colspan="2">STD CT</td><td colspan="2">STD Screening</td><td colspan="2">ED Screening</td></tr>
<tr><td></td><td>HIV +</td><td>HIV -</td><td>HIV +</td><td>HIV -</td><td>HIV +</td><td>HIV -</td></tr>
<tr><td>Total provider cost: conventional test</td><td>$76.73</td><td>$23.44</td><td>$66.30</td><td>$13.01</td><td>$60.95</td><td>$10.16</td></tr>
<tr><td>Total provider cost: rapid test</td><td>$86.84</td><td>$28.05</td><td>$76.41</td><td>$17.62</td><td>$65.71</td><td>$14.77</td></tr>
</table>
<br>Overall costs of the rapid testing procedure were higher than those of conventional testing because of more expensive test kits and, for patients who tested positive, the need for additional specimen collection and posttest counselling during both the initial and return visits. STD CT was more expensive than STD Screening due to the additional pretest counselling costs. Per-patient costs of receiving results were lowest in the ED screening scenario.<br><br>Cost per HIV-infected patient receiving test results in three HIV testing scenarios (in 2006 dollars)<br><br>
<table>
<tr><td></td><td colspan="2">STD CT</td><td colspan="2">STD Screening</td><td colspan="2">ED Screening</td></tr>
<tr><td></td><td>Conventional test</td><td>Rapid test</td><td>Conventional test</td><td>Rapid test</td><td>Conventional test</td><td>Rapid test</td></tr>
<tr><td>Cost per HIV-infecte</td><td>$4334</td><td>$2925</td><td>$1995</td><td>$1868</td><td>$1807</td><td>$1638</td></tr>
</table>
</td>
<td>The study was subject to several limitations. There may be longer term effects of counselling and testing compared with screening that could not be included in this analysis. Counselling might affect the behaviour of either infected or uninfected patients, influence their likelihood of returning for test results, or influence whether they are likely to enter into care. This study did not attempt to assign any reduction in value attributable to preliminary false-positive results. This study also did not attempt to address the costs associated with follow-up of HIV-infected people who failed to return for their test results, or of facilitating entry into care following a positive HIV test. Although this is an important issue, data are sparse, cost estimates of the process vary widely, and these costs are often incurred by other institutions.</td>
</tr>
</table>

| Study details | Inclusion / Exclusion criteria | Population | Intervention / Comparison | Method of analysis | Results | Notes |
|---|---|---|---|---|---|---|
| **Length of follow up**<br><br>n/a<br><br>**Source of funding**<br><br>Not reported | | | | | d patient<br><br>The cost per HIV-infected patient receiving test results was lower for the rapid test compared with conventional testing in all scenarios. | |
| **Full citation**<br>Haukoos, J. S., Campbell, J. D., Conroy, A. A., Hopkins, E., Bucossi, M. M., Sasson, C., Al-Tayyib, A. A., Thrun, M. W., Programmatic cost evaluation of nontargeted opt-out rapid HIV screening in the emergency department, PloS one, 8, 2013<br><br>**Quality score**<br><br>+<br><br>**Study type**<br><br>Prospective cohort study<br><br>**Aim of the study** | **Inclusion criteria**<br><br>All patients $16 years of age and capable of providing consent for general emergency medical care were eligible to receive HIV testing.<br><br>**Exclusion criteria**<br><br>Patients were excluded from HIV testing if they were: (1) unable to provide consent as determined by registration or clinical staff (e.g., altered mentation or requiring urgent or emergent evaluation or intervention); (2) prisoners or detainees; (3) victims of sexual assault; (4) sought care as a result of | **Number of participants**<br><br>Intervention phase = 28,043<br><br>Control phase = 29,925<br><br>**Participant characteristics**<br><br>Not reported | **Intervention / Comparison**<br><br>Non-targeted rapid HIV screening (intervention) and diagnostic rapid HIV testing (control) were alternated in 4-month time blocks.<br><br>Intervention: The intervention phase consisted of non-targeted rapid opt-out HIV screening performed 24-hours per day using only existing ED and hospital staff. Registration staff obtained general medical consent from all patients and additionally offered voluntary and free rapid HIV testing to those who met criteria for inclusion using an opt- | **Method of analysis**<br><br>An economic evaluation from the ED perspective was performed to compare the two HIV testing methods. Cost effectiveness ratios (CERs), or the total costs per patient identified with HIV infection, and the incremental cost effectiveness ratio (ICER), or the additional costs per patient identified with HIV infection above and beyond those incurred by diagnostic testing, were used to compare both testing programs.<br><br>A sensitivity analysis was | **Primary outcomes**<br><br>Of those in the intervention phase, 6,762 (24%) did not opt-out and 6,702 (99%) were screened for HIV infection. Of the 6,702 patients, 10 (0.2%, 95% CI: 0.07%–0.3%) were newly-diagnosed with HIV infection. Of the 21,281 patients who opted-out, 231 (1%) were diagnostically tested by physicians, and 5 (2.2%, 95% CI: 0.7%–5.0%) were newly-diagnosed with HIV infection.<br><br>The annualized direct costs of non-targeted screening and diagnostic testing were $148,977 and $31,355, respectively, and the costs per person tested during these phases were $19 and $121, respectively. The difference in annualised direct costs of non-targeted screening and diagnostic testing was $117,622.<br><br>The CER of non-targeted screening for identifying patients with newly-diagnosed HIV infection was $9,932, whereas the CER of diagnostic testing was $7,839. Compared to diagnostic HIV testing, non-targeted HIV screening identified 11 additional newly diagnosed HIV infections at a cost of $10,693 per additional new infection identified (ICER).<br><br>The ICER comparing nontargeted HIV screening to diagnostic HIV testing was not sensitive to changes in unit cost inputs or other important cost assumptions. The | **Limitations identified by author**<br><br>This study used newly-diagnosed HIV infection as an intermediate outcome and therefore did not model costs relative to quality-adjusted life-years or other future health outcomes. Differences in the lifetime medical costs and transmissions averted between patients identified with HIV infection in the two study arms may impact cost effectiveness. Cost assumptions and inputs were not sensitive to the ICER (i.e., all ICERs derived from sensitivity analyses were greater than $7,839, the CER of diagnostic testing). Also, given the small number of outcomes, we did not use statistical |

| Study details | Inclusion / Exclusion criteria | Population | Intervention / Comparison | Method of analysis | Results | Notes |
|---|---|---|---|---|---|---|
| To compare programmatic costs of non-targeted opt-out rapid HIV screening with physician-directed diagnostic rapid HIV testing in an urban emergency department (ED) as part of the Denver ED HIV Opt-Out Trial.<br><br>**Location and setting**<br><br>An urban emergency department, Denver USA<br><br>**Length of follow up**<br><br>n/a<br><br>**Source of funding**<br><br>The study was funded by U18PS000314 from the Centers for Disease Control and Prevention (Haukoos), and supported, in part, by K02HS017526 | an occupational exposure; (5) self-identified as being infected with HIV; or (6) left the ED prior to being placed in a treatment room. | | out consent approach. Consent for HIV testing was integrated into the general medical consent and required the patient to check a box and provide a signature indicating his or her decision to opt out. For patients who agreed to HIV testing, registration personnel triggered an automatic order using the electronic ED patient tracking system. Nurses and healthcare technicians used the electronic system to identify patients who agreed to HIV testing and obtained a blood sample, which was sent it to the hospital's laboratory for rapid HIV testing. For patients who opted out during registration, physicians had the opportunity to diagnostically test them.<br><br>Control: During the control phase physician-directed diagnostic rapid opt-in HIV testing | performed where HIV test kits were changed to $0 in order to simulate a scenario where HIV tests kits were fully reimbursed to the hospital by an external payer. All costs were obtained and reported in 2009 dollars to correspond with the time period in which the study occurred. | most influential unit cost was the initial rapid HIV test cost. Varying the Uni-Gold Recombigen HIV Test unit cost by 625% of the base-case ($9.50) changed the ICER to $9,096 and $12,290, respectively. Also, when the costs of HIV test kits were reduced to $0 for both study groups, the ICER became $3,968. Additional assumptions made to bias the findings away from diagnostic testing resulted in the following ICERs:<br><br>(1) $9,977 assuming the same start-up costs between study groups;<br><br>(2) $9,481 assuming the same ED and laboratory staff costs between study groups; and<br><br>(3) $9,271 assuming the same administrative staff costs between study groups | methods (e.g., bootstrapping) to provide estimates of uncertainty for reported ICERs. We do believe, however, that reporting cost and effectiveness results from an actual clinical trial is important and contributes meaningfully to the broader knowledge base of HIV screening performance in EDs. Finally, costs analyses may be influenced by the HIV screening program, which was performed at a single institution and therefore may not be generalisable. |

| Study details | Inclusion / Exclusion criteria | Population | Intervention / Comparison | Method of analysis | Results | Notes |
|---|---|---|---|---|---|---|
| from the Agency for Healthcare Research and Quality (Haukoos) and R01AI106057 from the National Institute of Allergy and Infectious Diseases (Haukoos). | | | was performed 24-hours per day using only existing ED and hospital staff. Consent was obtained directly by physicians and documented in the patient's medical record. The physician then ordered a rapid HIV test using conventional methods of ordering diagnostic blood tests in the ED. Nurses or healthcare technicians obtained a blood sample and sent it to the laboratory for rapid HIV testing using the same sequential algorithm as in the intervention phase. | | | |
| **Full citation**<br>Hutchinson, Angela B., Farnham, Paul G., Lyss, Sheryl B., White, Douglas A. E., Sansom, Stephanie L., Branson, Bernard M., Emergency department HIV screening with rapid | **Inclusion criteria**<br><br>N/A<br><br>**Exclusion criteria**<br><br>N/A | **Number of participants**<br><br>Theoretical sample of 50,000 per model. | **Intervention / Comparison**<br><br>The authors compared the costs and outcomes of a model that used the hospital's Emergency | **Method of analysis**<br><br>A simple decision model was constructed to compare the cost per new HIV diagnosis for the testing approaches. The | **Primary outcomes**<br><br>Assuming an annual ED census of 50,000 patients for each ED testing model, the total program costs were estimated to be: $101,028 for the existing staff model, $64,200 for the supplemental staff model, and $229,939 for the hybrid model. These costs, derived from the decision analysis, were the total costs for an ED testing program with an annual census of 50,000 adjusted for the probabilities of offering, accepting, being | **Limitations identified by author**<br><br>The authors did not assess the opportunity cost of using existing staff to conduct testing instead of activities related to the ED's mission of providing |

| Study details | Inclusion / Exclusion criteria | Population | Intervention / Comparison | Method of analysis | Results | Notes |
|---|---|---|---|---|---|---|
| tests: a cost comparison of alternative models, AIDS education and prevention : official publication of the International Society for AIDS Education, 23, 58-69, 2011<br><br>**Quality score**<br><br>+<br><br>**Study type**<br><br>Cost comparison<br><br>**Aim of the study**<br><br>To compare the costs and outcomes of 3 alternative methods of implementing ED screening for HIV.<br><br>**Location and setting**<br><br>Hospital emergency department, USA<br><br>**Length of follow up** | | | Department staff to conduct screening, a supplemental staff model that used non-ED staff hired to conduct screening and a hypothetical hybrid model that combined aspects of both approaches. We developed a decision analytic model to estimate the cost per HIV-infected identified using alternative ED testing models. | model included the probabilities of being offered, accepting and receiving an HIV test, and testing positive for HIV infection as well as HIV testing costs and estimates the proportion of persons tested and diagnosed and testing costs for each approach. These estimates were applied to a cohort of 50,000 patients representing an annual ED census of 50,000, which allowed us to estimate total program costs, HIV infections diagnosed, and cost per diagnosed infection. | tested, and testing positive. The existing staff model identified 29 more cases of HIV infection than the supplemental staff model at an annual additional cost of $36,828 or $1,264 per additional case identified. The hybrid model identified 76 more HIV infections than the existing staff model at an additional annual program cost of $128,911, or $1,700 per additional case identified. The average cost per case (total program cost divided by the number of newly identified cases of HIV infection) under the supplemental, existing and hybrid models, respectively, was $3,319, $2,084, and $1,850. | acute care. These costs are difficult to value and are not often included in cost-effectiveness analyses. They did not attempt to value downstream costs (such as medical care) and benefits (such as HIV transmissions averted). |

<table>
<tr><th>Study details</th><th>Inclusion / Exclusion criteria</th><th>Population</th><th>Intervention / Comparison</th><th>Method of analysis</th><th>Results</th><th>Notes</th></tr>
<tr><td>N/A<br><br>Source of funding<br><br>Not reported</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Full citation<br>Juusola, Jessie L., Brandeau, Margaret L., Long, Elisa F., Owens, Douglas K., Bendavid, Eran, The cost-effectiveness of symptom-based testing and routine screening for acute HIV infection in men who have sex with men in the USA, AIDS (London, England), 25, 1779-87, 2011<br><br>Quality score<br><br>++<br><br>Study type<br><br>Cost effectiveness analysis<br><br>Aim of the study<br><br>To examine the cost effectiveness of</td><td>Inclusion criteria<br><br>MSM aged 13-64</td><td>Number of participants<br><br>n/a<br><br>Participant characteristics<br><br>n/a</td><td>Intervention / Comparison<br><br>The following testing approaches were evaluated:<br><br>Expanded annual antibody screening coverage to 90% annually, antibody testing + viral load (VL) testing + symptom-based<br>Expanded annual antibody screening coverage to 90% annually, antibody testing + symptom-based<br>Status quo of 67% annual antibody screening, antibody testing + VL + symptom-based<br>Status quo of 67% annual antibody screening, antibody testing + symptom-based<br>Expanded annual antibody screening coverage to 90%</td><td>Method of analysis<br><br>A dynamic compartmental model of HIV transmission and progression was developed<br>to compare the cost-effectiveness of alternative testing strategies. The model<br>was implemented us ing weekly time steps and calibrated to estimates of HIV incidence among MSM. HIV prevalence, incidence, quality-adjusted life years (QALYs),<br>and healthcare costs were estimated over a 20-year time horizon. All costs (in 2009 US dollars) were assessed from a societal perspective, and costs and QALYs were discounted at 3%</td><td>Primary outcomes<br><table><tr><th>Strategy</th><th>HIV infections prevented</th><th>ICER relative to Status Quo</th><th>ICER relative to next best strategy</th></tr><tr><td>90% annually, antibody testing + viral load (VL) testing + symptom-based</td><td>38,995 (7.2%)</td><td>$35,032</td><td>$105,398</td></tr><tr><td>90% annually, antibody testing + symptom-based</td><td>30,780 (5.7%)</td><td>$20,013</td><td>$29,923</td></tr><tr><td>67% annually, antibody testing + VL + symptom-based</td><td>27,720 (5.1%)</td><td>$38,783</td><td>Dominated</td></tr><tr><td>67% annually, antibody testing + symptom-based</td><td>22,446 (4.2%)</td><td>$22,786</td><td>Dominated</td></tr><tr><td>90% annually, antibody testing</td><td>14,923 (2.8%)</td><td>$12,582</td><td>$12,582</td></tr></table><br>Overall, expanding annual antibody screening coverage to 90% is effective and cost-effective compared to the status quo. Adding symptom-based viral load testing to current antibody screening rates is more expensive than expanded screening, however, it is more effective. Combining expanded antibody screening with symptom-based testing prevents twice as many infections compared to expanded screening alone. The most expensive option is expanded screening with all testing</td><td>Limitations identified by author<br><br>The study has several limitations:<br><br>The authors assumed that treatment with ART during acute infection provides no benefits to the treated individual. Observational studies suggest that ART during acute infection may delay CD4 decline, increase the probability of low plasma viral load after treatment discontinuation, and delay immunological decline. Incorporating such benefits would only improve cost-effectiveness estimates and the case for early identification.<br>The authors assumed that HIV antibody tests are<br>completely insensitive during acute infection. However, the point at which antibodies become</td></tr>
</table>

| Study details | Inclusion / Exclusion criteria | Population | Intervention / Comparison | Method of analysis | Results | Notes |
|---|---|---|---|---|---|---|
| strategies for expanded testing of MSM.<br><br>**Location and setting**<br><br>USA<br><br>**Length of follow up**<br><br>n/a<br><br>**Source of funding**<br><br>Sponsorship: This work was supported by Grant Number R01-DA15612 from the National Institute on Drug Abuse. Dr. Owens is supported by the Department of Veterans Affairs. Dr. Bendavid is supported by the National Institute of Allergy and Infectious Diseases (K01-AI084582). | | | annually, antibody testing | annually. | options. In general, symptom-based testing offers gains in health benefits with favourable cost-effectiveness ratios. | detectable varies. A fourth-generation enzyme immunoassay (EIA) that detects infection earlier was approved for use in the US in June 2010. Standard VL tests are more sensitive to acute infection, however, and the new fourth-generation EIA does not distinguish between the detection of acute infection or HIV antibodies. Since acutely infected patients must be identified as such in order to receive ART during the acute phase, strategies using fourth generation EIAs to detect acute infection would require confirmatory testing to identify infections as acute, complicating the testing algorithm and reducing the cost savings from avoiding VL tests. Thus, VL tests may be more appropriate for symptom-based testing. The authors assumed a homogeneous population of MSM, while in reality MSM fall along a spectrum of risky behaviour. If high-risk MSM are less likely than low-risk men to present to a healthcare setting when they have ILI, the impact of symptom-based VL testing may |

| Study details | Inclusion / Exclusion criteria | Population | Intervention / Comparison | Method of analysis | Results | Notes |
|---|---|---|---|---|---|---|
| | | | | | | be overestimated here; if the converse is true, the impact of symptom-based testing may be underestimated.<br>The authors did not consider the possibility of increased drug resistance, which could be a concern with increased ART use. However, the effects of resistance could be approximated by lower ART efficacy and higher ART cost, to which our results were not sensitive. Fifth, we did not explicitly model non-AIDS defining events, such as neurocognitive decline, cardiovascular events, renal disease, and cancers, which factor into the life expectancy and quality of life of AIDS patients. However, the authors accounted for these in the mortality rates and quality-of-life weights that we use for HIV patients.<br>The authors assumed individual VL tests. While this is necessary for symptom-based testing and critical for short turnaround times in reporting results and initiating ART, annual VL screening could make use of pooling schemes to reduce cost. |

| Study details | Inclusion / Exclusion criteria | Population | Intervention / Comparison | Method of analysis | Results | Notes |
|---|---|---|---|---|---|---|
| **Full citation**<br>Long, Elisa F., Mandalia, Roshni, Mandalia, Sundhiya, Alistar, Sabina S., Beck, Eduard J., Brandeau, Margaret L., Expanded HIV testing in low-prevalence, high-income countries: a cost-effectiveness analysis for the United Kingdom, PloS one, 9, e95735, 2014<br><br>**Quality score**<br><br>++<br><br>**Study type**<br><br>Cost-effectiveness analysis<br><br>**Aim of the study**<br><br>To estimate the effectiveness and cost-effectiveness of HIV testing in the United Kingdom (UK), where 25% of PLHIV are estimated to be undiagnosed.<br><br>**Location and** | **Inclusion criteria**<br><br>adult population aged 15 to 64 in the UK. | **Number of participants**<br><br>N/A<br><br>**Participant characteristics**<br><br>The population were divided into six groups, distinguished by risk behaviours or country of origin: MSM; PWID; men from HIV-endemic countries with high HIV prevalence; women from HIV-endemic countries; other men; and other women. | **Intervention / Comparison**<br><br>The model compared universal HIV testing and with targeted HIV testing for risk groups. | **Method of analysis**<br><br>The authors populated a previously published dynamic HIV epidemic model with epidemiological, behavioural, and cost data from the UK. The model simulated HIV transmission in the UK adult population, accounting for varying risk behaviour, and projected the future epidemic trajectory under different HIV testing and treatment scale-up scenarios. They performed a cost-effectiveness analysis to estimate the relative costs and health benefits associated with each scenario. | **Primary outcomes**<br><br>Annual HIV testing of all adults could avert 5% of new infections, even with no behaviour change following HIV diagnosis because of earlier ART initiation, or up to 18% if risky behaviour is halved. This strategy costs £67,000–£106,000/ QALY gained. Providing annual testing only to MSM, PWID, and people from HIV-endemic countries, and one-time testing for all other adults, prevents 4–15% of infections, requires one-fourth as many tests to diagnose each PLHIV, and costs £17,500/QALY gained. Augmenting this program with increased ART access could add 145,000 QALYs to the population over 10 years, at £26,800/QALY gained. | **Limitations identified by author**<br><br>As with many epidemic models, the complex dynamics of HIV disease progression , development of resistance, and changes in viral suppression were simplified. Although the model captured the reduction in primary transmission to the partners of persons diagnosed with HIV, as well as secondary transmission to those partners' partners, a standard proportional mixing model of partnership selection was assumed. Due to data limitations there was no preferential mixing by HIV status, race or immigration status, nor did the model consider differential condom use by HIV status. Similar HIV prevalence levels for newly arriving immigrants and those already living in the UK were assumed, due to a lack of data on HIV infection rates of those just arriving. Improved data on baseline demographics, sexual behaviour and other risk behaviours |

| Study details | Inclusion / Exclusion criteria | Population | Intervention / Comparison | Method of analysis | Results | Notes |
|---|---|---|---|---|---|---|
| **setting**<br><br>UK<br><br>**Length of follow up**<br><br>N/A<br><br>**Source of funding**<br><br>3 of the authors were supported by a grant from the United States National Institute on Drug Abuse (R01-DA15612). | | | | | | would allow for more refined estimates of testing impact. Finally, costs were estimated on a per person basis using current estimates of the costs of HIV testing and counselling and treatment for HIV infection. If expansion of HIV testing coverage were linked with a broad national campaign or with significant changes in delivery of health care services then costs could be higher than have been estimated. |
| **Full citation**<br>Phillips, K. A., Fernyak, S., The cost-effectiveness of expanded HIV counselling and testing in primary care settings: a first look, AIDS (London, England), 14, 2159-69, 2000<br><br>**Quality score**<br><br>++<br><br>**Study type** | **Inclusion criteria**<br><br>N/A<br><br>**Exclusion criteria**<br><br>N/A | **Number of participants**<br><br>A cohort based on the number of annual new (versus returning) patient visits to primary care providers (general and family practice and internal medicine) in the USA for persons between the ages of 15 and 65 years | **Intervention / Comparison**<br><br>Two approaches were examined: (i) requesting all patients to complete an HIV-risk screening instrument, with counselling as well as testing offered only to patients disclosing risk factors (`risk histories' option); and (ii) routine offering of voluntary testing to all | **Method of analysis**<br><br>A decision analytical approach was used to examine the incremental costs and effectiveness of each approach. Analyses were run using DATA and were verified using EXCEL spreadsheets. The analysis is from a societal perspective. Costs and effectiveness were discounted at 3% | **Primary outcomes**<br><br>Routine, voluntary testing is the most cost-effective approach at an incremental cost of US$4200 per infection identified, whereas using risk histories is both more costly and less effective than routine testing. However, if routine testing were excluded as a policy option, the risk histories approach would cost US$5300 per infection identified compared with current practices.<br><br>Multi-way sensitivity analyses were also conducted by varying key factors simultaneously. Under a `best' case scenario with high HIV prevalence (1%), a high percentage of patients with risk factors (75%), high acceptance of testing (75%), and low costs of negative tests (US$5), the cost per infection identified fell to US$780 for routine testing. Conversely, under a | **Limitations identified by author**<br><br>Data uncertainty |

| Study details | Inclusion / Exclusion criteria | Population | Intervention / Comparison | Method of analysis | Results | Notes |
|---|---|---|---|---|---|---|
| Cost effectiveness analysis<br><br>**Aim of the study**<br><br>To estimate the cost-effectiveness of approaches to expanded HIV counselling and testing.<br><br>**Location and setting**<br><br>Primary care (general and family practice and internal medicine) in the USA<br><br>**Length of follow up**<br><br>N/A<br><br>**Source of funding**<br><br>Not reported | | | patients, with consent obtained but no pre-test counselling (`routine testing'). | (range 0±10%). | `worst' case scenario with low HIV prevalence (0.1%), a low percentage of patients with risk factors (15%), low acceptance of routine testing (25%), and high costs of negative tests (US$10 for routine testing and US$70 for risk histories), the cost per infection identified increased to US$11 000 for routine testing. | |
| **Full citation**<br>Sanders, G. D., Anaya, H. D., Asch, S., Hoang, T., Golden, J. F., Bayoumi, A. M., Owens, D. K., Cost- | **Inclusion criteria**<br><br>The cohort was modelled to reflect the patients in an RCT: Patients were eligible for | **Number of participants**<br><br>**Participant characteristics**<br><br>Patients in the trial | **Intervention / Comparison**<br><br>3 intervention models for HIV counselling and testing were | **Method of analysis**<br><br>The authors adapted a Markov model developed to assess the cost effectiveness of | **Primary outcomes**<br>Model A resulted in per-patient lifetime discounted costs of $48,650 and benefits of 16.271 QALYs ($2,990/QALY).<br>Model B increased lifetime costs by $53 and benefits by 0.0013 QALYs (corresponding to 0.48 quality-adjusted life days). | **Limitations identified by author**<br><br>The study has several limitations. As noted, the trial was performed in VA primary and urgent |

| Study details | Inclusion / Exclusion criteria | Population | Intervention / Comparison | Method of analysis | Results | Notes |
|---|---|---|---|---|---|---|
| effectiveness of strategies to improve HIV testing and receipt of results: economic analysis of a randomized controlled trial, Journal of general internal medicine, 25, 556-63, 2010<br><br>**Quality score**<br><br>+<br><br>**Study type**<br><br>Cost effectiveness analysis<br><br>**Aim of the study**<br><br>To examine the costs and benefits of strategies to improve HIV testing and receipt of results.<br><br>**Location and setting**<br><br>Primary care setting, Southern California<br><br>**Length of follow** | inclusion in the RCT if they met all of the following criteria: aged 18–65 years, unaware of their HIV status, had not received an HIV test in the past year, had an appointment with a provider in the target clinic that day, were proficient in English and were competent to consent to the study. | were on average 49.7 years old, 32% White, 43% African American, essentially all men, 9.6% were men who have sex with men, and the prevalence of undiagnosed HIV in the population was 0.398% | compared:<br><br>Model A = traditional HIV counselling and testing;<br><br>Model B = nurse-initiated routine screening with traditional HIV testing and counselling;<br><br>Model C = nurse-initiated routine screening with rapid HIV testing and streamlined counselling. | voluntary HIV screening in healthcare settings. The perspective of a perfect insurer which uses costs to the insurer and patient, and corresponds to what most studies term a societal perspective, was used. Both costs and benefits were discounted at a 3% annual rate and patients were followed for their lifetime. | Model C cost $66 more than Model A with an increase of 0.0018 QALYs (0.66 quality adjusted life days) and an incremental cost-effectiveness of $36,390/QALY. When the benefit reduced HIV transmission was included, Model C cost $10,660/QALY relative to Model A. The cost-effectiveness of Model C was robust in sensitivity analyses. | care settings, which have different patient populations than many primary or urgent care practices. In the trial, about 17% of patients approached for participation agreed to enter the study. Because this was a research study, informed consent was required, and the requirements for follow-up may have discouraged some patients from participating. Thus, the implications for implementation of screening outside a trial are not known. The cost-effectiveness of screening however would not be affected by the participation rate since a change in participation would increase/decrease costs and benefits proportionally. In addition, the VA populations we studied do not reflect the distributions or the risk groups in some other populations or settings. Because our results may not be generalizable to non-VA setting, further study in other settings would be helpful. In addition, longer term assessment of effectiveness of |

| Study details | Inclusion / Exclusion criteria | Population | Intervention / Comparison | Method of analysis | Results | Notes |
|---|---|---|---|---|---|---|
| **up**<br><br>Patients were followed for their lifetime.<br><br>**Source of funding**<br><br>This project was supported by the Department of Veterans Affairs Health Services Research and Development Servic e and the National Institute on Drug Abuse (R01 DA15612-01). | | | | | | streamlined counselling would be useful;<br>our follow-up did not extend beyond 4 weeks. Finally, our cost-effectiveness analysis assumed that identified patients would have access to HIV care, which is true in the VA, but may not hold in some settings. The benefit from screening would be less than we estimated if patients did not have full access to care. |
| **Full citation**<br>Schackman, B. R., Metsch, L. R., Colfax, G. N., Leff, J. A., Wong, A., Scott, C. A., Feaster, D. J., Gooden, L., Matheson, T., Haynes, L. F., Paltiel, A. D., Walensky, R. P., The cost-effectiveness of rapid HIV testing in substance abuse treatment: results of a randomized trial, Drug and alcohol dependence, 128, 90-7, 2013 | **Inclusion criteria**<br><br>Participation was limited to individuals who reported being HIV negative or of unknown status and who had not received results of an HIV test initiated in the previous 12 months. | **Number of participants**<br><br>1,281 participants were recruited from 12 participating community-based substance abuse treatment programs that were geographically diverse and provided a variety of drug treatment modalities.<br><br>**Participant characteristics** | **Intervention / Comparison**<br><br>The authors measured the cost-effectiveness of three HIV testing strategies evaluated in a randomized trial conducted in 12 community-based substance abuse treatment programs in 2009:<br><br>• off-site testing referral<br>• on-site rapid | **Method of analysis**<br><br>The Cost-Effectiveness of Preventing AIDS Complications (CEPAC) computer simulation model was used to project life expectancy, lifetime costs, and quality-adjusted life years (QALYs) for individuals in this population with undiagnosed HIV in the absence of any offer of HIV testing at the substance abuse | **Primary outcomes**<br><br>Referral for off-site testing is less efficient (dominated) compared to offering on-site testing with information only. The cost-effectiveness ratio for on-site testing with information is $60,300/QALY in the base case, or $76,300/QALY with 0.1% undiagnosed HIV prevalence. HIV risk-reduction counselling costs $36 per person more without additional benefit. | **Limitations identified by author**<br><br>Data were collected in a clinical trial conducted in community-based substance abuse treatment programs that were diverse, but may not be generalisable outside the context of a randomized clinical trial. The trial was not powered to detect prevalence of undiagnosed HIV so the 0.4% prevalence used in the base case is only an estimate. Prevalence of undiagnosed HIV may be higher in settings |

| Study details | Inclusion / Exclusion criteria | Population | Intervention / Comparison | Method of analysis | Results | Notes |
|---|---|---|---|---|---|---|
| **Quality score**<br><br>++<br><br>**Study type**<br><br>Cost-effectiveness analysis<br><br>**Aim of the study**<br>To estimate the cost-effectiveness of three HIV testing strategies conducted in 12 community-based substance abuse treatment programs<br><br>**Location and setting**<br><br>Community based substance abuse treatment programmes, US<br><br>**Length of follow up**<br><br>N/A<br><br>**Source of funding**<br><br>National Institute on Drug Abuse (R01 DA027379; | | Not reported | • testing with information only<br>• on-site rapid testing with risk reduction counselling.<br><br>There were no statistically significant differences among the three groups in the trial (p=0.66 for differences across all 3 groups) in the primary outcome of sexually risky behaviours defined as self-reported anal and vaginal sex acts with either primary or non-primary partner measured at 6 months.<br><br>Data from the trial included patient demographics, prior testing history, test acceptance and receipt of results, undiagnosed HIV prevalence (0.4%) and program costs. The Cost Effectiveness of Preventing AIDS Complications (CEPAC) computer | treatment program. The authors modelled projected changes in these outcomes as a result of earlier HIV diagnosis based on the acceptance and receipt of HIV test results and the testing costs for each testing strategy evaluated in the trial.<br><br>Incremental cost-effectiveness ratios for each strategy were calculated from the projected outcomes for HIV-infected individuals and the cost of testing HIV-negative individuals (including adverse quality-of-life effects of false reactive rapid test results). All cost-effectiveness ratios were calculated as the incremental cost per QALY gained compared with the next least expensive strategy after eliminating strategies due to dominance or extended dominance. The analysis was | | where there is higher overall HIV prevalence and fewer substance users have been tested previously. In addition, both the CD4 count at diagnosis and the frequency of testing elsewhere were unobserved. |

| Study details | Inclusion / Exclusion criteria | Population | Intervention / Comparison | Method of analysis | Results | Notes |
|---|---|---|---|---|---|---|
| K23DA019809), the National Drug Abuse Treatment Clinical Trials Network (CTN) (U10 DA013720, U10DA13720-09S, U10 DA020036, U10DA15815, U10DA13034, U10DA013038, U10 DA013732, U10 DA13036, U10 DA13727, U10DA01 5833, HHSN27120052208 1C, HHSN27120052207 1C); the National Institute of Mental Health (R01 MH063869), and the National Institute of Allergy and Infectious Diseases (R37 A1042006). | | | simulation model was used to project life expectancy, lifetime costs, and quality-adjusted life years (QALYs) for HIV infected individuals. Incremental cost-effectiveness ratios (2009 US$/QALY) were calculated after adding costs of testing HIV-uninfected individuals; costs and QALYs were discounted at 3% annually. | conducted from the societal perspective, and all costs and QALYs were discounted at an annual rate of 3%. | | |
| **Full citation**<br>Stevinson,Kendall, Martin,Eugene G., Marcella,Stephen, Paul,Sindy M., Cost effectiveness analysis of the New Jersey rapid testing algorithm for HIV testing in publicly funded testing sites, Journal of clinical virology : the official publication of the Pan American | **Inclusion criteria**<br>Not reported<br><br>**Exclusion criteria**<br>Not reported | **Number of participants**<br>Standard testing = 19677<br>Rapid testing = 20299<br><br>**Participant characteristics**<br>Not reported | **Intervention / Comparison**<br>Reference period 1 (2008): A standard confirmation algorithm was used including an initial rapid test followed by Western Blot confirmatory testing at a second visit for clients with a positive test result. Reference period 2 (2009): A rapid | **Method of analysis**<br>Each algorithm's effectiveness was measured by: percentage of positive clients who were notified of their results and the number of days between initial test date and date of communication of positive results to the client. Incremental costs | **Primary outcomes**<br>Reference period 1 (2008): 215 of 247 clients with a positive rapid HIV test were confirmed positive by Western Blot (WB). Of those with positive test results, 90.9% were notified and 9.1% did not return for a second visit to receive their results. There was a lag of 11.4 days until notification of confirmed positive results.<br>Reference period 2 (2009): 152 of 170 clients with one positive rapid test had a confirmatory second positive test and were notified on the same day.<br>Per positive test, the incremental cost effectiveness ratio (ICER) of the RTA compared to the standard algorithm was $30.46 per additional percent notified ($24.31 per day earlier notification) and $4.85 per additional percent notified ($3.87 per day earlier notification) modelled with | **Limitations identified by author**<br>Not reported |

| Study details | Inclusion / Exclusion criteria | Population | Intervention / Comparison | Method of analysis | Results | Notes |
|---|---|---|---|---|---|---|
| Society for Clinical VirologyJ Clin Virol, 52 Suppl 1, S29-S33, 2011<br><br>**Quality score**<br>+<br><br>**Study type**<br>Retrospective cost-effectiveness analysis<br><br>**Aim of the study**<br>To compare the cost-effectiveness of a rapid testing algorithm with a standard testing algorithm.<br><br>**Location and setting**<br>15 publicly funded counselling and testing sites in New Jersey, USA<br><br>**Length of follow up**<br>N/A<br><br>**Source of funding**<br>None | | | testing algorithm was used including same day confirmatory testing using a second rapid test for clients with a positive test result. | and incremental cost effectiveness ratios (ICERs) were calculated for each algorithm. | elimination of the WB. Calculated for the 170 positives in 2009, this represents a potential saving of $14.68 (16%) per positive person with the RTA. | |

# 7. Appendix 2 Quality of included studies

| | Question | | | | | | | | | | | | | | | | | | | | | Overall Assessment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Section 1 | | | | | | | | | | Section 2 | | | | | | | | | | | |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | |
| Chan, K., Hernandez, L., et al 2014 | - | ++ | - | - | N/A | N/A | - | - | - | | + | N/A | N/A | N/A | ++ | + | + | + | + | + | - | + |
| Ekwueme, Donatus U., Pinkerton, et al 2003 | + | + | ++ | ++ | N/A | - | N/A | + | + | | + | N/A | + | + | + | ++ | + | + | - | ++ | Unclear | + |
| Farnham, P. G., Gorsky, R. D., Holtgrave, D. R., et al 1996 | + | ++ | + | ++ | N/A | - | - | + | + | | + | N/A | + | + | Unclear | ++ | + | + | + | ++ | Unclear | + |
| Farnham, Paul G., Hutchinson, Angela B., et al 2008 | ++ | ++ | + | + | N/A | - | - | - | + | | + | N/A | + | + | + | + | + | + | - | + | Unclear | + |
| Haukoos, J. S., Campbell, J. D et al 2013 | + | + | + | + | N/A | N/A | N/A | + | + | | + | N/A | + | + | Unclear | + | + | + | ++ | + | ++ | + |
| Hutchinson, Angela B., Farnham et al 2011 | ++ | ++ | - | - | N/A | - | - | - | + | | + | - | + | + | + | - | + | + | - | + | - | + |
| Juusola, Jessie L., Brandeau, Margaret L. et al, 2011 | + | ++ | Unclear | ++ | N/A | + | + | ++ | ++ | | ++ | ++ | + | + | Unclear | ++ | + | ++ | ++ | ++ | Unclear | ++ |
| Long, Elisa F., Mandalia, et al 2014 | ++ | ++ | ++ | ++ | ++ | ++ | ++ | ++ | ++ | | ++ | + | ++ | ++ | ++ | ++ | ++ | ++ | + | + | - | ++ |
| Phillips, K. A., Fernyak, S., 2000 | ++ | ++ | - | ++ | + | ++ | + | + | ++ | | ++ | + | ++ | + | ++ | ++ | + | + | ++ | ++ | - | ++ |
| Sanders, G. D., Anaya, H. D et al 2010 | ++ | ++ | + | + | + | + | + | + | + | | ++ | ++ | ++ | + | + | ++ | + | + | ++ | ++ | ++ | + |
| Schackman, B. R., Metsch, L. R., et al 2013 | + | ++ | - | ++ | + | ++ | ++ | + | + | | ++ | ++ | ++ | ++ | ++ | ++ | ++ | ++ | ++ | ++ | - | ++ |
| Stevinson,Kendall, Martin,Eugene | Unclear | + | + | Unclear | N/A | N/A | + | N/A | + | | N/A | N/A | + | + | + | + | + | Unclear | ++ | - | ++ | + |

| | Question | | | | | | | | | | | | | | | | | | | | | Overall Assessment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Section 1 | | | | | | | | | | Section 2 | | | | | | | | | | | |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | |
| G. et al 2011 | | | | | | | | | | | | | | | | | | | | | | |

# 8. Appendix 3 Quality Appraisal checklist

## QA Checklist for Economic evaluations

***Administrative details***

| | |
|---|---|
| **Study name or author and year**<br>[Type study name, or author and year (include letter if more than 1 paper with the same author and year, e.g. 'Smith 2010a')] | **STAR ID**<br>[Type STAR ID] |
| **Citation**<br>[Include citation details – usually authors, title of study, journal details, year] | |
| **Linked studies (study name or author, year, STAR ID)**<br>[Include study name or author, year and STAR ID of any related studies, or state 'None'] | |
| **Final study quality score**<br>[Click to choose the final quality score. See 'Calculation of final study quality score' below for details on how to complete this.] | |
| **Date of QA**<br>[Click to choose the date the QA was completed] | **Reviewer(s) names**<br>[Type name of the reviewer/reviewers completing the quality assessment] |

**Calculation of final study quality score (from box 6.1 on page 95 of the NICE Guidelines Manual)**

**++** All or most of the checklist criteria have been fulfilled, and where they have not been fulfilled the conclusions are very unlikely to alter.

**+** Some of the checklist criteria have been fulfilled, and where they have not been fulfilled, or are not adequately described, the conclusions are unlikely to alter.

**-** Few or no checklist criteria have been fulfilled and the conclusions are likely or very likely to alter.

## *Quality Assessment*

**For all questions:**

| | | |
|---|---|---|
| ++ | 'Yes' | The study full meets the criterion. |
| + | 'Partly' | The study largely meets the criterion but differs in some important respect. |
| - | 'No' | The study deviates substantially from the criterion. |
| | 'Unclear' | Report provides insufficient information to judge whether the study complies with the criterion. |
| | 'NA (not applicable' | The criterion is not relevant in this particular instance. |

For detailed notes on completing the checklist, please see p10-20 of Appendix H of the Manual.

| Item | Decision | Comments |
|---|---|---|
| **Section 1: Applicability** (relevance to specific review questions and the NICE reference case as described in section 7.3 of the Manual)<br>This checklist should be used first to filter out irrelevant studies. | | |
| 1.1 Is the study population appropriate for the review question? | [Click here to choose a decision. | |
| 1.2 Are the interventions appropriate for the review question? | [Click here to choose a decision. | |
| 1.3 Is the system in which the study was conducted sufficiently similar to the current UK context? | [Click here to choose a decision. | |
| 1.4 Are the perspectives clearly stated and are they appropriate for the review question? | [Click here to choose a decision. | |
| 1.5 Are all direct effects on individuals included, and are all other effects included where they are material? | [Click here to choose a decision. | |
| 1.6 Are all future costs and outcomes discounted appropriately? | [Click here to choose a decision. | |
| 1.7 Is QALY used as an outcome, and was it derived using NICE's preferred methods? If not, describe rationale and outcomes used in line with analytical perspectives taken (item 1.4 above). | [Click here to choose a decision. | |
| 1.8 Are costs and outcomes from other sectors fully and appropriately measured and valued? | [Click here to choose a decision. | |
| 1.9 **Overall judgement:** There is no need to use section 2 of the checklist if the study is considered 'not applicable'.<br><br>• **Directly applicable** – the study meets all applicability criteria, or fails to meet 1 or more applicability criteria but this is unlikely to change the conclusions about cost effectiveness.<br>• **Partially applicable** – the study fails to meet 1 or more of the applicability criteria, and this could change the conclusions about cost effectiveness. | [Click here to choose a decision. Score ++ for directly applicable, + for partially applicable and – for not applicable | |

| | | |
|---|---|---|
| • **Not applicable** – the study fails to meet 1 or more of the applicability criteria, and this is likely to change the conclusions about cost effectiveness. Such studies would usually be excluded from further consideration and there is no need to continue with the rest of the checklist. | | |
| **Other comments:** | | |
| **Section 2: Study limitations** (the level of methodological quality)<br>This checklist should be used once it has been decided that the study is sufficiently applicable to the context of the guideline | | |
| 2.1 Does the model structure adequately reflect the nature of the topic under evaluation? | [Click here to choose a decision. | |
| 2.2 Is the time horizon sufficiently long to reflect all important differences in costs and outcomes? | [Click here to choose a decision. | |
| 2.3 Are all important and relevant outcomes included? | [Click here to choose a decision. | |
| 2.4 Are the estimates of baseline outcomes from the best available source? | [Click here to choose a decision. | |
| 2.5 Are the estimates of relative intervention effects from the best available source? | [Click here to choose a decision. | |
| 2.6 Are all important and relevant costs included? | [Click here to choose a decision. | |
| 2.7 Are the estimates of resource use from the best available source? | [Click here to choose a decision. | |
| 2.8 Are the unit costs of resources from the best available source? | [Click here to choose a decision. | |
| 2.9 Is an appropriate incremental analysis presented or can it be calculated from the data? | [Click here to choose a decision. | |
| 2.10 Are all important parameters whose values are uncertain subjected to appropriate sensitivity analysis? | [Click here to choose a decision. | |
| 2.11 Is there any potential conflict of interest? | [Click here to choose a decision. | |
| 2.12 **Overall assessment:** Minor limitations/potentially serious limitations/very serious limitations.<br><br>• **Minor limitations** – the study meets all quality criteria, or fails to meet 1 or more quality criteria but this is unlikely to change the conclusions about cost effectiveness.<br>• **Potentially serious limitations** – the study fails to meet 1 or more | [Click here to choose a decision. Score ++ for minor limitations, + for potentially serious limitations and – for very serious limitations | |

| | |
|---|---|
| quality criteria, and this could change the conclusions about cost effectiveness.<br>• **Very serious limitations** – the study fails to meet 1 or more quality criteria, and this is highly likely to change the conclusions about cost effectiveness. Such studies should usually be excluded from further consideration. | |
| **Other comments:** | |