

# BMJ Open

BMJ Open is committed to open peer review. As part of this commitment we make the peer review history of every article we publish publicly available.

When an article is published we post the peer reviewers' comments and the authors' responses online. We also post the versions of the paper that were used during peer review. These are the versions that the peer review comments apply to.

The versions of the paper that follow are the versions that were submitted during the peer review process. They are not the versions of record or the final published versions. They should not be cited or distributed as the published version of this manuscript.

BMJ Open is an open access journal and the full, final, typeset and author-corrected version of record of the manuscript is available on our site with no access controls, subscription charges or pay-per-view fees (<http://bmjopen.bmj.com>).

If you have any questions on BMJ Open's open peer review process please email [info.bmjopen@bmj.com](mailto:info.bmjopen@bmj.com)

# BMJ Open

## A comparison of the cost of different methods of retesting chlamydia positive individuals in England

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2018-024828
Article Type:	Research
Date Submitted by the Author:	15-Jun-2018
Complete List of Authors:	<p>Looker, Katharine; University of Bristol, Population Health Sciences, Bristol Medical School</p> <p>Buitendam, Erna; Public Health England, HIV &amp; STI Department, National Infection Service</p> <p>Woodhall, Sarah; Public Health England, HIV &amp; STI; UCL, Research Department of Infection and Population Health</p> <p>Hollis, Emma; Public Health England, HIV/STI</p> <p>Ong, Koh Jun; Public Health England, National Infections Service - HIV/STI</p> <p>Saunders, John; Public Health England, HIV &amp; STI Department; University College London, Research Department of Infection and Population Health</p> <p>Dunbar, Kevin; Public Health England, HIV &amp; STI Department</p> <p>Turner, Katy; Bristol University, School of Social and Community Medicine</p>
Keywords:	Public health < INFECTIOUS DISEASES, HEALTH SERVICES ADMINISTRATION & MANAGEMENT, HEALTH ECONOMICS

SCHOLARONE™  
Manuscripts

# A comparison of the cost of different methods of retesting chlamydia positive individuals in England

Looker, K. J.<sup>1\*</sup>, Buitendam, E.<sup>2</sup>, Woodhall, S. C.<sup>2</sup>, Hollis, E.<sup>2</sup>, Ong, K.-J.<sup>2</sup>,  
Saunders, J.<sup>2</sup>, Dunbar, K.<sup>2</sup> and Turner, K. M. E.<sup>1</sup>

<sup>1</sup>Population Health Sciences, Bristol Medical School, University of Bristol, Bristol, United Kingdom

<sup>2</sup>HIV & STI Department, National Infection Service, Public Health England, United Kingdom

\*Corresponding author. Correspondence should be sent to:

Dr Katharine Looker

Population Health Sciences, Bristol Medical School

University of Bristol

Oakfield House, Oakfield Grove

Bristol BS8 2BN

United Kingdom

katharine.looker@bristol.ac.uk

## 18 **ABSTRACT**

### 19 **Objectives**

20 The National Chlamydia Screening Programme (NCSP) in England opportunistically screens eligible  
21 individuals for chlamydia infection. In 2013, the NCSP recommended retesting three months after  
22 treatment following a positive test result. However, no guidance was given on how local areas  
23 should recall individuals for retesting. Here we compare cost estimates for different recall methods  
24 to inform the optimal delivery of retesting programmes.

### 25 **Methods**

26 We estimated the cost of chlamydia retesting for each of the six most commonly-used recall  
27 methods in 2014 based on existing cost estimates of a chlamydia screen. Proportions accepting  
28 retesting, opting for retesting by post, returning postal testing kits and retesting positive were  
29 informed by 2014 NCSP audit data. Costs were “sense-checked” by health professionals.

### 30 **Results**

31 We estimated the cost of the chlamydia retest pathway, including treatment and follow-up call, to  
32 be between £45-£70 per completed test. At the lower end this compared favourably to the cost of a  
33 clinic-based screen. After adjusting for incomplete uptake, and non-return of postal kits, the cost  
34 estimate rose to £109-£289 per test offered. The most economical method in terms of the adjusted  
35 cost per retest was no active recall, as gains in retest rates with active recall did not outweigh the  
36 higher cost. Nurse-led client contact by phone was particularly uneconomical, as was sending out  
37 postal testing kits automatically. However, if the cost of sending an SMS could be lowered by  
38 reducing administration costs, the higher retest rate achieved by an SMS invitation could make this  
39 the most economical way of delivering retesting.

### 40 **Conclusions**

41 Retesting using the least-intensive methods (no active recall/recall by single SMS) is more  
42 economical than more intensive methods such as recalling by phone and automatically sending out  
43 postal kits. However, patient choice and local accessibility of services should be taken into  
44 consideration in planning.

### 45 **Strengths and limitations of this study**

- 46 • We compared the cost of the chlamydia retest pathway in England across the five most  
47 commonly-used methods of recalling individuals for retesting, to enable local service planners to  
48 assess whether they are delivering retesting economically or should consider an alternative  
49 approach.
- 50 • Our cost estimates included both clinic retesting, and retesting using postal kits.
- 51 • We incorporated incomplete uptake, and non-return of postal kits, to estimate cost based on  
52 actual patterns of use.
- 53 • We did not specifically look at the cost of on-line testing, nor account for the effect of  
54 demographic and clinical factors on retest uptake by recall method.

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

- 56 • Extra detail on the methods is available in the Appendix.

For peer review only

## 57 INTRODUCTION

58 *Chlamydia trachomatis* (chlamydia) is the most commonly-diagnosed bacterial sexually-transmitted  
59 infection (STI) in England[1]. Since 2003 there has been a National Chlamydia Screening Programme  
60 (NCSP) in England which opportunistically tests sexually-active 15-24 year olds[2]. NCSP guidelines  
61 recommend retesting three months after treatment for chlamydia[3]. British Association for Sexual  
62 Health and HIV (BASHH) national guidelines recommend retesting under 25 year olds three to six  
63 months after treatment[4]. No guidance is given by either the NCSP or BASHH on how local areas  
64 should recall individuals for retesting, which can be done in many ways. The 2014 NCSP retesting  
65 audit[5] found that the most common methods of recalling individuals for retesting were as follows:  
66 (1) conversation with client at time of test result with no further reminder (32%); (2) reminder card  
67 given to client at time of test result with no further reminder (1%); (3) client sent text message when  
68 retest due (29%); (4) client invited by phone call when retest due (8%); testing kit posted to client's  
69 chosen address when retest due (5%); and (6) retesting advised at follow up call with client - text  
70 message sent at 3 months (19%).

71 Previous estimates exist for the cost of a clinic-based chlamydia screen[6, 7]. However, to our  
72 knowledge there are no estimates of the cost of a chlamydia retest, and how this varies by recall  
73 method. Specifically, we do not know the best way to balance getting the optimal number of people  
74 to retest versus the additional cost of delivering invitations or reminders to retest. Understanding  
75 how the cost of retesting varies depending on the approach taken is critical for optimal programme  
76 delivery. Here we present cost estimates for different recall methods, firstly for the retest pathway  
77 itself, and then for the adjusted cost per retest, allowing for incomplete uptake, and non-return of  
78 postal kits, to impact on cost.

## 79 METHODS

80 We estimated the cost of chlamydia retesting using Microsoft Excel 2016 for each of the six most  
81 commonly-used recall methods reported in the 2014 NCSP retesting audit[5] (Table 1) as follows.  
82 First, we entered existing cost estimates for a chlamydia test from Pathway Analytics (costed for  
83 clinic-based chlamydia screening for 2011), which excluding a follow-up call was around £45[6]  
84 (Appendix Table 1). We used this costing as given. We then added additional costs to reflect costs  
85 specifically associated with retesting, such as a nurse-led conversation about retesting after  
86 diagnosis, and issuing retest invitations/reminders (e.g., by phone or text message [SMS]). In  
87 addition, we amended the clinic-based chlamydia test costs to allow for postal testing.

88 For each of the six recall methods, we costed both the retest pathway, and the adjusted cost per  
89 retest (Appendix Figure 1). The adjusted cost per retest accounts for incomplete uptake, and non-  
90 return of postal kits. For all methods except method five (automatic postal testing kit) we allowed  
91 clients to choose either to attend a clinic for retesting, or to request a postal testing kit. Thus, for  
92 methods one to four, and method six, we incorporated the following parameters: retest uptake, the  
93 proportion who opt for postal testing, and the return rate of requested kits. The 2014 NCSP audit[5]  
94 measured overall retest rates, which were calculated from the number that attended a clinic for a  
95 retest or returned a postal testing kit, divided by the total number recalled for retesting. This is  
96 different to retest uptake, which is the number that attended a clinic for a retest or ordered or were  
97 sent a postal testing kit, divided by the total number recalled for retesting. Retest uptake for each of

the six recall methods was fitted to overall retest rates from the 2014 NCSP audit[5], taking a value of 24% for the proportion of clients who opt for postal testing (also from the audit), and a value of 67% for the return rate of requested kits[8]. For method five, uptake was equivalent to overall retest rate and was simply the return rate of postal kits (10%) from the 2014 NCSP audit[5]. Chlamydia retest positivity (12%) was taken from the NCSP audit[5], and was averaged over all six recall methods due to small numbers by individual method. For a table of parameter values see Appendix Table 2. We also calculated the cost and adjusted cost per retest positive, i.e., the cost of finding one positive retest incorporating the cost of other, negative retests.

The time frame for calculating the parameter values was 10-14 weeks, corresponding to NCSP guidance for retesting. We sense-checked our retesting costs (Appendix Table 1) with health professionals. We conducted two sensitivity analyses. In the first sensitivity analysis we replaced the parameters for the retesting pathway with those obtained from data for retesting done between 10-26 weeks (corresponding to BASHH guidance) (Appendix Table 2). This simply allows more time for clients to retest: there is no additional contact with clients to remind them to retest. In the second sensitivity analysis we altered staff salary costs from nurse bands to administrator bands for nurse-based costs associated with phone invitations to retest, managing a retest negative, and a follow-up call at three months for those retesting positive (leaving the nurse-based costs associated with the initial retest conversation and managing a retest positive unchanged). The purpose of this was to show the difference in price that could be achieved if administrative staff instead of nurses contacted clients by phone, except where a lower band of advisor might not be appropriate.

During the study, we also had access to unpublished data from the 2017 NCSP retesting audit (Erna Buitendam, personal communication). For the six most commonly-used recall methods in the 2014 audit, we found that retest rates significantly increased for method one (client-led) and method five (automatic postal test kit) between the 2014 and 2017 audits ( $p>0.05$ ). Therefore, it was not appropriate to combine the data for 2014 and 2017, and we restricted our analyses to 2014 data only. However, we carried out an analysis of whether retest positivity was statistically-significantly different for no active recall (method one) versus active recall (methods three and six) using both 2014 and 2017 audit data, since there was no statistically-significant difference in the positivity rates for each of these methods when comparing 2014 and 2017 data.

**Table 1 Chlamydia retest costs by recall method**

	Recall method					
	1. Client-led	2. Reminder card	3. SMS invitation	4. Phone invitation	5. Automatic postal test kit	6. Advice at follow-up & SMS
Number of retest invitations by each method (%), N=2853 <sup>1</sup> (NCSP audit, 2014[5])	912 (32%)	27 (1%)	840 (29%)	227 (8%)	130 (5%)	528 (19%)
Description	Conversation with client at time of test result with no further reminder	Reminder card given to client at time of test result with no further reminder	Client sent text message when retest due	Client invited by phone call when retest due	Testing kit posted to client's chosen address when retest due	Retesting advised at follow up call with client - text message sent at 3 months

COSTS USING BASELINE PARAMETERS (10-14 weeks since treatment for first infection)						
Cost of chlamydia retesting pathway <sup>2</sup>						
Cost of offering retesting	£2.68	£2.78	£5.42	£14.44	£2.68	£17.18
Cost of delivering retest	£24.16	£24.16	£24.16	£24.16	£13.45	£24.16
Cost of processing retest and giving results	£28.71	£28.71	£28.71	£28.71	£28.71	£28.71
<b>TOTAL COST</b>	<b>£55.54</b>	<b>£55.64</b>	<b>£58.28</b>	<b>£67.31</b>	<b>£44.83</b>	<b>£70.05</b>
<b>Cost per retest positive</b>	<b>£481</b>	<b>£482</b>	<b>£505</b>	<b>£583</b>	<b>£389</b>	<b>£607</b>
<b>Retest rate</b>	<b>5%</b>	<b>4%</b>	<b>8%</b>	<b>6%</b>	<b>10%</b>	<b>12%</b>
<b>Adjusted cost per retest incorporating incomplete uptake/non-return of kits</b>	<b>£109</b>	<b>£130</b>	<b>£120</b>	<b>£289</b>	<b>£190</b>	<b>£195</b>
<b>Adjusted cost per retest positive incorporating incomplete uptake/non-return of kits</b>	<b>£946</b>	<b>£1,126</b>	<b>£1,039</b>	<b>£2,506</b>	<b>£1,646</b>	<b>£1,686</b>
COSTS USING LONGER TIME WINDOW FOR RETESTING (10-26 weeks since treatment for first infection)						
Total cost of chlamydia retesting pathway	£55.38	£55.48	£58.12	£67.15	£45.32	£69.89
Cost per retest positive	£344	£345	£361	£417	£282	£435
Retest rate	15%	19%	21%	17%	23%	25%
Adjusted cost per retest incorporating incomplete uptake/non-return of kits	£73	£71	£82	£142	£99	£126
Adjusted cost per retest positive incorporating incomplete uptake/non-return of kits	£456	£440	£508	£883	£616	£780
COSTS IF ADMINISTRATORS USED INSTEAD OF NURSES						
Total cost of chlamydia retesting pathway	£52.13	£52.23	£54.87	£60.24	£41.42	£62.98
Cost per retest positive	£452	£453	£476	£522	£359	£546
Adjusted cost per retest incorporating incomplete uptake/non-return of kits	£106	£126	£117	£227	£187	£161
Adjusted cost per retest positive incorporating incomplete uptake/non-return of kits	£917	£1,096	£1,010	£1,963	£1,617	£1,399

<sup>1</sup>Other methods or method not recorded account for the remaining 7% (N=189) of retests. <sup>2</sup>Some costs were taken (and some subsequently amended) from the basic cost of a (first) chlamydia test<sup>[6]</sup> which is under a Creative Commons licence:



© Pathway Analytics

## RESULTS

The estimated cost of the chlamydia retest pathway ranged from £45-£70 per completed test, while the cost per retest positive ranged from £389-£607 (Table 1). Posting testing kits automatically with no further reminder (method five) was the cheapest recall method, while methods involving inviting clients by phone to retest (methods four and six) were the most expensive. After adjusting for incomplete uptake and non-return of postal kits, the cost per chlamydia retest ranged from £109-£289 per test offered, while the cost per retest positive ranged from £946-£2,506. Here, the most economical recall method in terms of the adjusted cost per retest was no active recall (method one). The most expensive methods were still those involving inviting clients by phone to retest (methods four and six). This was despite these methods achieving higher retest rates (6% and 12% for methods four and six, respectively) compared to no active recall (5%). Sending postal testing kits out automatically (method five) was also an uneconomical way of delivering a retest, due to the cost of



1  
2  
3 145 non-returned kits. An SMS invitation (method three) increased retest rates for comparatively small  
4 146 cost but was only the most economical if administration time for sending an SMS was reduced from  
5 147 five to three minutes (results not shown). Retest positivity was not statistically-significantly different  
6 148 for no active recall (method one) versus active recall (methods three and six) when 2014 and 2017  
7 149 audit data were combined.

9  
10 150 Extending the retesting period to 10-26 weeks did not impact substantially on the chlamydia  
11 151 retesting pathway cost (range £45-£70) (Table 1). However, the adjusted cost per retest  
12 152 incorporating incomplete uptake and non-return of kits was substantially lower (range £71-£126), as  
13 153 was the adjusted cost per retest positive (range £440-£883), than with a tighter retest window,  
14 154 particularly for automatically sending out postal kits (method five). However, this assumed positivity  
15 155 was higher for the 10-26 week window across all methods. In any case, methods with no or else  
16 156 minimal active recall were still the most economical. Replacing nurse bands with administrator  
17 157 bands only had a substantial impact on costs for those methods where clients were contacted by  
18 158 phone to recall for retest (Table 1).

## 159 **DISCUSSION**

160 The estimated cost of the chlamydia retest pathway ranged from £45-£70 per completed test, which  
161 161 at the cheapest end was very similar to the cost of a clinic-based chlamydia screen[6, 7]. Important  
162 162 differences were seen when uptake and kit return rates were varied. This is because successfully  
163 163 completed retests effectively absorbed the cost of incomplete retests. Here, the most economical  
164 164 recall method involved no active recall after the initial retest conversation. Sending out postal  
165 165 testing kits automatically was an expensive way of doing retesting because of wastage of kits.  
166 166 However, the most expensive methods involved contacting clients by phone to invite them to retest,  
167 167 primarily because of nurse time required.

168 168 When the retesting window was increased from 10-14 weeks to 10-26 weeks, all methods of recall  
169 169 had a reduced adjusted cost per retest, due in part to higher positivity for 10-26 weeks. However, a  
170 170 longer time window means there is further potential for onward transmission, so it is important  
171 171 clients are counselled on the best time to retest.

172 172 Active recall increased retest rates but this did not outweigh the additional cost. We assumed that  
173 173 sending an SMS involved administration time to retrieve clients' details from a database. If the  
174 174 associated cost was reduced, then an SMS invitation or reminder could be an economical way of  
175 175 increasing retest rates. We did not find any evidence that retest positivity was different for active  
176 176 recall versus no active recall, meaning there is no evidence that active recall merely results in more  
177 177 negatives being tested. However, evidence from a retesting pilot in South-West England did show  
178 178 that those who retested without being actively recalled had higher chlamydia retest positivity than  
179 179 those who were actively recalled[8]. Furthermore, the unpublished 2017 audit data showed a  
180 180 statistically-significant increase in the recall rate for client-led retesting for 10-14 weeks compared to  
181 181 2014 (Erna Buitendam, personal communication), which could make no active recall even more  
182 182 economical than shown here.

183 183 Our analysis was done for the pathway cost of testing for chlamydia alone[6]. Where chlamydia  
184 184 testing is done at the same time as testing for other STIs (such as gonorrhoea), the proportionate  
185 185 cost of testing for chlamydia will be reduced. Another consideration is that since our analysis was

186 carried out, the estimated pathway cost has fallen, which will reduce costs further across all  
187 methods of retesting. Lastly, online testing with automated recall is likely to be the most economical  
188 method of all, but was beyond the scope of this analysis. A further limitation is we did not account  
189 for the effect on retest uptake of different demographic and clinical factors, such as gender, location  
190 of services, country of birth, sexual orientation and presence of symptoms.

191 Our analysis suggests that no active recall after the initial retest conversation is the most economical  
192 way of retesting, although an SMS invitation or reminder could be considered. Patient choice and  
193 accessibility of services should still be taken into consideration for local delivery planning, and it is  
194 important that retest uptake is monitored as this determines how economical retesting is.

## 195 **CONTRIBUTORS**

196 KJL undertook the itemisation and costing, analysed the results and drafted the manuscript. KMET  
197 oversaw the study and provided advice as needed. EB and SW provided audit data and advised on  
198 parameterisation. K-JO helped with sources for costs. KJL, EB, SW, EH, K-JO, JS, KD and KMET all  
199 contributed to the progress of the study and manuscript revisions.

## 200 **CONFLICT OF INTEREST**

201 The authors declare there are no conflicts of interest.

## 202 **ACKNOWLEDGEMENTS**

203 KJL and KMET thank the National Institute for Health Research (NIHR) Health Protection Research  
204 Unit (HPRU) in Evaluation of Interventions at the University of Bristol, in partnership with Public  
205 Health England, for research support. We would like to thank Rose Tobin (North East and North  
206 Central London Adult Critical Care Network, Royal Free London NHS Foundation Trust), Stephanie  
207 Rumsey (East Cheshire NHS Trust), Jan Cremer (Essex Partnership University NHS Foundation Trust)  
208 and Stephanie Sawyer (London Borough of Bromley Public Health) for sense-checking the costs, and  
209 Pathway Analytics for data on the cost of a chlamydia test.

## 210 **FUNDING**

211 This work was supported by the NIHR Health Protection Research Unit in Evaluation of Interventions  
212 at the University of Bristol, in partnership with Public Health England. This funder had no role in the  
213 writing of the manuscript nor the decision to submit it for publication. The views expressed are  
214 those of the authors and not necessarily those of the NHS, the NIHR, the Department of Health or  
215 Public Health England.

## 216 **REFERENCES**

- 217 1. *National chlamydia screening programme (NCSP): data tables*  
218 [https://www.gov.uk/government/statistics/national-chlamydia-screening-programme-ncsp-](https://www.gov.uk/government/statistics/national-chlamydia-screening-programme-ncsp-data-tables)  
219 [data-tables](https://www.gov.uk/government/statistics/national-chlamydia-screening-programme-ncsp-data-tables) Accessed 13/09/2016.
- 220 2. *NCSP: programme overview* [https://www.gov.uk/government/publications/ncsp-](https://www.gov.uk/government/publications/ncsp-programme-overview)  
221 [programme-overview](https://www.gov.uk/government/publications/ncsp-programme-overview) Accessed 13/09/2016.

- 1  
2  
3 222 3. *Consultation Report: Routine offer of re-test to young adults testing positive for chlamydia*  
4 223 *(Consultation findings and evidence summary)*  
5 224 [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/508364/N](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/508364/N_CSP_Report_Consultation_on_Re-testing_of_Positive_Chlamydia_Cases_August_2013_FINAL.pdf)  
6 225 [CSP\\_Report\\_Consultation\\_on\\_Re-](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/508364/N_CSP_Report_Consultation_on_Re-testing_of_Positive_Chlamydia_Cases_August_2013_FINAL.pdf)  
7 226 [testing\\_of\\_Positive\\_Chlamydia\\_Cases\\_August\\_2013\\_FINAL.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/508364/N_CSP_Report_Consultation_on_Re-testing_of_Positive_Chlamydia_Cases_August_2013_FINAL.pdf) Accessed 14/09/2016.  
8 227 4. Nwokolo, N.C., et al. 2015 UK national guideline for the management of infection with  
9 228 *Chlamydia trachomatis*  
10 229 <http://www.bashh.org/documents/UK%20Chlamydia%20Guidelines%202015.pdf> Accessed  
11 230 14/09/2016.  
12 231 5. *Re-testing of those who tested positive for chlamydia: National audit report*  
13 232 [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/471585/N](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/471585/N_CSPre-testingauditfinalversion.pdf)  
14 233 [CSPre-testingauditfinalversion.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/471585/N_CSPre-testingauditfinalversion.pdf) Accessed 13/09/2016.  
15 234 6. Pathway Analytics: Pathway Prices for Integrated Sexual Health Tariffs 118. *T3 Chlamydia,*  
16 235 *gonorrhoea and syphilis tests* [https://www.pathwayanalytics.com/pathways/26-t3-](https://www.pathwayanalytics.com/pathways/26-t3-chlamydia-gonorrhoea-syphilis-tests/118-t3-chlamydia-gonorrhoea-and-syphilis-tests)  
17 236 [chlamydia-gonorrhoea-syphilis-tests/118-t3-chlamydia-gonorrhoea-and-syphilis-tests](https://www.pathwayanalytics.com/pathways/26-t3-chlamydia-gonorrhoea-syphilis-tests/118-t3-chlamydia-gonorrhoea-and-syphilis-tests)  
18 237 Accessed 2013.  
19 238 7. Turner, K., et al., *Costs and cost effectiveness of different strategies for chlamydia screening*  
20 239 *and partner notification: an economic and mathematical modelling study.* BMJ, 2011. **342**: p.  
21 240 c7250.  
22 241 8. Angel, G., et al., *An observational study to evaluate three pilot programmes of retesting*  
23 242 *chlamydia-positive individuals within 6 months in the South West of England.* BMJ Open,  
24 243 2016. **5**(10): p. e007455.

244

# Appendix

## A comparison of the cost of different methods of retesting chlamydia positive individuals in England

Looker, K. J., Buitendam, E., Woodhall, S. C., Hollis, E., Ong, K.-J., Saunders, J., Dunbar, K. and Turner, K. M. E.

**Appendix Table 1 Chlamydia retest costs by recall method**

Activity	Price per unit (item/minute of staff time)	Recall method											
		1. Client-led		2. Reminder card		3. SMS invitation		4. Phone invitation		5. Automatic postal test kit		6. Advice at follow-up & SMS	
		Units	Cost	Units	Cost	Units	Cost	Units	Cost	Units	Cost	Units	Cost
<b>PATIENT OFFERED RETEST</b>													
<i>Nurse-led conversation about retesting at first diagnosis and issue subsequent reminders</i>													
Nurse band 5/6/7/8 <sup>2</sup>	£ 0.89	3	£ 2.68	3	£ 2.68	3	£ 2.68	13	£ 11.60	3	£ 2.68	13	£ 11.60
Blend admin/clerical <sup>1</sup>	£ 0.53	0	£ -	0	£ -	5	£ 2.64	5	£ 2.64	0	£ -	10	£ 5.27
Reminder card	£ 0.10	0	£ -	1	£ 0.10	0	£ -	0	£ -	0	£ -	0	£ -
SMS text message	£ 0.10	0	£ -	0	£ -	1	£ 0.10	0	£ -	0	£ -	1	£ 0.10
Phone call <sup>2</sup>	£ 0.07	0	£ -	0	£ -	0	£ -	3	£ 0.21	0	£ -	3	£ 0.21
<b>PATIENT DELIVERED RETEST<sup>8</sup></b>													
<i>Register, meet and greet</i>													
Blend admin/clerical <sup>3</sup>	£ 0.53	3.8	£ 2.00	3.8	£ 2.00	3.8	£ 2.00	3.8	£ 2.00	0.0	£ -	3.8	£ 2.00
<i>Actual retest</i>													
Consultation - blend of Community SRH staff (N2 to Doctor) <sup>3</sup>	£ 1.06	6.8	£ 7.22	6.8	£ 7.22	6.8	£ 7.22	6.8	£ 7.22	0.0	£ -	6.8	£ 7.22
Blend admin/clerical <sup>1,4</sup>	£ 0.53	1.2	£ 0.63	1.2	£ 0.63	1.2	£ 0.63	1.2	£ 0.63	5	£ 2.64	1.2	£ 0.63
Health professional-led retest - blend of Community SRH staff (N2 to Doctor) <sup>3</sup>	£ 1.06	4.56	£ 4.81	4.56	£ 4.81	4.56	£ 4.81	4.56	£ 4.81	0	£ -	4.56	£ 4.81
Gloves <sup>3</sup>	£ 0.05	0.76	£ 0.03	0.76	£ 0.03	0.76	£ 0.03	0.76	£ 0.03	0	£ -	0.76	£ 0.03
Lab request form with bag	£ 0.10	1	£ 0.10	1	£ 0.10	1	£ 0.10	1	£ 0.10	1	£ 0.10	1	£ 0.10

Sample collection instructions	£ 0.05	1	£ 0.05	1	£ 0.05	1	£ 0.05	1	£ 0.05	1	£ 0.05	1	£ 0.05
Transport tube	£ 0.26	1	£ 0.26	1	£ 0.26	1	£ 0.26	1	£ 0.26	1	£ 0.26	1	£ 0.26
Urine pot, sterile collection	£ 0.23	0.7	£ 0.16	0.7	£ 0.16	0.7	£ 0.16	0.7	£ 0.16	0.7	£ 0.16	0.7	£ 0.16
Urine specimen container (PCR tube and pipette)	£ 1.04	0.7	£ 0.73	0.7	£ 0.73	0.7	£ 0.73	0.7	£ 0.73	0.7	£ 0.73	0.7	£ 0.73
Vulvo-vaginal swab	£ 0.16	0.3	£ 0.05	0.3	£ 0.05	0.3	£ 0.05	0.3	£ 0.05	0.3	£ 0.05	0.3	£ 0.05
Postage/packaging <sup>4</sup>	£ 0.89	0.24	£ 0.21	0.24	£ 0.21	0.24	£ 0.21	0.24	£ 0.21	1	£ 0.89	0.24	£ 0.21
Return envelope and postage <sup>4</sup>	£ 0.89	0.24	£ 0.21	0.24	£ 0.21	0.24	£ 0.21	0.24	£ 0.21	1	£ 0.89	0.24	£ 0.21
<b>Health promotion/Q&amp;A<sup>6</sup></b>													
Health professional-led discussion - blend of Community SRH staff (N2 to Doctor)	£ 1.06	6	£ 6.33	6	£ 6.33	6	£ 6.33	6	£ 6.33	6	£ 6.33	6	£ 6.33
KY lubricant	£ 0.30	2	£ 0.60	2	£ 0.60	2	£ 0.60	2	£ 0.60	2	£ 0.60	2	£ 0.60
STI literature	£ 0.06	3	£ 0.18	3	£ 0.18	3	£ 0.18	3	£ 0.18	3	£ 0.18	3	£ 0.18
Male condom	£ 0.06	10	£ 0.58	10	£ 0.58	10	£ 0.58	10	£ 0.58	10	£ 0.58	10	£ 0.58
<b>RETEST PROCESSED AND RESULTS GIVEN</b>													
<b>Pathology</b>													
Lab processing	£ 12.51	1	£ 12.51	1	£ 12.51	1	£ 12.51	1	£ 12.51	1	£ 12.51	1	£ 12.51
<b>Results management (retest negatives)</b>													
Nurse band 5/6	£ 0.75	6	£ 4.50	6	£ 4.50	6	£ 4.50	6	£ 4.50	6	£ 4.50	6	£ 4.50
Letter notification	£ 0.58	0.02	£ 0.01	0.02	£ 0.01	0.02	£ 0.01	0.02	£ 0.01	0.02	£ 0.01	0.02	£ 0.01
Phone call	£ 0.07	0.03	£ 0.00	0.03	£ 0.00	0.03	£ 0.00	0.03	£ 0.00	0.03	£ 0.00	0.03	£ 0.00
SMS text message	£ 0.10	0.95	£ 0.10	0.95	£ 0.10	0.95	£ 0.10	0.95	£ 0.10	0.95	£ 0.10	0.95	£ 0.10
<b>Results management (retest positives/equivocal)</b>													
Nurse band 5/6/7/8	£ 0.89	15	£ 13.38	15	£ 13.38	15	£ 13.38	15	£ 13.38	15	£ 13.38	15	£ 13.38
Letter notification	£ 0.58	0.05	£ 0.03	0.05	£ 0.03	0.05	£ 0.03	0.05	£ 0.03	0.05	£ 0.03	0.05	£ 0.03
Phone call	£ 0.07	0.05	£ 0.00	0.05	£ 0.00	0.05	£ 0.00	0.05	£ 0.00	0.05	£ 0.00	0.05	£ 0.00
SMS text message	£ 0.10	0.9	£ 0.09	0.9	£ 0.09	0.9	£ 0.09	0.9	£ 0.09	0.9	£ 0.09	0.9	£ 0.09
Treatment <sup>7</sup>	£ 1.80	1	£ 1.80	1	£ 1.80	1	£ 1.80	1	£ 1.80	1	£ 1.80	1	£ 1.80
<b>Follow-up call<sup>5</sup></b>													
Blend admin/clerical <sup>1,4</sup>	£ 0.53	5	£ 2.64	5	£ 2.64	5	£ 2.64	5	£ 2.64	5	£ 2.64	5	£ 2.64
Nurse band 5/6 <sup>2</sup>	£ 0.75	10	£ 7.50	10	£ 7.50	10	£ 7.50	10	£ 7.50	10	£ 7.50	10	£ 7.50
Phone call <sup>2</sup>	£ 0.07	3	£ 0.21	3	£ 0.21	3	£ 0.21	3	£ 0.21	3	£ 0.21	3	£ 0.21

Shaded entries were taken directly from the basic cost of a (first) chlamydia test[1] which is reproduced here under a Creative Commons licence:

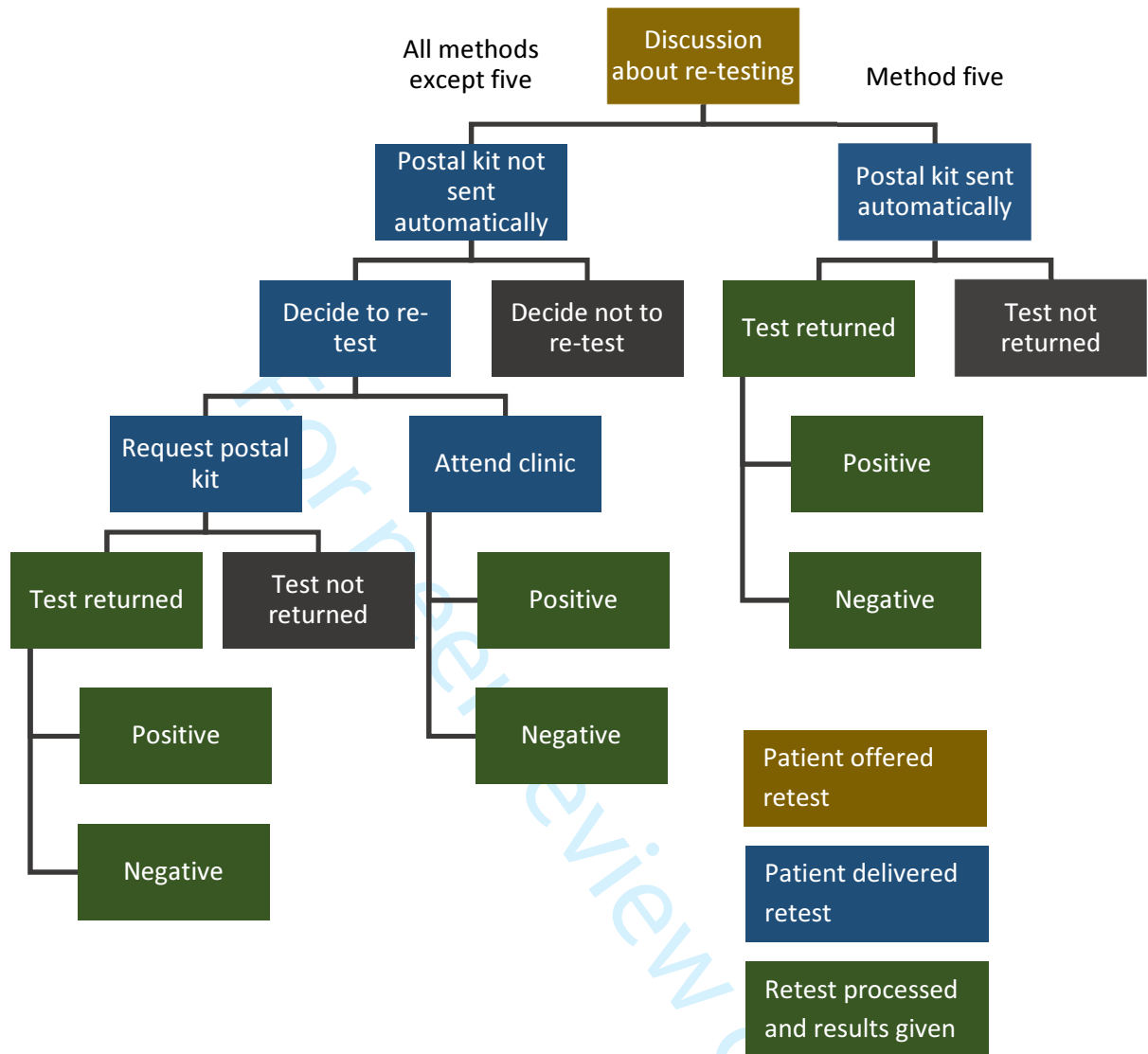


All other costs are either amended costs from Pathway Analytics (see below for explanation), or costs added in. <sup>1</sup>Any contact at a distance with client further to the initial retest conversation is assumed to require 5 minutes of admin time to retrieve and update the client’s details on a database. <sup>2</sup>A phone call is assumed to be 3 minutes in length but requiring 10 minutes of nurse time to accommodate chasing time. <sup>3</sup>Applicable to clinic retesting: these costs are removed entirely where retesting involves postal testing only, and reduced

1  
2  
3 proportionally for the remaining recall methods to allow for some clients opting for postal retesting. <sup>4</sup>Applies to postal kits: includes postage to client's address and return postage[2], and associated admin time for  
4 sending out a kit. <sup>5</sup>Positives only. <sup>6</sup>It is assumed that all clients will received these at some point including those opting for retesting by post. <sup>7</sup>4 x 250mg of azithromycin in tablet form[3]. VAT, dispensing costs and  
5 costs associated with a test for cure are not included. <sup>8</sup>Number of units for clinic vs postal testing kit costs obtained by multiplying base costs by the percentage using each.  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46

For peer review only

Appendix Figure 1 Retesting pathway



Appendix Table 2 Parameter values

Parameter	Baseline value (10-14 weeks since treatment for first infection)		Sensitivity value (10-26 weeks since treatment for first infection)		Reference
Retest uptake (i.e., percentage of (first) positives who choose to accept retesting) (all methods except method five) <sup>1</sup>	1. Client-led	5%	1. Client-led	15%	NCSP audit report[4] and NCSP audit data provided by PHE
	2. Reminder card	4%	2. Reminder card	19%	
	3. SMS invitation	9%	3. SMS invitation	21%	
	4. Phone invitation	7%	4. Phone invitation	17%	
	6. Advice at follow-up & SMS	13%	6. Advice at follow-up & SMS	25%	
Percentage of those retesting who choose to attend a clinic for a retest (all methods except method five) <sup>2</sup>	76%		73%		NCSP audit data provided by PHE
Percentage of those retesting who choose to request a postal kit (all methods except method five)	=100-76% =24%		=100-73% =27%		
Postal test kit return rate (requested kits)	67%		67%		Retesting pilot[5]
Postal test kit return rate (kits sent out automatically; method five)	5. Automatic postal test kit	10%	5. Automatic postal test kit	23%	NCSP audit report[4] and NCSP audit data provided by PHE
Chlamydia retest positivity <sup>3</sup>	12%		16%		NCSP audit report[4] and NCSP audit data provided by PHE

<sup>1</sup>Obtained by fitting to overall retest rates from the audit (i.e., accounting for non-return of requested postal kits); <sup>2</sup>The audit only has data on percentage of *completed* retests obtained from clinic testing vs postal testing (for those instances where a kit was not sent out automatically), not percentage of those who opt for a retest at a clinic among *all* retesters (i.e., including all those who request a kit, some of whom do not return the kit); <sup>3</sup>Average over the six most commonly-used methods.

## References

1. Pathway Analytics: Pathway Prices for Integrated Sexual Health Tariffs 118. *T3 Chlamydia, gonorrhoea and syphilis tests* <https://www.pathwayanalytics.com/pathways/26-t3-chlamydia-gonorrhoea-syphilis-tests/118-t3-chlamydia-gonorrhoea-and-syphilis-tests> Accessed 2013.
2. Royal Mail: Get a price <http://www.royalmail.com/price-finder> Accessed 14/08/2015.
3. British National Formulary: Azithromycin <http://www.evidence.nhs.uk/formulary/bnf/current/5-infections/51-antibacterial-drugs/515-macrolides/azithromycin> Accessed 02/02/2016.
4. *Re-testing of those who tested positive for chlamydia: National audit report* [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/471585/NCSPre-testingauditfinalversion.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/471585/NCSPre-testingauditfinalversion.pdf) Accessed 13/09/2016.
5. Angel, G., et al., *An observational study to evaluate three pilot programmes of retesting chlamydia-positive individuals within 6 months in the South West of England*. *BMJ Open*, 2016. 5(10): p. e007455.



# BMJ Open

## An economic evaluation of the cost of different methods of retesting chlamydia positive individuals in England

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2018-024828.R1
Article Type:	Research
Date Submitted by the Author:	11-Oct-2018
Complete List of Authors:	<p>Looker, Katharine; University of Bristol, Population Health Sciences, Bristol Medical School</p> <p>Buitendam, Erna; Public Health England, HIV &amp; STI Department, National Infection Service</p> <p>Woodhall, Sarah; Public Health England, HIV &amp; STI; UCL, Research Department of Infection and Population Health</p> <p>Hollis, Emma; Public Health England, HIV/STI</p> <p>Ong, Koh Jun; Public Health England, National Infections Service - HIV/STI</p> <p>Saunders, John; Public Health England, HIV &amp; STI Department; University College London, Research Department of Infection and Population Health</p> <p>Dunbar, Kevin; Public Health England, HIV &amp; STI Department</p> <p>Turner, Katy; Bristol University, School of Social and Community Medicine</p>
<b>Primary Subject Heading</b>:	Sexual health
Secondary Subject Heading:	Health services research, Health economics, Public health, Infectious diseases
Keywords:	Public health < INFECTIOUS DISEASES, HEALTH SERVICES ADMINISTRATION & MANAGEMENT, HEALTH ECONOMICS

SCHOLARONE™  
Manuscripts

# An economic evaluation of the cost of different methods of retesting chlamydia positive individuals in England

Looker, K. J.<sup>1\*</sup>, Buitendam, E.<sup>2</sup>, Woodhall, S. C.<sup>2</sup>, Hollis, E.<sup>2</sup>, Ong, K.-J.<sup>2</sup>, Saunders, J.<sup>2</sup>, Dunbar, K.<sup>2</sup> and Turner, K. M. E.<sup>1</sup>

<sup>1</sup>Population Health Sciences, Bristol Medical School, University of Bristol, Bristol, United Kingdom

<sup>2</sup>HIV & STI Department, National Infection Service, Public Health England, United Kingdom

\*Corresponding author. Correspondence should be sent to:

Dr Katharine Looker

Population Health Sciences, Bristol Medical School

University of Bristol

Oakfield House, Oakfield Grove

Bristol BS8 2BN

United Kingdom

katharine.looker@bristol.ac.uk

## 18 ABSTRACT

### 19 Objectives

20 The National Chlamydia Screening Programme in England opportunistically screens eligible individuals for  
21 chlamydia infection. Retesting is recommended three months after treatment following a positive test  
22 result, but no guidance is given on how local areas should recall individuals for retesting. Here we compare  
23 cost estimates for different recall methods to inform the optimal delivery of retesting programmes.

### 24 Design

25 Economic evaluation

### 26 Setting

27 England

### 28 Methods

29 We estimated the cost of chlamydia retesting for each of the six most commonly-used recall methods in  
30 2014 based on existing cost estimates of a chlamydia screen. Proportions accepting retesting, opting for  
31 retesting by post, returning postal testing kits and retesting positive were informed by 2014 NCSP audit  
32 data. Health professionals “sense-checked” the costs.

### 33 Primary and secondary outcomes

34 Cost and adjusted cost per chlamydia retest; cost and adjusted cost per chlamydia retest positive.

### 35 Results

36 We estimated the cost of the chlamydia retest pathway, including treatment/follow-up call, to be  
37 between £45-£70 per completed test. At the lower end this compared favourably to the cost of a clinic-  
38 based screen. Cost per retest positive was £389-£607. After adjusting for incomplete uptake, and non-  
39 return of postal kits, the cost rose to £109-£289 per completed test (cost per retest positive: £946-£2,506).  
40 The most economical method in terms of adjusted cost per retest was no active recall, as gains in retest  
41 rates with active recall did not outweigh the higher cost. Nurse-led client contact by phone was  
42 particularly uneconomical, as was sending out postal testing kits automatically.

### 43 Conclusions

44 Retesting without active recall is more economical than more intensive methods such as recalling by  
45 phone and automatically sending out postal kits. If sending an SMS could be automated, this could be the  
46 most economical way of delivering retesting. However, patient choice and local accessibility of services  
47 should be taken into consideration in planning.

48

## 49 Strengths and limitations of this study

50 We compared the cost of the chlamydia retest pathway in England across the five most commonly-used  
51 methods of recalling individuals for retesting, to enable local service planners to assess whether they are  
52 delivering retesting economically or should consider an alternative approach.

53  
54 Our cost estimates included both clinic retesting, and retesting using postal kits.

55  
56 We incorporated incomplete uptake, and non-return of postal kits, to estimate cost based on actual  
57 patterns of use.

58  
59 We did not specifically look at the effect of clinical factors on cost, although no active recall is likely to be  
60 associated with similar or higher test positivity than active recall.

61 We also did not consider other important factors besides cost such as the demography of the population:  
62 for example, automatically sending out postal kits might be the only feasible option in rural areas, and  
63 indeed, on-line testing, which was not considered in our analysis, is likely to be the most economical  
64 method of all.

## 65 INTRODUCTION

66 *Chlamydia trachomatis* (chlamydia) is the most commonly-diagnosed bacterial sexually-transmitted  
67 infection (STI) in England[1]. Since 2003 there has been a National Chlamydia Screening Programme  
68 (NCSP) in England which opportunistically tests sexually-active 15-24 year olds[2]. NCSP guidelines  
69 recommend retesting three months after treatment for chlamydia[3]. British Association for Sexual Health  
70 and HIV (BASHH) national guidelines recommend retesting under 25 year olds three to six months after  
71 treatment[4]. No guidance is given by either the NCSP or BASHH on how local areas should recall  
72 individuals for retesting, which can be done in many ways. The 2014 NCSP retesting audit[5] found that  
73 the most common methods of recalling individuals for retesting were as follows: (1) conversation with  
74 client at time of test result with no further reminder (32%); (2) reminder card given to client at time of  
75 test result with no further reminder (1%); (3) client sent text message when retest due (29%); (4) client  
76 invited by phone call when retest due (8%); (5) testing kit posted to client's chosen address when retest  
77 due (5%); and (6) retesting advised at follow up call with client - text message sent at 3 months (19%). The  
78 audit also measured overall retest rates for each recall method, which were calculated from the number  
79 that attended a clinic for a retest or returned a postal testing kit, divided by the total number recalled for  
80 retesting. This is different to retest uptake, which is the number that attended a clinic for a retest or  
81 *ordered* or were sent a postal testing kit, divided by the total number recalled for retesting, which has cost  
82 implications. Retest uptake was not measured by the audit. Unpublished data from the 2017 NCSP  
83 retesting audit (Erna Buitendam, personal communication) showed that, for the six most commonly-used  
84 recall methods in the 2014 audit, retest rates significantly increased for method one (client-led) and  
85 method five (automatic postal test kit) between the 2014 and 2017 audits.

86 Previous estimates exist for the cost of a clinic-based chlamydia screen[6, 7]. However, to our knowledge  
87 there are no estimates of the cost of a chlamydia retest, and how this varies by recall method. Specifically,  
88 we do not know the best way to balance getting the optimal number of people to retest versus the  
89 additional cost of delivering invitations or reminders to retest. Understanding how the cost of retesting  
90 varies depending on the approach taken is critical for optimal programme delivery. Here we present cost  
91 estimates for different recall methods in England, firstly for the retest pathway itself, and then for the  
92 adjusted cost per retest, allowing for incomplete uptake, and non-return of postal kits, to impact on cost.

## 93 METHODS

94 We estimated the cost of chlamydia retesting in England using Microsoft Excel 2016 for each of the six  
95 most commonly-used recall methods reported in the 2014 NCSP retesting audit[5] (Table 1) as follows.  
96 First, we entered existing cost estimates for a chlamydia test from Pathway Analytics (costed for clinic-  
97 based chlamydia screening for 2011), which excluding a follow-up call was around £45[6] (Appendix Table  
98 1). We used this costing as given. We then added additional costs to reflect costs specifically associated  
99 with retesting, such as a nurse-led conversation about retesting after diagnosis, and issuing retest  
100 invitations/reminders (e.g., by phone or text message [SMS]). In addition, we amended the clinic-based  
101 chlamydia test costs to allow for postal testing. Costs were then totalled across the following cost  
102 categories: cost of offering retesting, cost of delivering retest, and cost of processing retest and giving  
103 results, as well as overall.

104 For each of the six recall methods, we costed both the retest pathway, and the adjusted cost per retest  
105 (Appendix Figure 1). The adjusted cost per retest accounts for incomplete uptake, and non-return of postal  
106 kits, within each cost category. For all methods except method five (automatic postal testing kit) we  
107 allowed clients to choose either to attend a clinic for retesting, or to request a postal testing kit. Thus, for  
108 methods one to four, and method six, we incorporated the following parameters: retest uptake, the  
109 proportion who opt for postal testing, and the return rate of requested kits. Retest uptake for each of the  
110 six recall methods was fitted to overall retest rates from the 2014 NCSP audit[5], taking a value of 24% for  
111 the proportion of clients who opt for postal testing (also from the audit), and a value of 67% for the return  
112 rate of requested kits[8]. For method five, uptake was equivalent to overall retest rate and was simply the  
113 return rate of postal kits (10%) from the 2014 NCSP audit[5]. Chlamydia retest positivity (12%), which  
114 informs the relative weight given to the cost of managing a positive retest result versus managing a  
115 negative retest result in the average cost of the chlamydia retesting pathway, was taken from the NCSP  
116 audit[5], and was averaged over all six recall methods due to small numbers by individual method. We  
117 also calculated the cost and adjusted cost per retest positive, i.e., the cost of finding one positive retest  
118 incorporating the cost of other, negative retests, by dividing test costs by the chlamydia positivity. For a  
119 table of parameter values see Appendix Table 2.

120 The time frame for calculating the parameter values was 10-14 weeks, corresponding to NCSP guidance  
121 for retesting. We sense-checked our retesting costs (Appendix Table 1) with health professionals. We  
122 conducted two sensitivity analyses. In the first sensitivity analysis we replaced the parameters for the  
123 retesting pathway with those obtained from data for retesting done between 10-26 weeks (corresponding  
124 to BASHH guidance) (Appendix Table 2). This simply allows more time for clients to retest: there is no

1  
2  
3 125 additional contact with clients to remind them to retest. In the second sensitivity analysis we altered staff  
4 126 salary costs from nurse bands to administrator bands for nurse-based costs associated with phone  
5 127 invitations to retest, managing a retest negative, and a follow-up call at three months for those retesting  
6 128 positive (leaving the nurse-based costs associated with the initial retest conversation and managing a  
7 129 retest positive unchanged). The purpose of this was to show the difference in price that could be achieved  
8 130 if administrative staff instead of nurses contacted clients by phone, except where a lower band of advisor  
9 131 might not be appropriate.

12  
13 132 Since retest rates significantly increased for method one (client-led) and method five (automatic postal  
14 133 test kit) between the 2014 and (unpublished) 2017 audits ( $p>0.05$ ), we restricted our analyses to 2014  
15 134 data only. However, we carried out an analysis of whether retest positivity was statistically-significantly  
16 135 different for no active recall (method one) versus active recall (methods three and six) using both 2014  
17 136 and 2017 audit data, since there was no statistically-significant difference in the positivity rates for each  
18 137 of these methods when comparing 2014 and 2017 data.

## 21 22 138 **Patient and Public Involvement**

23  
24 139 Patients and the public were not involved in this analysis.

25  
26 140  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

141 **Table 1 Chlamydia retest costs by recall method**

	Recall method					
	1. Client-led	2. Reminder card	3. SMS invitation	4. Phone invitation	5. Automatic postal test kit	6. Advice at follow-up & SMS
Number of retest invitations by each method (%), N=2853 <sup>1</sup> (NCSP audit, 2014[5])	912 (32%)	27 (1%)	840 (29%)	227 (8%)	130 (5%)	528 (19%)
Description	Conversation with client at time of test result with no further reminder	Reminder card given to client at time of test result with no further reminder	Client sent text message when retest due	Client invited by phone call when retest due	Testing kit posted to client's chosen address when retest due	Retesting advised at follow up call with client - text message sent at 3 months
<b>COSTS USING BASELINE PARAMETERS (10-14 weeks since treatment for first infection)</b>						
<b>Cost of chlamydia retesting pathway<sup>2</sup></b>						
Cost of offering retesting	£2.68	£2.78	£5.42	£14.44	£2.68	£17.18
Cost of delivering retest	£24.16	£24.16	£24.16	£24.16	£13.45	£24.16
Cost of processing retest and giving results	£28.71	£28.71	£28.71	£28.71	£28.71	£28.71
<b>TOTAL COST</b>	<b>£55.54</b>	<b>£55.64</b>	<b>£58.28</b>	<b>£67.31</b>	<b>£44.83</b>	<b>£70.05</b>
<b>Cost per retest positive</b>	<b>£481</b>	<b>£482</b>	<b>£505</b>	<b>£583</b>	<b>£389</b>	<b>£607</b>
<b>Retest uptake</b>	<b>5%</b>	<b>4%</b>	<b>9%</b>	<b>7%</b>	<b>10%</b>	<b>13%</b>
<b>Retest rate</b>	<b>5%</b>	<b>4%</b>	<b>8%</b>	<b>6%</b>	<b>10%</b>	<b>12%</b>
<b>Adjusted cost per retest incorporating incomplete uptake/non-return of kits</b>	<b>£109</b>	<b>£130</b>	<b>£120</b>	<b>£289</b>	<b>£190</b>	<b>£195</b>
<b>Adjusted cost per retest positive incorporating incomplete uptake/non-return of kits</b>	<b>£946</b>	<b>£1,126</b>	<b>£1,039</b>	<b>£2,506</b>	<b>£1,646</b>	<b>£1,686</b>
<b>COSTS USING LONGER TIME WINDOW FOR RETESTING (10-26 weeks since treatment for first infection)</b>						
<b>Total cost of chlamydia retesting pathway</b>	<b>£55.38</b>	<b>£55.48</b>	<b>£58.12</b>	<b>£67.15</b>	<b>£45.32</b>	<b>£69.89</b>
<b>Cost per retest positive</b>	<b>£344</b>	<b>£345</b>	<b>£361</b>	<b>£417</b>	<b>£282</b>	<b>£435</b>
<b>Retest uptake</b>	<b>16%</b>	<b>20%</b>	<b>23%</b>	<b>18%</b>	<b>23%</b>	<b>27%</b>
<b>Retest rate</b>	<b>15%</b>	<b>19%</b>	<b>21%</b>	<b>17%</b>	<b>23%</b>	<b>25%</b>
<b>Adjusted cost per retest incorporating incomplete uptake/non-return of kits</b>	<b>£73</b>	<b>£71</b>	<b>£82</b>	<b>£142</b>	<b>£99</b>	<b>£126</b>
<b>Adjusted cost per retest positive incorporating incomplete uptake/non-return of kits</b>	<b>£456</b>	<b>£440</b>	<b>£508</b>	<b>£883</b>	<b>£616</b>	<b>£780</b>
<b>COSTS IF ADMINISTRATORS USED INSTEAD OF NURSES</b>						
<b>Total cost of chlamydia retesting pathway</b>	<b>£52.13</b>	<b>£52.23</b>	<b>£54.87</b>	<b>£60.24</b>	<b>£41.42</b>	<b>£62.98</b>
<b>Cost per retest positive</b>	<b>£452</b>	<b>£453</b>	<b>£476</b>	<b>£522</b>	<b>£359</b>	<b>£546</b>
<b>Adjusted cost per retest incorporating incomplete uptake/non-return of kits</b>	<b>£106</b>	<b>£126</b>	<b>£117</b>	<b>£227</b>	<b>£187</b>	<b>£161</b>

<b>Adjusted cost per retest positive incorporating incomplete uptake/non-return of kits</b>	<b>£917</b>	<b>£1,096</b>	<b>£1,010</b>	<b>£1,963</b>	<b>£1,617</b>	<b>£1,399</b>
---	-------------	---------------	---------------	---------------	---------------	---------------

<sup>1</sup>Other methods or method not recorded account for the remaining 7% (N=189) of retests. <sup>2</sup>Some costs were taken (and some subsequently amended) from the basic cost of a (first) chlamydia test[6] which is under a Creative Commons licence:



© Pathway Analytics

## RESULTS

The estimated cost of the chlamydia retest pathway ranged from £45-£70 per completed test, while the cost per retest positive ranged from £389-£607 (Table 1). Posting testing kits automatically with no further reminder (method five) was the cheapest recall method, while methods involving inviting clients by phone to retest (methods four and six) were the most expensive. After adjusting for incomplete uptake and non-return of postal kits, the cost per chlamydia retest ranged from £109-£289 per completed test, while the cost per retest positive ranged from £946-£2,506. Here, the most economical recall method in terms of the adjusted cost per retest was no active recall (method one). An SMS invitation (method three) increased retest rates for comparatively small additional cost, however. The most expensive methods were still those involving inviting clients by phone to retest (methods four and six). This was despite these methods achieving higher retest rates (6% and 12% for methods four and six, respectively) compared to no active recall (5%). Sending postal testing kits out automatically (method five) was also an uneconomical way of delivering a retest, due to the cost of non-returned kits. Retest positivity was not statistically-significantly different for no active recall (method one) versus active recall (methods three and six) when 2014 and 2017 audit data were combined.

Extending the retesting period to 10-26 weeks did not impact substantially on the chlamydia retesting pathway cost (range £45-£70) (Table 1). However, the adjusted cost per retest incorporating incomplete uptake and non-return of kits was substantially lower (range £71-£126), as was the adjusted cost per retest positive (range £440-£883), than with a tighter retest window, particularly for automatically sending out postal kits (method five). However, this assumed positivity was higher for the 10-26 week window across all methods. In any case, methods with no or else minimal active recall were still the most economical. Replacing nurse bands with administrator bands only had a substantial impact on costs for those methods where clients were contacted by phone to recall for retest (Table 1).

## DISCUSSION

The estimated cost of the chlamydia retest pathway ranged from £45-£70 per completed test, which at the cheapest end was very similar to the cost of a clinic-based chlamydia screen[6, 7]. The cost per retest positive, meanwhile, ranged from £389-£607. Important differences were seen when uptake and kit return rates were varied. This is because successfully completed retests effectively absorbed the cost of incomplete retests. Here, the most economical recall method involved no active recall after the initial retest conversation. Sending out postal testing kits automatically was an expensive way of doing retesting because of wastage of kits. However, the most expensive methods involved contacting clients by phone to invite them to retest, primarily because of nurse time required.



179 When the retesting window was increased from 10-14 weeks to 10-26 weeks, all methods of recall had a  
180 reduced adjusted cost per retest, due in part to higher positivity for 10-26 weeks. However, a longer time  
181 window means there is further potential for onward transmission, so it is important clients are counselled  
182 on the best time to retest.

183 Active recall increased retest rates but this did not outweigh the additional cost. We assumed that sending  
184 an SMS involved administration time to retrieve clients' details from a database. In our analysis we  
185 considered only the effect of altering staff salary costs from nurse bands to administrator bands for some  
186 nurse-based activities. If the time needed to send an SMS could be shortened by automating this process,  
187 then an SMS invitation or reminder could be an economical way of increasing retest rates. Conversations  
188 with health professionals during the course of our study suggested that a shorter administration time to  
189 send an SMS was theoretically feasible. We did not find any evidence that retest positivity was different  
190 for active recall versus no active recall, meaning there is no evidence that active recall merely results in  
191 more negatives being tested. However, evidence from a retesting pilot in South-West England did show  
192 that those who retested without being actively recalled had higher chlamydia retest positivity than those  
193 who were actively recalled[8]. Furthermore, the unpublished 2017 audit data showed a statistically-  
194 significant increase in the recall rate for client-led retesting for 10-14 weeks compared to 2014 (Erna  
195 Buitendam, personal communication), which could make no active recall even more economical than  
196 shown here.

197 Our analysis was done for the pathway cost of testing for chlamydia alone[6]. Where chlamydia testing is  
198 done at the same time as testing for other STIs (such as gonorrhoea), the proportionate cost of testing for  
199 chlamydia will be reduced. Another consideration is that since our analysis was carried out, the estimated  
200 pathway cost has fallen, which will reduce costs further across all methods of retesting. However, cost is  
201 not the only important factor to consider. For example, the cheapest recall methods also had the lowest  
202 retest rates, although as noted above, active recall may not necessarily identify more infected people if  
203 those opting to retest self-select on the basis of their perceived risk or presence of symptoms. We also  
204 did not account for the effect on retest uptake of factors such as gender, location of services, country of  
205 birth, and sexual orientation. The composition of the population is an important consideration in local  
206 planning: a large rural population, for example, might affect how retesting needs to be delivered. Given  
207 the much higher return rate for requested postal testing kits compared to kits sent out automatically,  
208 online testing with automated recall is likely to be the most economical method of all, but was beyond  
209 the scope of this analysis.

210 Our analysis suggests that no active recall after the initial retest conversation is the most economical way  
211 of retesting, although an SMS invitation or reminder could be considered. Patient choice and accessibility  
212 of services should still be taken into consideration for local delivery planning and it is important that retest  
213 uptake is monitored as this determines how economical retesting is.

## 214 **CONTRIBUTORS**

215 KJL undertook the itemisation and costing, analysed the results and drafted the manuscript. KMET  
216 oversaw the study and provided advice as needed. EB and SW provided audit data and advised on

217 parameterisation. K-JO helped with sources for costs. KJL, EB, SW, EH, K-JO, JS, KD and KMET all  
218 contributed to the progress of the study and manuscript revisions.

## 219 CONFLICT OF INTEREST

220 The authors declare there are no conflicts of interest.

## 221 ACKNOWLEDGEMENTS

222 KJL and KMET thank the National Institute for Health Research (NIHR) Health Protection Research Unit  
223 (HPRU) in Evaluation of Interventions at the University of Bristol, in partnership with Public Health  
224 England, for research support. We would like to thank Rose Tobin (North East and North Central London  
225 Adult Critical Care Network, Royal Free London NHS Foundation Trust), Stephanie Rumsey (East Cheshire  
226 NHS Trust), Jan Cremer (Essex Partnership University NHS Foundation Trust) and Stephanie Sawyer  
227 (London Borough of Bromley Public Health) for sense-checking the costs, and Pathway Analytics for data  
228 on the cost of a chlamydia test.

## 229 FUNDING

230 This work was supported by the NIHR Health Protection Research Unit in Evaluation of Interventions at  
231 the University of Bristol, in partnership with Public Health England. This funder had no role in the writing  
232 of the manuscript nor the decision to submit it for publication. The views expressed are those of the  
233 authors and not necessarily those of the NHS, the NIHR, the Department of Health or Public Health  
234 England.

## 235 REFERENCES

- 236 1. *National chlamydia screening programme (NCSP): data tables*  
237 [https://www.gov.uk/government/statistics/national-chlamydia-screening-programme-ncsp-](https://www.gov.uk/government/statistics/national-chlamydia-screening-programme-ncsp-data-tables)  
238 [data-tables](https://www.gov.uk/government/statistics/national-chlamydia-screening-programme-ncsp-data-tables) Accessed 13/09/2016.
- 239 2. *NCSP: programme overview* [https://www.gov.uk/government/publications/ncsp-programme-](https://www.gov.uk/government/publications/ncsp-programme-overview)  
240 [overview](https://www.gov.uk/government/publications/ncsp-programme-overview) Accessed 13/09/2016.
- 241 3. *Consultation Report: Routine offer of re-test to young adults testing positive for chlamydia*  
242 *(Consultation findings and evidence summary)*  
243 [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/508364/NCSP](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/508364/NCSP_Report_Consultation_on_Re-testing_of_Positive_Chlamydia_Cases_August_2013_FINAL.pdf)  
244 [\\_Report\\_Consultation\\_on\\_Re-testing\\_of\\_Positive\\_Chlamydia\\_Cases\\_August\\_2013\\_FINAL.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/508364/NCSP_Report_Consultation_on_Re-testing_of_Positive_Chlamydia_Cases_August_2013_FINAL.pdf)  
245 Accessed 14/09/2016.
- 246 4. Nwokolo, N.C., et al. *2015 UK national guideline for the management of infection with Chlamydia*  
247 *trachomatis* <http://www.bashh.org/documents/UK%20Chlamydia%20Guidelines%202015.pdf>  
248 Accessed 14/09/2016.
- 249 5. *Re-testing of those who tested positive for chlamydia: National audit report*  
250 [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/471585/NCSP](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/471585/NCSP_re-testingauditfinalversion.pdf)  
251 [re-testingauditfinalversion.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/471585/NCSP_re-testingauditfinalversion.pdf) Accessed 13/09/2016.
- 252 6. Pathway Analytics: *Pathway Prices for Integrated Sexual Health Tariffs 118. T3 Chlamydia,*  
253 *gonorrhoea and syphilis tests* [https://www.pathwayanalytics.com/pathways/26-t3-chlamydia-](https://www.pathwayanalytics.com/pathways/26-t3-chlamydia-gonorrhoea-syphilis-tests/118-t3-chlamydia-gonorrhoea-and-syphilis-tests)  
254 [gonorrhoea-syphilis-tests/118-t3-chlamydia-gonorrhoea-and-syphilis-tests](https://www.pathwayanalytics.com/pathways/26-t3-chlamydia-gonorrhoea-syphilis-tests/118-t3-chlamydia-gonorrhoea-and-syphilis-tests) Accessed 2013.

- 1  
2  
3 255 7. Turner, K., et al., *Costs and cost effectiveness of different strategies for chlamydia screening and*  
4 256 *partner notification: an economic and mathematical modelling study*. BMJ, 2011. **342**: p. c7250.  
5 257 8. Angel, G., et al., *An observational study to evaluate three pilot programmes of retesting*  
6 258 *chlamydia-positive individuals within 6 months in the South West of England*. BMJ Open, 2016.  
7 259 **5**(10): p. e007455.  
8  
9  
10 260  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

For peer review only

# Appendix

## An economic evaluation of the cost of different methods of retesting chlamydia positive individuals in England

Looker, K. J., Buitendam, E., Woodhall, S. C., Hollis, E., Ong, K.-J., Saunders, J., Dunbar, K. and Turner, K. M. E.

Appendix Table 1 Chlamydia retest costs by recall method

Activity	Price per unit (item/minute of staff time)	Recall method											
		1. Client-led		2. Reminder card		3. SMS invitation		4. Phone invitation		5. Automatic postal test kit		6. Advice at follow-up & SMS	
		Units	Cost	Units	Cost	Units	Cost	Units	Cost	Units	Cost	Units	Cost
<b>PATIENT OFFERED RETEST</b>													
<i>Nurse-led conversation about retesting at first diagnosis and issue subsequent reminders</i>													
Nurse band 5/6/7/8 <sup>2</sup>	£ 0.89	3	£ 2.68	3	£ 2.68	3	£ 2.68	13	£ 11.60	3	£ 2.68	13	£ 11.60
Blend admin/clerical <sup>1</sup>	£ 0.53	0	£ -	0	£ -	5	£ 2.64	5	£ 2.64	0	£ -	10	£ 5.27
Reminder card	£ 0.10	0	£ -	1	£ 0.10	0	£ -	0	£ -	0	£ -	0	£ -
SMS text message	£ 0.10	0	£ -	0	£ -	1	£ 0.10	0	£ -	0	£ -	1	£ 0.10
Phone call <sup>2</sup>	£ 0.07	0	£ -	0	£ -	0	£ -	3	£ 0.21	0	£ -	3	£ 0.21
<b>PATIENT DELIVERED RETEST<sup>8</sup></b>													
<i>Register, meet and greet</i>													
Blend admin/clerical <sup>3</sup>	£ 0.53	3.8	£ 2.00	3.8	£ 2.00	3.8	£ 2.00	3.8	£ 2.00	0.0	£ -	3.8	£ 2.00
<i>Actual retest</i>													
Consultation - blend of Community SRH staff (N2 to Doctor) <sup>3</sup>	£ 1.06	6.8	£ 7.22	6.8	£ 7.22	6.8	£ 7.22	6.8	£ 7.22	0.0	£ -	6.8	£ 7.22
Blend admin/clerical <sup>1,4</sup>	£ 0.53	1.2	£ 0.63	1.2	£ 0.63	1.2	£ 0.63	1.2	£ 0.63	5	£ 2.64	1.2	£ 0.63
Health professional-led retest - blend of Community SRH staff (N2 to Doctor) <sup>3</sup>	£ 1.06	4.56	£ 4.81	4.56	£ 4.81	4.56	£ 4.81	4.56	£ 4.81	0	£ -	4.56	£ 4.81
Gloves <sup>3</sup>	£ 0.05	0.76	£ 0.03	0.76	£ 0.03	0.76	£ 0.03	0.76	£ 0.03	0	£ -	0.76	£ 0.03
Lab request form with bag	£ 0.10	1	£ 0.10	1	£ 0.10	1	£ 0.10	1	£ 0.10	1	£ 0.10	1	£ 0.10

Sample collection instructions	£ 0.05	1	£ 0.05	1	£ 0.05	1	£ 0.05	1	£ 0.05	1	£ 0.05	1	£ 0.05
Transport tube	£ 0.26	1	£ 0.26	1	£ 0.26	1	£ 0.26	1	£ 0.26	1	£ 0.26	1	£ 0.26
Urine pot, sterile collection	£ 0.23	0.7	£ 0.16	0.7	£ 0.16	0.7	£ 0.16	0.7	£ 0.16	0.7	£ 0.16	0.7	£ 0.16
Urine specimen container (PCR tube and pipette)	£ 1.04	0.7	£ 0.73	0.7	£ 0.73	0.7	£ 0.73	0.7	£ 0.73	0.7	£ 0.73	0.7	£ 0.73
Vulvo-vaginal swab	£ 0.16	0.3	£ 0.05	0.3	£ 0.05	0.3	£ 0.05	0.3	£ 0.05	0.3	£ 0.05	0.3	£ 0.05
Postage/packaging <sup>4</sup>	£ 0.89	0.24	£ 0.21	0.24	£ 0.21	0.24	£ 0.21	0.24	£ 0.21	1	£ 0.89	0.24	£ 0.21
Return envelope and postage <sup>4</sup>	£ 0.89	0.24	£ 0.21	0.24	£ 0.21	0.24	£ 0.21	0.24	£ 0.21	1	£ 0.89	0.24	£ 0.21
<b>Health promotion/Q&amp;A<sup>6</sup></b>													
Health professional-led discussion - blend of Community SRH staff (N2 to Doctor)	£ 1.06	6	£ 6.33	6	£ 6.33	6	£ 6.33	6	£ 6.33	6	£ 6.33	6	£ 6.33
KY lubricant	£ 0.30	2	£ 0.60	2	£ 0.60	2	£ 0.60	2	£ 0.60	2	£ 0.60	2	£ 0.60
STI literature	£ 0.06	3	£ 0.18	3	£ 0.18	3	£ 0.18	3	£ 0.18	3	£ 0.18	3	£ 0.18
Male condom	£ 0.06	10	£ 0.58	10	£ 0.58	10	£ 0.58	10	£ 0.58	10	£ 0.58	10	£ 0.58
<b>RETEST PROCESSED AND RESULTS GIVEN</b>													
<b>Pathology</b>													
Lab processing	£ 12.51	1	£ 12.51	1	£ 12.51	1	£ 12.51	1	£ 12.51	1	£ 12.51	1	£ 12.51
<b>Results management (retest negatives)</b>													
Nurse band 5/6	£ 0.75	6	£ 4.50	6	£ 4.50	6	£ 4.50	6	£ 4.50	6	£ 4.50	6	£ 4.50
Letter notification	£ 0.58	0.02	£ 0.01	0.02	£ 0.01	0.02	£ 0.01	0.02	£ 0.01	0.02	£ 0.01	0.02	£ 0.01
Phone call	£ 0.07	0.03	£ 0.00	0.03	£ 0.00	0.03	£ 0.00	0.03	£ 0.00	0.03	£ 0.00	0.03	£ 0.00
SMS text message	£ 0.10	0.95	£ 0.10	0.95	£ 0.10	0.95	£ 0.10	0.95	£ 0.10	0.95	£ 0.10	0.95	£ 0.10
<b>Results management (retest positives/equivocal)</b>													
Nurse band 5/6/7/8	£ 0.89	15	£ 13.38	15	£ 13.38	15	£ 13.38	15	£ 13.38	15	£ 13.38	15	£ 13.38
Letter notification	£ 0.58	0.05	£ 0.03	0.05	£ 0.03	0.05	£ 0.03	0.05	£ 0.03	0.05	£ 0.03	0.05	£ 0.03
Phone call	£ 0.07	0.05	£ 0.00	0.05	£ 0.00	0.05	£ 0.00	0.05	£ 0.00	0.05	£ 0.00	0.05	£ 0.00
SMS text message	£ 0.10	0.9	£ 0.09	0.9	£ 0.09	0.9	£ 0.09	0.9	£ 0.09	0.9	£ 0.09	0.9	£ 0.09
Treatment <sup>7</sup>	£ 1.80	1	£ 1.80	1	£ 1.80	1	£ 1.80	1	£ 1.80	1	£ 1.80	1	£ 1.80
<b>Follow-up call<sup>5</sup></b>													
Blend admin/clerical <sup>1,4</sup>	£ 0.53	5	£ 2.64	5	£ 2.64	5	£ 2.64	5	£ 2.64	5	£ 2.64	5	£ 2.64
Nurse band 5/6 <sup>2</sup>	£ 0.75	10	£ 7.50	10	£ 7.50	10	£ 7.50	10	£ 7.50	10	£ 7.50	10	£ 7.50
Phone call <sup>2</sup>	£ 0.07	3	£ 0.21	3	£ 0.21	3	£ 0.21	3	£ 0.21	3	£ 0.21	3	£ 0.21

Shaded entries were taken directly from the basic cost of a (first) chlamydia test<sup>[1]</sup> which is reproduced here under a Creative Commons licence:



All other costs are either amended costs from Pathway Analytics (see below for explanation), or costs added in.

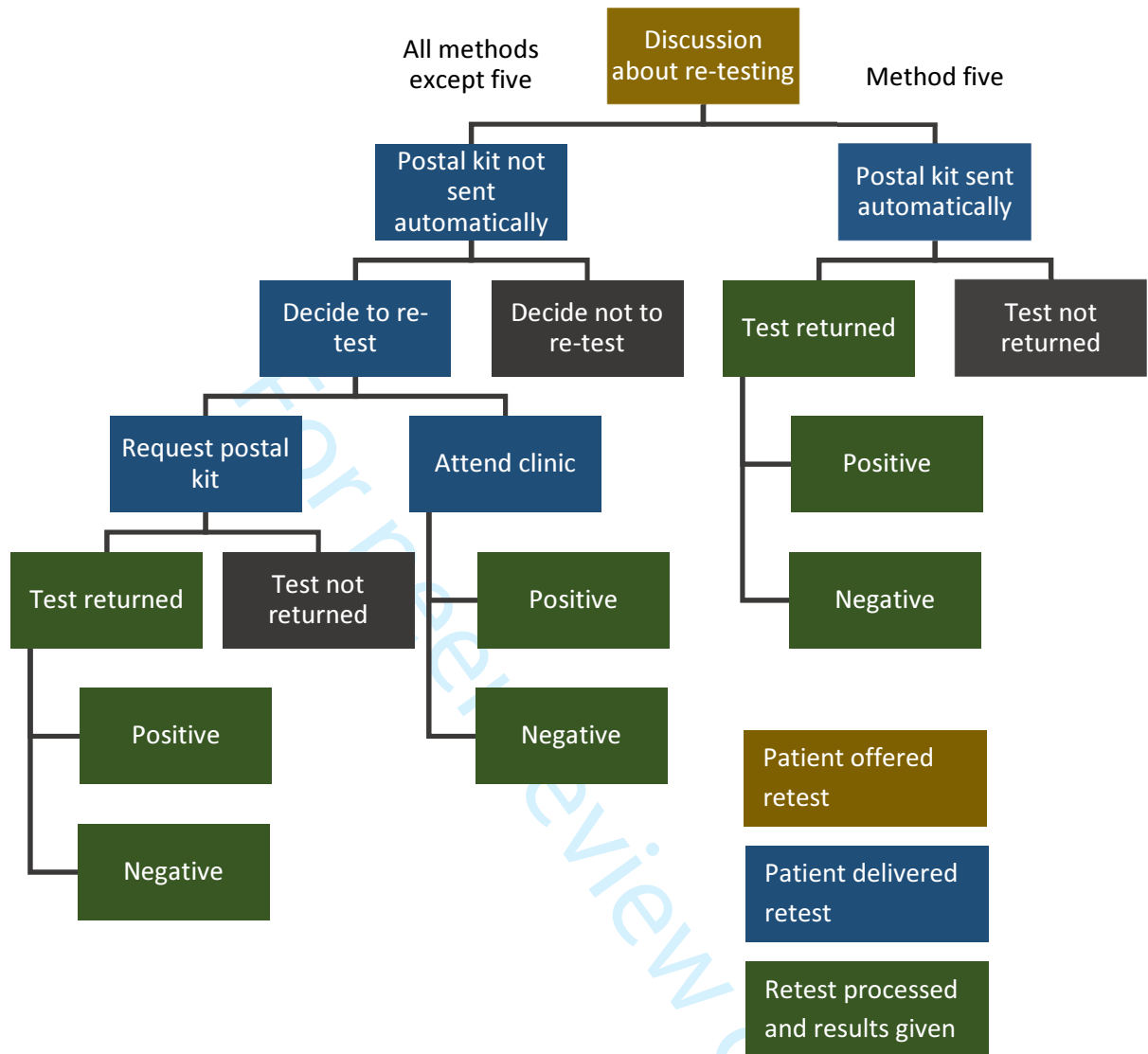
<sup>1</sup>Any contact at a distance with client further to the initial retest conversation is assumed to require 5 minutes of admin time to retrieve and update the client's details on a database. <sup>2</sup>A phone call is assumed to be 3 minutes in length but requiring 10 minutes of nurse time to accommodate chasing time. <sup>3</sup>Applicable to clinic retesting: these costs are removed entirely where retesting involves postal testing only, and reduced

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46

proportionally for the remaining recall methods to allow for some clients opting for postal retesting. <sup>4</sup>Applies to postal kits: includes postage to client's address and return postage<sup>[2]</sup>, and associated admin time for sending out a kit. <sup>5</sup>Positives only. <sup>6</sup>It is assumed that all clients will received these at some point including those opting for retesting by post. <sup>7</sup>4 x 250mg of azithromycin in tablet form<sup>[3]</sup>. VAT, dispensing costs and costs associated with a test for cure are not included. <sup>8</sup>Number of units for clinic vs postal testing kit costs obtained by multiplying base costs by the percentage using each.

For peer review only

Appendix Figure 1 Retesting pathway



Appendix Table 2 Parameter values

Parameter	Baseline value (10-14 weeks since treatment for first infection)		Sensitivity value (10-26 weeks since treatment for first infection)		Reference
Retest uptake (i.e., percentage of (first) positives who choose to accept retesting) (all methods except method five) <sup>1</sup>	1. Client-led	5%	1. Client-led	15%	NCSP audit report[4] and NCSP audit data provided by PHE
	2. Reminder card	4%	2. Reminder card	19%	
	3. SMS invitation	9%	3. SMS invitation	21%	
	4. Phone invitation	7%	4. Phone invitation	17%	
	6. Advice at follow-up & SMS	13%	6. Advice at follow-up & SMS	25%	
Percentage of those retesting who choose to attend a clinic for a retest (all methods except method five) <sup>2</sup>	76%		73%		NCSP audit data provided by PHE
Percentage of those retesting who choose to request a postal kit (all methods except method five)	=100-76% =24%		=100-73% =27%		
Postal test kit return rate (requested kits)	67%		67%		Retesting pilot[5]
Postal test kit return rate (kits sent out automatically; method five)	5. Automatic postal test kit	10%	5. Automatic postal test kit	23%	NCSP audit report[4] and NCSP audit data provided by PHE
Chlamydia retest positivity <sup>3</sup>	12%		16%		NCSP audit report[4] and NCSP audit data provided by PHE

<sup>1</sup>Obtained by fitting to overall retest rates from the audit (i.e., accounting for non-return of requested postal kits); <sup>2</sup>The audit only has data on percentage of *completed* retests obtained from clinic testing vs postal testing (for those instances where a kit was not sent out automatically), not percentage of those who opt for a retest at a clinic among *all* retesters (i.e., including all those who request a kit, some of whom do not return the kit); <sup>3</sup>Average over the six most commonly-used methods.

## References

1. Pathway Analytics: Pathway Prices for Integrated Sexual Health Tariffs 118. *T3 Chlamydia, gonorrhoea and syphilis tests* <https://www.pathwayanalytics.com/pathways/26-t3-chlamydia-gonorrhoea-syphilis-tests/118-t3-chlamydia-gonorrhoea-and-syphilis-tests> Accessed 2013.
2. Royal Mail: Get a price <http://www.royalmail.com/price-finder> Accessed 14/08/2015.
3. British National Formulary: Azithromycin <http://www.evidence.nhs.uk/formulary/bnf/current/5-infections/51-antibacterial-drugs/515-macrolides/azithromycin> Accessed 02/02/2016.
4. *Re-testing of those who tested positive for chlamydia: National audit report* [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/471585/NCSPre-testingauditfinalversion.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/471585/NCSPre-testingauditfinalversion.pdf) Accessed 13/09/2016.
5. Angel, G., et al., *An observational study to evaluate three pilot programmes of retesting chlamydia-positive individuals within 6 months in the South West of England*. BMJ Open, 2016. 5(10): p. e007455.



CHEERS checklist—Items to include when reporting economic evaluations of health interventions (BMJ 2013;346:f1049)

Section/item	Item No	Recommendation	Reported on page No/ line No
<b>Title and abstract</b>			
Title	1	Identify the study as an economic evaluation or use more specific terms such as “cost-effectiveness analysis”, and describe the interventions compared.	p1/line 1-3
Abstract	2	Provide a structured summary of objective perspective, setting, methods (including study design and inputs), results (including base case and uncertainty analyses), and conclusions.	p2
<b>Introduction</b>			
Background and objectives	3	Provide an explicit statement of the broader context for the study.	p3/line 67-73
		Present the study question and its relevance for health policy or practice decisions.	p3-4/line 90-95
<b>Methods</b>			
Target population and subgroups	4	Describe characteristics of the base case population and subgroups analysed, including why they were chosen.	N/A
Setting and location	5	State relevant aspects of the system(s) in which the decision(s) need(s) to be made.	p4/line 97
Study perspective	6	Describe the perspective of the study and relate this to the costs being evaluated.	p4/line 97-98
Comparators	7	Describe the interventions or strategies being compared and state why they were chosen.	p4/line 97-98

Section/item	Item No	Recommendation	Reported on page No/ line No
Time horizon	8	State the time horizon(s) over which costs and consequences are being evaluated and say why appropriate.	p4/line 97-100
Discount rate	9	Report the choice of discount rate(s) used for costs and outcomes and say why appropriate.	N/A
Choice of health outcomes	10	Describe what outcomes were used as the measure(s) of benefit in the evaluation and their relevance for the type of analysis performed.	N/A
Measurement of effectiveness	11a	<i>Single study-based estimates:</i> Describe fully the design features of the single effectiveness study and why the single study was a sufficient source of clinical effectiveness data.	N/A
	11b	<i>Synthesis-based estimates:</i> Describe fully the methods used for identification of included studies and synthesis of clinical effectiveness data.	N/A
Measurement and valuation of preference based outcomes	12	If applicable, describe the population and methods used to elicit preferences for outcomes.	N/A
Estimating resources and costs	13a	<i>Single study-based economic evaluation:</i> Describe approaches used to estimate resource use associated with the alternative interventions. Describe primary or secondary research methods for valuing each resource item in terms of its unit cost. Describe any adjustments made to approximate to opportunity costs.	p4/line 99-104 and Appendix Table 1
	13b	<i>Model-based economic evaluation:</i> Describe approaches and data sources used to estimate resource use associated with model health states.	N/A

136/bmjopen-2018-024828 on 23 March 2019. Downloaded from <http://bmjopen.bmj.com/> on April 23, 2024 by guest. Protected by copyright.

Section/item	Item No	Recommendation	Reported on page No/ line No
		Describe primary or secondary research methods for valuing each resource item in terms of its unit cost. Describe any adjustments made to approximate to opportunity costs.	
Currency, price date, and conversion	14	Report the dates of the estimated resource quantities and unit costs. Describe methods for adjusting estimated unit costs to the year of reported costs if necessary. Describe methods for converting costs into a common currency base and the exchange rate.	pP4/line 100
Choice of model	15	Describe and give reasons for the specific type of decision-analytical model used. Providing a figure to show model structure is strongly recommended.	Appendix Figure 1
Assumptions	16	Describe all structural or other assumptions underpinning the decision-analytical model.	p4/line 107-120 and Appendix Table 2
Analytical methods	17	Describe all analytical methods supporting the evaluation. This could include methods for dealing with skewed, missing, or censored data; extrapolation methods; methods for pooling data; approaches to validate or make adjustments (such as half cycle corrections) to a model; and methods for handling population heterogeneity and uncertainty.	N/A
<b>Results</b>			
Study parameters	18	Report the values, ranges, references, and, if used, probability distributions for all parameters. Report reasons or sources for distributions used to represent uncertainty where appropriate. Providing a table to show the input values is strongly recommended.	p4/line 107-120 and Appendix Table 2

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47

Section/item	Item No	Recommendation	Reported on page No/ line No
Incremental costs and outcomes	19	For each intervention, report mean values for the main categories of estimated costs and outcomes of interest, as well as mean differences between the comparator groups. If applicable, report incremental cost-effectiveness ratios.	Table 1
Characterising uncertainty	20a	<i>Single study-based economic evaluation:</i> Describe the effects of sampling uncertainty for the estimated incremental cost and incremental effectiveness parameters, together with the impact of methodological assumptions (such as discount rate, study perspective).	N/A
	20b	<i>Model-based economic evaluation:</i> Describe the effects on the results of uncertainty for all input parameters, and uncertainty related to the structure of the model and assumptions.	Table 1
Characterising heterogeneity	21	If applicable, report differences in costs, outcomes, or cost-effectiveness that can be explained by variations between subgroups of patients with different baseline characteristics or other observed variability in effects that are not reducible by more information.	N/A
<b>Discussion</b>			
Study findings, limitations, generalisability, and current knowledge	22	Summarise key study findings and describe how they support the conclusions reached. Discuss limitations and the generalisability of the findings and how the findings fit with current knowledge.	p7-8
<b>Other</b>			

136/bmjopen-2018-024828 on 23 March 2019. Downloaded from <http://bmjopen.bmj.com/> on April 23, 2024 by guest. Protected by copyright.

Section/item	Item No	Recommendation	Reported on page No/ line No
Source of funding	23	Describe how the study was funded and the role of the funder in the identification, design, conduct and reporting of the analysis. Describe other non-monetary sources of support.	p8-9
Conflicts of interest	24	Describe any potential for conflict of interest of study contributors in accordance with journal policy. In the absence of a journal policy, we recommend authors comply with International Committee of Medical Journal Editors recommendations.	p9

For consistency, the CHEERS statement checklist format is based on the format of the CONSORT statement checklist

Peer review only

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47

# BMJ Open

## An economic evaluation of the cost of different methods of retesting chlamydia positive individuals in England

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2018-024828.R2
Article Type:	Research
Date Submitted by the Author:	11-Jan-2019
Complete List of Authors:	<p>Looker, Katharine; University of Bristol, Population Health Sciences, Bristol Medical School            Buitendam, Erna; Public Health England, HIV &amp; STI Department, National Infection Service            Woodhall, Sarah; Public Health England, HIV &amp; STI; UCL, Research Department of Infection and Population Health            Hollis, Emma; Public Health England, HIV/STI            Ong, Koh Jun; Public Health England, National Infections Service - HIV/STI            Saunders, John; Public Health England, HIV &amp; STI Department; University College London, Research Department of Infection and Population Health            Dunbar, Kevin; Public Health England, HIV &amp; STI Department            Turner, Katy; Bristol University, School of Social and Community Medicine</p>
<b>Primary Subject Heading</b>:	Sexual health
Secondary Subject Heading:	Health services research, Health economics, Public health, Infectious diseases
Keywords:	Public health < INFECTIOUS DISEASES, HEALTH SERVICES ADMINISTRATION & MANAGEMENT, HEALTH ECONOMICS

SCHOLARONE™  
Manuscripts

# An economic evaluation of the cost of different methods of retesting chlamydia positive individuals in England

Looker, K. J.<sup>1\*</sup>, Buitendam, E.<sup>2</sup>, Woodhall, S. C.<sup>2</sup>, Hollis, E.<sup>2</sup>, Ong, K.-J.<sup>2</sup>,  
Saunders, J.<sup>2</sup>, Dunbar, K.<sup>2</sup> and Turner, K. M. E.<sup>1</sup>

<sup>1</sup>Population Health Sciences, Bristol Medical School, University of Bristol, Bristol, United Kingdom

<sup>2</sup>HIV & STI Department, National Infection Service, Public Health England, United Kingdom

\*Corresponding author. Correspondence should be sent to:

Dr Katharine Looker

Population Health Sciences, Bristol Medical School

University of Bristol

Oakfield House, Oakfield Grove

Bristol BS8 2BN

United Kingdom

katharine.looker@bristol.ac.uk

## 18 **ABSTRACT**

### 19 **Objectives**

20 The National Chlamydia Screening Programme in England opportunistically screens eligible individuals  
21 for chlamydia infection. Retesting is recommended three months after treatment following a positive  
22 test result, but no guidance is given on how local areas should recall individuals for retesting. Here we  
23 compare cost estimates for different recall methods to inform the optimal delivery of retesting  
24 programmes.

### 25 **Design**

26 Economic evaluation

### 27 **Setting**

28 England

### 29 **Methods**

30 We estimated the cost of chlamydia retesting for each of the six most commonly-used recall methods  
31 in 2014 based on existing cost estimates of a chlamydia screen. Proportions accepting retesting, opting  
32 for retesting by post, returning postal testing kits and retesting positive were informed by 2014 NCSP  
33 audit data. Health professionals “sense-checked” the costs.

### 34 **Primary and secondary outcomes**

35 Cost and adjusted cost per chlamydia retest; cost and adjusted cost per chlamydia retest positive.

### 36 **Results**

37 We estimated the cost of the chlamydia retest pathway, including treatment/follow-up call, to be  
38 between £45-£70 per completed test. At the lower end this compared favourably to the cost of a  
39 clinic-based screen. Cost per retest positive was £389-£607. After adjusting for incomplete uptake,  
40 and non-return of postal kits, the cost rose to £109-£289 per completed test (cost per retest positive:  
41 £946-£2,506). The most economical method in terms of adjusted cost per retest was no active recall,  
42 as gains in retest rates with active recall did not outweigh the higher cost. Nurse-led client contact by  
43 phone was particularly uneconomical, as was sending out postal testing kits automatically.

### 44 **Conclusions**

45 Retesting without active recall is more economical than more intensive methods such as recalling by  
46 phone and automatically sending out postal kits. If sending an SMS could be automated, this could be  
47 the most economical way of delivering retesting. However, patient choice and local accessibility of  
48 services should be taken into consideration in planning.

49



## 50 **Strengths and limitations of this study**

51 We compared the cost of the chlamydia retest pathway in England across the five most commonly-  
52 used methods of recalling individuals for retesting, to enable local service planners to assess whether  
53 they are delivering retesting economically or should consider an alternative approach.

54  
55 Our cost estimates included both clinic retesting, and retesting using postal kits.

56  
57 We incorporated incomplete uptake, and non-return of postal kits, to estimate cost based on actual  
58 patterns of use.

59  
60 We did not specifically look at the effect of factors such as gender, country of birth, sexual orientation,  
61 perceived risk of infection and presence of symptoms on retest uptake and therefore cost, although  
62 no active recall is likely to be associated with similar or higher test positivity than active recall.

63 We also did not consider other important factors besides cost such as the demography of the  
64 population: for example, automatically sending out postal kits might be the only feasible option in  
65 rural areas, and indeed, on-line testing, which was not considered in our analysis, is likely to be the  
66 most economical method of all.

## 67 **INTRODUCTION**

68 *Chlamydia trachomatis* (chlamydia) is the most commonly-diagnosed bacterial sexually-transmitted  
69 infection (STI) in England[1]. Since 2003 there has been a National Chlamydia Screening Programme  
70 (NCSP) in England which opportunistically tests sexually-active 15-24 year olds[2]. NCSP guidelines  
71 recommend retesting three months after treatment for chlamydia[3]. British Association for Sexual  
72 Health and HIV (BASHH) national guidelines recommend retesting under 25 year olds three to six  
73 months after treatment[4]. No guidance is given by either the NCSP or BASHH on how local areas  
74 should recall individuals for retesting, which can be done in many ways. The 2014 NCSP retesting  
75 audit[5] found that the most common methods of recalling individuals for retesting were as follows:  
76 (1) conversation with client at time of test result with no further reminder (32%); (2) reminder card  
77 given to client at time of test result with no further reminder (1%); (3) client sent text message when  
78 retest due (29%); (4) client invited by phone call when retest due (8%); (5) testing kit posted to client's  
79 chosen address when retest due (5%); and (6) retesting advised at follow up call with client - text  
80 message sent at 3 months (19%). The audit also measured overall retest rates for each recall method,  
81 which were calculated from the number that attended a clinic for a retest or returned a postal testing  
82 kit, divided by the total number recalled for retesting. This is different to retest uptake, which is the  
83 number that attended a clinic for a retest or *ordered* or were sent a postal testing kit, divided by the  
84 total number recalled for retesting, which has cost implications. Retest uptake was not measured by  
85 the audit. Unpublished data from the 2017 NCSP retesting audit (Erna Buitendam, personal  
86 communication) showed that, for the six most commonly-used recall methods in the 2014 audit, retest  
87 rates significantly increased for method one (client-led) and method five (automatic postal test kit)  
88 between the 2014 and 2017 audits.

89 Previous estimates exist for the cost of a clinic-based chlamydia screen[6, 7]. However, to our  
90 knowledge there are no estimates of the cost of a chlamydia retest, and how this varies by recall

1  
2  
3 91 method. Specifically, we do not know the best way to balance getting the optimal number of people  
4 92 to retest versus the additional cost of delivering invitations or reminders to retest. Understanding how  
5 93 the cost of retesting varies depending on the approach taken is critical for optimal programme  
6 94 delivery. Here we present cost estimates for different recall methods in England, firstly for the retest  
7 95 pathway itself, and then for the adjusted cost per retest, allowing for incomplete uptake, and non-  
8 96 return of postal kits, to impact on cost.

## 97 **METHODS**

98 We estimated the cost of chlamydia retesting in England using Microsoft Excel 2016 for each of the  
99 six most commonly-used recall methods reported in the 2014 NCSP retesting audit[5] (Table 1) as  
100 follows. First, we entered existing cost estimates for a chlamydia test from Pathway Analytics (costed  
101 for clinic-based chlamydia screening for 2011), which excluding a follow-up call was around £45[6]  
102 (Appendix Table 1). We used this costing as given. We then added additional costs to reflect costs  
103 specifically associated with retesting, such as a nurse-led conversation about retesting after diagnosis,  
104 and issuing retest invitations/reminders (e.g., by text message [SMS] or phone). A nurse-led  
105 conversation about retesting after diagnosis was assumed to involve only extra nurse time to  
106 additionally discuss retesting; other associated costs were assumed to be already factored into the  
107 cost of a first test. Both an SMS and a phone call were assumed to involve administration time and the  
108 cost of the SMS or call itself, while the latter was assumed to also include both nurse time for the  
109 actual call as well as chasing time. In addition, we amended the clinic-based chlamydia test costs to  
110 allow for postal testing. Costs were then totalled across the following cost categories: cost of offering  
111 retesting, cost of delivering retest, and cost of processing retest and giving results, as well as overall.

112 For each of the six recall methods, we costed both the retest pathway, and the adjusted cost per retest  
113 (Appendix Figure 1). The adjusted cost per retest accounts for incomplete uptake, and non-return of  
114 postal kits, within each cost category. For all methods except method five (automatic postal testing  
115 kit) we allowed clients to choose either to attend a clinic for retesting, or to request a postal testing  
116 kit. Thus, for methods one to four, and method six, we incorporated the following parameters: retest  
117 uptake, the proportion who opt for postal testing, and the return rate of requested kits. Retest uptake  
118 for each of the six recall methods was fitted to overall retest rates from the 2014 NCSP audit[5], taking  
119 a value of 24% for the proportion of clients who opt for postal testing (also from the audit), and a  
120 value of 67% for the return rate of requested kits[8]. For method five, uptake was equivalent to overall  
121 retest rate and was simply the return rate of postal kits (10%) from the 2014 NCSP audit[5]. Chlamydia  
122 retest positivity (12%), which informs the relative weight given to the cost of managing a positive  
123 retest result versus managing a negative retest result in the average cost of the chlamydia retesting  
124 pathway, was taken from the NCSP audit[5], and was averaged over all six recall methods due to small  
125 numbers by individual method. We also calculated the cost and adjusted cost per retest positive, i.e.,  
126 the cost of finding one positive retest incorporating the cost of other, negative retests, by dividing test  
127 costs by the chlamydia positivity. For a table of parameter values see Appendix Table 2.

128 The time frame for calculating the parameter values was 10-14 weeks, corresponding to NCSP  
129 guidance for retesting. We sense-checked our retesting costs (Appendix Table 1) with health  
130 professionals. We conducted two sensitivity analyses. In the first sensitivity analysis we replaced the  
131 parameters for the retesting pathway with those obtained from data for retesting done between 10-  
132 26 weeks (corresponding to BASHH guidance) (Appendix Table 2). This simply allows more time for

1  
2  
3 133 clients to retest: there is no additional contact with clients to remind them to retest. In the second  
4 134 sensitivity analysis we altered staff salary costs from nurse bands to administrator bands for nurse-  
5 135 based costs associated with phone invitations to retest, managing a retest negative, and a follow-up  
6 136 call at three months for those retesting positive (leaving the nurse-based costs associated with the  
7 137 initial retest conversation and managing a retest positive unchanged). The purpose of this was to show  
8 138 the difference in price that could be achieved if administrative staff instead of nurses contacted clients  
9 139 by phone, except where a lower band of advisor might not be appropriate.

10  
11  
12  
13 140 Since retest rates significantly increased for method one (client-led) and method five (automatic  
14 141 postal test kit) between the 2014 and (unpublished) 2017 audits ( $p>0.05$ ), we restricted our analyses  
15 142 to 2014 data only. However, we carried out an analysis of whether retest positivity was statistically-  
16 143 significantly different for no active recall (method one) versus active recall (methods three and six)  
17 144 using both 2014 and 2017 audit data, since there was no statistically-significant difference in the  
18 145 positivity rates for each of these methods when comparing 2014 and 2017 data.

## 146 **Patient and Public Involvement**

147 Patients and the public were not involved in this analysis.

148

149 **Table 1 Chlamydia retest costs by recall method**

	Recall method					
	1. Client-led	2. Reminder card	3. SMS invitation	4. Phone invitation	5. Automatic postal test kit	6. Advice at follow-up & SMS
Number of retest invitations by each method (%), N=2853 <sup>1</sup> (NCSP audit, 2014[5])	912 (32%)	27 (1%)	840 (29%)	227 (8%)	130 (5%)	528 (19%)
Description	Conversation with client at time of test result with no further reminder	Reminder card given to client at time of test result with no further reminder	Client sent text message when retest due	Client invited by phone call when retest due	Testing kit posted to client's chosen address when retest due	Retesting advised at follow up call with client - text message sent at 3 months
<b>COSTS USING BASELINE PARAMETERS (10-14 weeks since treatment for first infection)</b>						
<b>Cost of chlamydia retesting pathway<sup>2</sup></b>						
Cost of offering retesting	£2.68	£2.78	£5.42	£14.44	£2.68	£17.18
Cost of delivering retest	£24.16	£24.16	£24.16	£24.16	£13.45	£24.16
Cost of processing retest and giving results	£28.71	£28.71	£28.71	£28.71	£28.71	£28.71
<b>TOTAL COST</b>	<b>£55.54</b>	<b>£55.64</b>	<b>£58.28</b>	<b>£67.31</b>	<b>£44.83</b>	<b>£70.05</b>
<b>Cost per retest positive</b>	<b>£481</b>	<b>£482</b>	<b>£505</b>	<b>£583</b>	<b>£389</b>	<b>£607</b>
<b>Retest uptake</b>	<b>5%</b>	<b>4%</b>	<b>9%</b>	<b>7%</b>	<b>10%</b>	<b>13%</b>
<b>Retest rate</b>	<b>5%</b>	<b>4%</b>	<b>8%</b>	<b>6%</b>	<b>10%</b>	<b>12%</b>
<b>Adjusted cost per retest incorporating incomplete uptake/non-return of kits</b>	<b>£109</b>	<b>£130</b>	<b>£120</b>	<b>£289</b>	<b>£190</b>	<b>£195</b>
<b>Adjusted cost per retest positive incorporating incomplete uptake/non-return of kits</b>	<b>£946</b>	<b>£1,126</b>	<b>£1,039</b>	<b>£2,506</b>	<b>£1,646</b>	<b>£1,686</b>
<b>COSTS USING LONGER TIME WINDOW FOR RETESTING (10-26 weeks since treatment for first infection)</b>						
<b>Total cost of chlamydia retesting pathway</b>	<b>£55.38</b>	<b>£55.48</b>	<b>£58.12</b>	<b>£67.15</b>	<b>£45.32</b>	<b>£69.89</b>
<b>Cost per retest positive</b>	<b>£344</b>	<b>£345</b>	<b>£361</b>	<b>£417</b>	<b>£282</b>	<b>£435</b>
<b>Retest uptake</b>	<b>16%</b>	<b>20%</b>	<b>23%</b>	<b>18%</b>	<b>23%</b>	<b>27%</b>
<b>Retest rate</b>	<b>15%</b>	<b>19%</b>	<b>21%</b>	<b>17%</b>	<b>23%</b>	<b>25%</b>
<b>Adjusted cost per retest incorporating incomplete uptake/non-return of kits</b>	<b>£73</b>	<b>£71</b>	<b>£82</b>	<b>£142</b>	<b>£99</b>	<b>£126</b>
<b>Adjusted cost per retest positive incorporating incomplete uptake/non-return of kits</b>	<b>£456</b>	<b>£440</b>	<b>£508</b>	<b>£883</b>	<b>£616</b>	<b>£780</b>
<b>COSTS IF ADMINISTRATORS USED INSTEAD OF NURSES (10-14 weeks since treatment for first infection)</b>						
<b>Total cost of chlamydia retesting pathway</b>	<b>£52.13</b>	<b>£52.23</b>	<b>£54.87</b>	<b>£60.24</b>	<b>£41.42</b>	<b>£62.98</b>
<b>Cost per retest positive</b>	<b>£452</b>	<b>£453</b>	<b>£476</b>	<b>£522</b>	<b>£359</b>	<b>£546</b>
<b>Adjusted cost per retest incorporating incomplete uptake/non-return of kits</b>	<b>£106</b>	<b>£126</b>	<b>£117</b>	<b>£227</b>	<b>£187</b>	<b>£161</b>
<b>Adjusted cost per retest positive incorporating incomplete uptake/non-return of kits</b>	<b>£917</b>	<b>£1,096</b>	<b>£1,010</b>	<b>£1,963</b>	<b>£1,617</b>	<b>£1,399</b>

<sup>1</sup>Other methods or method not recorded account for the remaining 7% (N=189) of retests. <sup>2</sup>Some costs were taken (and some subsequently amended) from the basic cost of a (first) chlamydia test[6] which is under a Creative Commons licence:



© Pathway Analytics

152  
153  
154

## 155 RESULTS

156 The estimated cost of the chlamydia retest pathway ranged from £45-£70 per completed test, while  
157 the cost per retest positive ranged from £389-£607 (Table 1). Posting testing kits automatically with  
158 no further reminder (method five) was the cheapest recall method, while methods involving inviting  
159 clients by phone to retest (methods four and six) were the most expensive. After adjusting for  
160 incomplete uptake and non-return of postal kits, the cost per chlamydia retest ranged from £109-£289  
161 per completed test, while the cost per retest positive ranged from £946-£2,506. Here, the most  
162 economical recall method in terms of the adjusted cost per retest was no active recall (method one).  
163 An SMS invitation (method three) increased retest rates for comparatively small additional cost. The  
164 most expensive methods were still those involving inviting clients by phone to retest (methods four  
165 and six). This was despite these methods achieving higher retest rates (6% and 12% for methods four  
166 and six, respectively) compared to no active recall (5%). Sending postal testing kits out automatically  
167 (method five) was also an uneconomical way of delivering a retest, due to the cost of non-returned  
168 kits. Retest positivity was not statistically-significantly different for no active recall (method one)  
169 versus active recall (methods three and six) when 2014 and 2017 audit data were combined.

170 Extending the retesting period to 10-26 weeks did not impact substantially on the chlamydia retesting  
171 pathway cost (range £45-£70) (Table 1). However, the adjusted cost per retest incorporating  
172 incomplete uptake and non-return of kits was substantially lower (range £71-£126), as was the  
173 adjusted cost per retest positive (range £440-£883), than with a tighter retest window, particularly for  
174 automatically sending out postal kits (method five). However, this assumed positivity was higher for  
175 the 10-26 week window across all methods. In any case, methods with no or else minimal active recall  
176 were still the most economical. Replacing nurse bands with administrator bands only had a substantial  
177 impact on costs for those methods where clients were contacted by phone to recall for retest (Table  
178 1).

## 179 DISCUSSION

180 The estimated cost of the chlamydia retest pathway ranged from £45-£70 per completed test, which  
181 at the cheapest end was very similar to the cost of a clinic-based chlamydia screen[6, 7]. The cost per  
182 retest positive, meanwhile, ranged from £389-£607. Important differences were seen when uptake  
183 and kit return rates were varied. This is because successfully completed retests effectively absorbed  
184 the cost of incomplete retests. Here, the most economical recall method involved no active recall after  
185 the initial retest conversation. Sending out postal testing kits automatically was an expensive way of  
186 doing retesting because of wastage of kits. However, the most expensive methods involved contacting  
187 clients by phone to invite them to retest, primarily because of nurse time required.

188 When the retesting window was increased from 10-14 weeks to 10-26 weeks, all methods of recall  
189 had a reduced adjusted cost per retest, due in part to higher positivity for 10-26 weeks. However, a  
190 longer time window means there is further potential for onward transmission, so it is important clients  
191 are counselled on the best time to retest.

1  
2  
3 192 Active recall increased retest rates but this did not outweigh the additional cost. We assumed that  
4 193 sending an SMS involved administration time to retrieve clients' details from a database. In our  
5 194 analysis we considered only the effect of altering staff salary costs from nurse bands to administrator  
6 195 bands for some nurse-based activities. If the time needed to send an SMS could be shortened by  
7 196 automating this process, then an SMS invitation or reminder could be an economical way of increasing  
8 197 retest rates. For example, if the cost of associated administration time is removed, then the adjusted  
9 198 cost per chlamydia retest is £88 and the adjusted cost per retest positive is £765, making sending an  
10 199 SMS the most economical way of delivering retesting. Conversations with health professionals during  
11 200 the course of our study suggested that a shorter administration time to send an SMS was theoretically  
12 201 feasible. We did not find any evidence that retest positivity was different for active recall versus no  
13 202 active recall, meaning there is no evidence that active recall merely results in more negatives being  
14 203 tested. However, evidence from a retesting pilot in South-West England did show that those who  
15 204 retested without being actively recalled had higher chlamydia retest positivity than those who were  
16 205 actively recalled[8]. Furthermore, the unpublished 2017 audit data showed a statistically-significant  
17 206 increase in the retest rate for client-led retesting for 10-14 weeks compared to 2014 (Erna Buitendam,  
18 207 personal communication), which could make no active recall even more economical than shown here.

24 208 Our analysis was done for the pathway cost of testing for chlamydia alone[6]. Where chlamydia testing  
25 209 is done at the same time as testing for other STIs (such as gonorrhoea), the proportionate cost of  
26 210 testing for chlamydia will be reduced. Another consideration is that since our analysis was carried out,  
27 211 the estimated pathway cost has fallen, which will reduce costs further across all methods of retesting.  
28 212 However, cost is not the only important factor to consider. For example, no active recall also had the  
29 213 lowest retest rate, although as noted above, active recall may not necessarily identify more infected  
30 214 people if those opting to retest self-select on the basis of their perceived risk or presence of symptoms.  
31 215 We also did not account for the effect on retest uptake of factors such as gender, location of services,  
32 216 country of birth, and sexual orientation. The composition of the population is an important  
33 217 consideration in local planning: a large rural population, for example, might affect how retesting needs  
34 218 to be delivered. Given the much higher return rate for requested postal testing kits compared to kits  
35 219 sent out automatically, online testing with automated recall is likely to be the most economical  
36 220 method of all, but was beyond the scope of this analysis.

41 221 Our analysis suggests that no active recall after the initial retest conversation is the most economical  
42 222 way of retesting, although an SMS invitation or reminder could be considered. Patient choice and  
43 223 accessibility of services should still be taken into consideration for local delivery planning and it is  
44 224 important that retest uptake is monitored as this determines how economical retesting is.

## 47 225 **CONTRIBUTORS**

48 226 KJL undertook the itemisation and costing, analysed the results and drafted the manuscript. KMET  
49 227 oversaw the study and provided advice as needed. EB and SW provided audit data and advised on  
50 228 parameterisation. K-JO helped with sources for costs. KJL, EB, SW, EH, K-JO, JS, KD and KMET all  
51 229 contributed to the progress of the study and manuscript revisions.

## 52 230 **CONFLICT OF INTEREST**

53 231 The authors declare there are no conflicts of interest.

## 232 ACKNOWLEDGEMENTS

233 KJL and KMET thank the National Institute for Health Research (NIHR) Health Protection Research Unit  
 234 (HPRU) in Evaluation of Interventions at the University of Bristol, in partnership with Public Health  
 235 England, for research support. We would like to thank Rose Tobin (North East and North Central  
 236 London Adult Critical Care Network, Royal Free London NHS Foundation Trust), Stephanie Rumsey  
 237 (East Cheshire NHS Trust), Jan Cremer (Essex Partnership University NHS Foundation Trust) and  
 238 Stephanie Sawyer (London Borough of Bromley Public Health) for sense-checking the costs, and  
 239 Pathway Analytics for data on the cost of a chlamydia test.

## 240 FUNDING

241 The research was funded by the National Institute for Health Research Health Protection Research  
 242 Unit (NIHR HPRU) in Evaluation of Interventions at the University of Bristol in partnership with Public  
 243 Health England (PHE). The views expressed are those of the author(s) and not necessarily those of the  
 244 NHS, the NIHR, the Department of Health and Social Care or Public Health England.

## 245 DATA AVAILABILITY

246 All data relevant to the study are included in the article or uploaded as supplementary information.

## 247 REFERENCES

- 248 1. *National chlamydia screening programme (NCSP): data tables*  
 249 [https://www.gov.uk/government/statistics/national-chlamydia-screening-programme-ncsp-](https://www.gov.uk/government/statistics/national-chlamydia-screening-programme-ncsp-data-tables)  
 250 [data-tables](https://www.gov.uk/government/statistics/national-chlamydia-screening-programme-ncsp-data-tables) Accessed 13/09/2016.
- 251 2. *NCSP: programme overview* [https://www.gov.uk/government/publications/ncsp-](https://www.gov.uk/government/publications/ncsp-programme-overview)  
 252 [programme-overview](https://www.gov.uk/government/publications/ncsp-programme-overview) Accessed 13/09/2016.
- 253 3. *Consultation Report: Routine offer of re-test to young adults testing positive for chlamydia*  
 254 *(Consultation findings and evidence summary)*  
 255 [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/508364/N](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/508364/NCSP_Report_Consultation_on_Re-testing_of_Positive_Chlamydia_Cases_August_2013_FINAL.pdf)  
 256 [CSP\\_Report\\_Consultation\\_on\\_Re-](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/508364/NCSP_Report_Consultation_on_Re-testing_of_Positive_Chlamydia_Cases_August_2013_FINAL.pdf)  
 257 [testing\\_of\\_Positive\\_Chlamydia\\_Cases\\_August\\_2013\\_FINAL.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/508364/NCSP_Report_Consultation_on_Re-testing_of_Positive_Chlamydia_Cases_August_2013_FINAL.pdf) Accessed 14/09/2016.
- 258 4. Nwokolo, N.C., et al. *2015 UK national guideline for the management of infection with*  
 259 *Chlamydia trachomatis*  
 260 <http://www.bashh.org/documents/UK%20Chlamydia%20Guidelines%202015.pdf> Accessed  
 261 14/09/2016.
- 262 5. *Re-testing of those who tested positive for chlamydia: National audit report*  
 263 [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/471585/N](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/471585/NCSPPre-testingauditfinalversion.pdf)  
 264 [CSPPre-testingauditfinalversion.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/471585/NCSPPre-testingauditfinalversion.pdf) Accessed 13/09/2016.
- 265 6. Pathway Analytics: *Pathway Prices for Integrated Sexual Health Tariffs 118. T3 Chlamydia,*  
 266 *gonorrhoea and syphilis tests* [https://www.pathwayanalytics.com/pathways/26-t3-](https://www.pathwayanalytics.com/pathways/26-t3-chlamydia-gonorrhoea-syphilis-tests/118-t3-chlamydia-gonorrhoea-and-syphilis-tests)  
 267 [chlamydia-gonorrhoea-syphilis-tests/118-t3-chlamydia-gonorrhoea-and-syphilis-tests](https://www.pathwayanalytics.com/pathways/26-t3-chlamydia-gonorrhoea-syphilis-tests/118-t3-chlamydia-gonorrhoea-and-syphilis-tests)  
 268 Accessed 2013.
- 269 7. Turner, K., et al., *Costs and cost effectiveness of different strategies for chlamydia screening*  
 270 *and partner notification: an economic and mathematical modelling study.* *BMJ*, 2011. **342**: p.  
 271 c7250.
- 272 8. Angel, G., et al., *An observational study to evaluate three pilot programmes of retesting*  
 273 *chlamydia-positive individuals within 6 months in the South West of England.* *BMJ Open*, 2016.  
 274 **5**(10): p. e007455.

275

For peer review only

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60



# Appendix

## An economic evaluation of the cost of different methods of retesting chlamydia positive individuals in England

Looker, K. J., Buitendam, E., Woodhall, S. C., Hollis, E., Ong, K.-J., Saunders, J., Dunbar, K. and Turner, K. M. E.

Appendix Table 1 Chlamydia retest costs by recall method

Activity	Price per unit (item/minute of staff time)	Recall method											
		1. Client-led		2. Reminder card		3. SMS invitation		4. Phone invitation		5. Automatic postal test kit		6. Advice at follow-up & SMS	
		Units	Cost	Units	Cost	Units	Cost	Units	Cost	Units	Cost	Units	Cost
<b>PATIENT OFFERED RETEST</b>													
<i>Nurse-led conversation about retesting at first diagnosis and issue subsequent reminders</i>													
Nurse band 5/6/7/8 <sup>2</sup>	£ 0.89	3	£ 2.68	3	£ 2.68	3	£ 2.68	13	£ 11.60	3	£ 2.68	13	£ 11.60
Blend admin/clerical <sup>1</sup>	£ 0.53	0	£ -	0	£ -	5	£ 2.64	5	£ 2.64	0	£ -	10	£ 5.27
Reminder card	£ 0.10	0	£ -	1	£ 0.10	0	£ -	0	£ -	0	£ -	0	£ -
SMS text message	£ 0.10	0	£ -	0	£ -	1	£ 0.10	0	£ -	0	£ -	1	£ 0.10
Phone call <sup>2</sup>	£ 0.07	0	£ -	0	£ -	0	£ -	3	£ 0.21	0	£ -	3	£ 0.21
<b>PATIENT DELIVERED RETEST<sup>8</sup></b>													
<i>Register, meet and greet</i>													
Blend admin/clerical <sup>3</sup>	£ 0.53	3.8	£ 2.00	3.8	£ 2.00	3.8	£ 2.00	3.8	£ 2.00	0.0	£ -	3.8	£ 2.00
<i>Actual retest</i>													
Consultation - blend of Community SRH staff (N2 to Doctor) <sup>3</sup>	£ 1.06	6.8	£ 7.22	6.8	£ 7.22	6.8	£ 7.22	6.8	£ 7.22	0.0	£ -	6.8	£ 7.22
Blend admin/clerical <sup>1,4</sup>	£ 0.53	1.2	£ 0.63	1.2	£ 0.63	1.2	£ 0.63	1.2	£ 0.63	5	£ 2.64	1.2	£ 0.63
Health professional-led retest - blend of Community SRH staff (N2 to Doctor) <sup>3</sup>	£ 1.06	4.56	£ 4.81	4.56	£ 4.81	4.56	£ 4.81	4.56	£ 4.81	0	£ -	4.56	£ 4.81
Gloves <sup>3</sup>	£ 0.05	0.76	£ 0.03	0.76	£ 0.03	0.76	£ 0.03	0.76	£ 0.03	0	£ -	0.76	£ 0.03
Lab request form with bag	£ 0.10	1	£ 0.10	1	£ 0.10	1	£ 0.10	1	£ 0.10	1	£ 0.10	1	£ 0.10

Sample collection instructions	£ 0.05	1	£ 0.05	1	£ 0.05	1	£ 0.05	1	£ 0.05	1	£ 0.05	1	£ 0.05
Transport tube	£ 0.26	1	£ 0.26	1	£ 0.26	1	£ 0.26	1	£ 0.26	1	£ 0.26	1	£ 0.26
Urine pot, sterile collection	£ 0.23	0.7	£ 0.16	0.7	£ 0.16	0.7	£ 0.16	0.7	£ 0.16	0.7	£ 0.16	0.7	£ 0.16
Urine specimen container (PCR tube and pipette)	£ 1.04	0.7	£ 0.73	0.7	£ 0.73	0.7	£ 0.73	0.7	£ 0.73	0.7	£ 0.73	0.7	£ 0.73
Vulvo-vaginal swab	£ 0.16	0.3	£ 0.05	0.3	£ 0.05	0.3	£ 0.05	0.3	£ 0.05	0.3	£ 0.05	0.3	£ 0.05
Postage/packaging <sup>4</sup>	£ 0.89	0.24	£ 0.21	0.24	£ 0.21	0.24	£ 0.21	0.24	£ 0.21	1	£ 0.89	0.24	£ 0.21
Return envelope and postage <sup>4</sup>	£ 0.89	0.24	£ 0.21	0.24	£ 0.21	0.24	£ 0.21	0.24	£ 0.21	1	£ 0.89	0.24	£ 0.21
<b>Health promotion/Q&amp;A<sup>6</sup></b>													
Health professional-led discussion - blend of Community SRH staff (N2 to Doctor)	£ 1.06	6	£ 6.33	6	£ 6.33	6	£ 6.33	6	£ 6.33	6	£ 6.33	6	£ 6.33
KY lubricant	£ 0.30	2	£ 0.60	2	£ 0.60	2	£ 0.60	2	£ 0.60	2	£ 0.60	2	£ 0.60
STI literature	£ 0.06	3	£ 0.18	3	£ 0.18	3	£ 0.18	3	£ 0.18	3	£ 0.18	3	£ 0.18
Male condom	£ 0.06	10	£ 0.58	10	£ 0.58	10	£ 0.58	10	£ 0.58	10	£ 0.58	10	£ 0.58
<b>RETEST PROCESSED AND RESULTS GIVEN</b>													
<b>Pathology</b>													
Lab processing	£ 12.51	1	£ 12.51	1	£ 12.51	1	£ 12.51	1	£ 12.51	1	£ 12.51	1	£ 12.51
<b>Results management (retest negatives)</b>													
Nurse band 5/6	£ 0.75	6	£ 4.50	6	£ 4.50	6	£ 4.50	6	£ 4.50	6	£ 4.50	6	£ 4.50
Letter notification	£ 0.58	0.02	£ 0.01	0.02	£ 0.01	0.02	£ 0.01	0.02	£ 0.01	0.02	£ 0.01	0.02	£ 0.01
Phone call	£ 0.07	0.03	£ 0.00	0.03	£ 0.00	0.03	£ 0.00	0.03	£ 0.00	0.03	£ 0.00	0.03	£ 0.00
SMS text message	£ 0.10	0.95	£ 0.10	0.95	£ 0.10	0.95	£ 0.10	0.95	£ 0.10	0.95	£ 0.10	0.95	£ 0.10
<b>Results management (retest positives/equivocal)</b>													
Nurse band 5/6/7/8	£ 0.89	15	£ 13.38	15	£ 13.38	15	£ 13.38	15	£ 13.38	15	£ 13.38	15	£ 13.38
Letter notification	£ 0.58	0.05	£ 0.03	0.05	£ 0.03	0.05	£ 0.03	0.05	£ 0.03	0.05	£ 0.03	0.05	£ 0.03
Phone call	£ 0.07	0.05	£ 0.00	0.05	£ 0.00	0.05	£ 0.00	0.05	£ 0.00	0.05	£ 0.00	0.05	£ 0.00
SMS text message	£ 0.10	0.9	£ 0.09	0.9	£ 0.09	0.9	£ 0.09	0.9	£ 0.09	0.9	£ 0.09	0.9	£ 0.09
Treatment <sup>7</sup>	£ 1.80	1	£ 1.80	1	£ 1.80	1	£ 1.80	1	£ 1.80	1	£ 1.80	1	£ 1.80
<b>Follow-up call<sup>5</sup></b>													
Blend admin/clerical <sup>1,4</sup>	£ 0.53	5	£ 2.64	5	£ 2.64	5	£ 2.64	5	£ 2.64	5	£ 2.64	5	£ 2.64
Nurse band 5/6 <sup>2</sup>	£ 0.75	10	£ 7.50	10	£ 7.50	10	£ 7.50	10	£ 7.50	10	£ 7.50	10	£ 7.50
Phone call <sup>2</sup>	£ 0.07	3	£ 0.21	3	£ 0.21	3	£ 0.21	3	£ 0.21	3	£ 0.21	3	£ 0.21

Shaded entries were taken directly from the basic cost of a (first) chlamydia test<sup>[1]</sup> which is reproduced here under a Creative Commons licence:



All other costs are either amended costs from Pathway Analytics (see below for explanation), or costs added in.

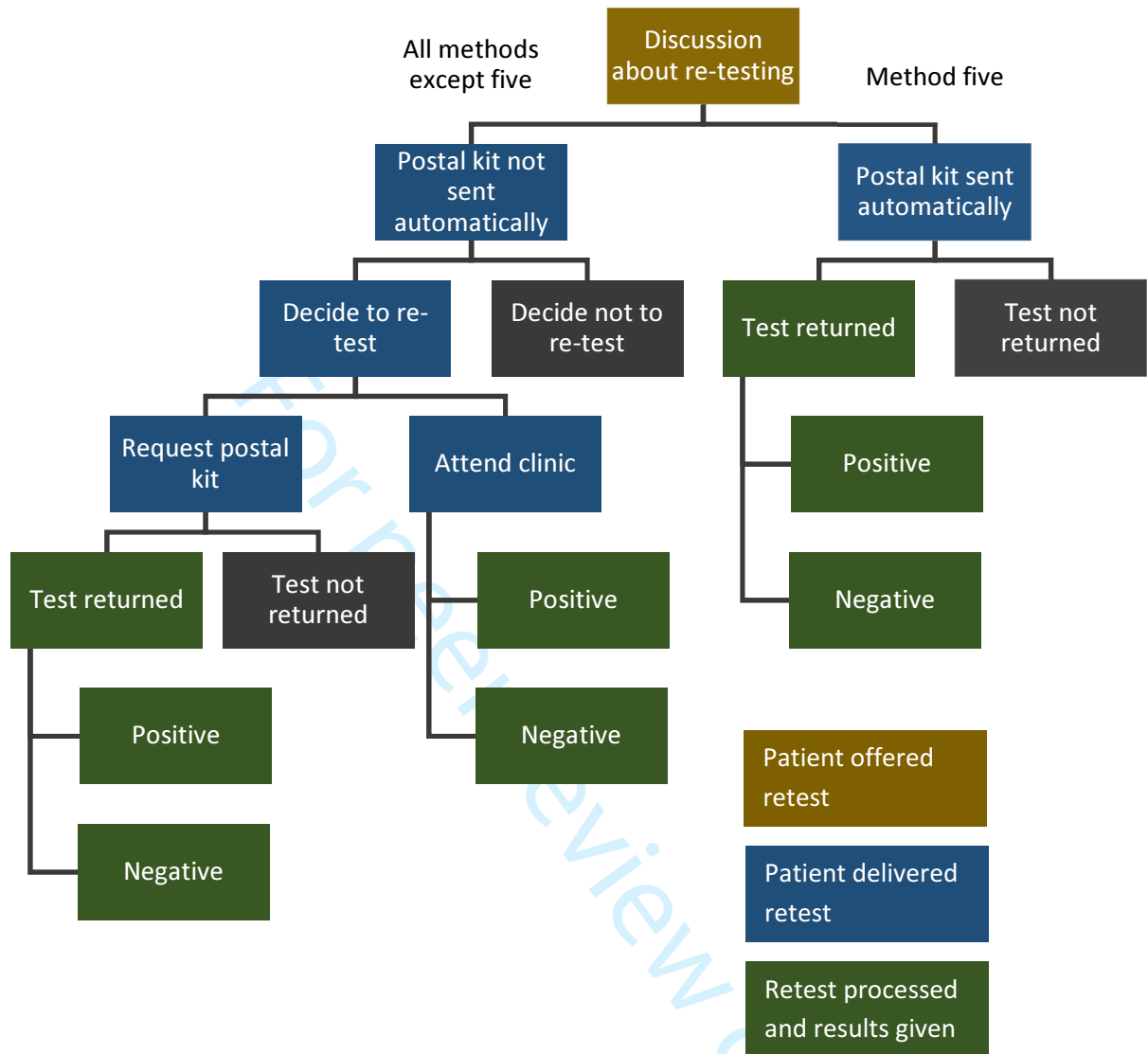
<sup>1</sup>Any contact at a distance with client further to the initial retest conversation is assumed to require 5 minutes of admin time to retrieve and update the client's details on a database. <sup>2</sup>A phone call is assumed to be 3 minutes in length but requiring 10 minutes of nurse time to accommodate chasing time. <sup>3</sup>Applicable to clinic retesting: these costs are removed entirely where retesting involves postal testing only, and reduced

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46

proportionally for the remaining recall methods to allow for some clients opting for postal retesting. <sup>4</sup>Applies to postal kits: includes postage to client's address and return postage<sup>[2]</sup>, and associated admin time for sending out a kit. <sup>5</sup>Positives only. <sup>6</sup>It is assumed that all clients will received these at some point including those opting for retesting by post. <sup>7</sup>4 x 250mg of azithromycin in tablet form<sup>[3]</sup>. VAT, dispensing costs and costs associated with a test for cure are not included. <sup>8</sup>Number of units for clinic vs postal testing kit costs obtained by multiplying base costs by the percentage using each.

For peer review only

Appendix Figure 1 Retesting pathway



Appendix Table 2 Parameter values

Parameter	Baseline value (10-14 weeks since treatment for first infection)		Sensitivity value (10-26 weeks since treatment for first infection)		Reference
Retest uptake (i.e., percentage of (first) positives who choose to accept retesting) (all methods except method five) <sup>1</sup>	1. Client-led	5%	1. Client-led	15%	NCSP audit report[4] and NCSP audit data provided by PHE
	2. Reminder card	4%	2. Reminder card	19%	
	3. SMS invitation	9%	3. SMS invitation	21%	
	4. Phone invitation	7%	4. Phone invitation	17%	
	6. Advice at follow-up & SMS	13%	6. Advice at follow-up & SMS	25%	
Percentage of those retesting who choose to attend a clinic for a retest (all methods except method five) <sup>2</sup>	76%		73%		NCSP audit data provided by PHE
Percentage of those retesting who choose to request a postal kit (all methods except method five)	=100-76% =24%		=100-73% =27%		
Postal test kit return rate (requested kits)	67%		67%		Retesting pilot[5]
Postal test kit return rate (kits sent out automatically; method five)	5. Automatic postal test kit	10%	5. Automatic postal test kit	23%	NCSP audit report[4] and NCSP audit data provided by PHE
Chlamydia retest positivity <sup>3</sup>	12%		16%		NCSP audit report[4] and NCSP audit data provided by PHE

<sup>1</sup>Obtained by fitting to overall retest rates from the audit (i.e., accounting for non-return of requested postal kits); <sup>2</sup>The audit only has data on percentage of *completed* retests obtained from clinic testing vs postal testing (for those instances where a kit was not sent out automatically), not percentage of those who opt for a retest at a clinic among *all* retesters (i.e., including all those who request a kit, some of whom do not return the kit); <sup>3</sup>Average over the six most commonly-used methods.

## References

1. Pathway Analytics: Pathway Prices for Integrated Sexual Health Tariffs 118. *T3 Chlamydia, gonorrhoea and syphilis tests* <https://www.pathwayanalytics.com/pathways/26-t3-chlamydia-gonorrhoea-syphilis-tests/118-t3-chlamydia-gonorrhoea-and-syphilis-tests> Accessed 2013.
2. Royal Mail: Get a price <http://www.royalmail.com/price-finder> Accessed 14/08/2015.
3. British National Formulary: Azithromycin <http://www.evidence.nhs.uk/formulary/bnf/current/5-infections/51-antibacterial-drugs/515-macrolides/azithromycin> Accessed 02/02/2016.
4. *Re-testing of those who tested positive for chlamydia: National audit report* [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/471585/NCSPre-testingauditfinalversion.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/471585/NCSPre-testingauditfinalversion.pdf) Accessed 13/09/2016.
5. Angel, G., et al., *An observational study to evaluate three pilot programmes of retesting chlamydia-positive individuals within 6 months in the South West of England*. BMJ Open, 2016. 5(10): p. e007455.

CHEERS checklist—Items to include when reporting economic evaluations of health interventions (BMJ 2013;346:f1049)

Section/item	Item No	Recommendation	Reported on page No/ line No
<b>Title and abstract</b>			
Title	1	Identify the study as an economic evaluation or use more specific terms such as “cost-effectiveness analysis”, and describe the interventions compared.	p1/line 1-3
Abstract	2	Provide a structured summary of objectives, perspective, setting, methods (including study design and inputs), results (including base case and uncertainty analyses), and conclusions.	p2
<b>Introduction</b>			
Background and objectives	3	Provide an explicit statement of the broader context for the study.	p3/line 67-73
		Present the study question and its relevance for health policy or practice decisions.	p3-4/line 89-96
<b>Methods</b>			
Target population and subgroups	4	Describe characteristics of the base case population and subgroups analysed, including why they were chosen.	N/A
Setting and location	5	State relevant aspects of the system(s) in which the decision(s) need(s) to be made.	p4/line 98
Study perspective	6	Describe the perspective of the study and relate this to the costs being evaluated.	p4/line 98-100
Comparators	7	Describe the interventions or strategies being compared and state why they were chosen.	p4/line 98-100

Section/item	Item No	Recommendation	Reported on page No/ line No
Time horizon	8	State the time horizon(s) over which costs and consequences are being evaluated and say why appropriate.	p4/line 98-102
Discount rate	9	Report the choice of discount rate(s) used for costs and outcomes and say why appropriate.	N/A
Choice of health outcomes	10	Describe what outcomes were used as the measure(s) of benefit in the evaluation and their relevance for the type of analysis performed.	N/A
Measurement of effectiveness	11a	<i>Single study-based estimates:</i> Describe fully the design features of the single effectiveness study and why the single study was a sufficient source of clinical effectiveness data.	N/A
	11b	<i>Synthesis-based estimates:</i> Describe fully the methods used for identification of included studies and synthesis of clinical effectiveness data.	N/A
Measurement and valuation of preference based outcomes	12	If applicable, describe the population and methods used to elicit preferences for outcomes.	N/A
Estimating resources and costs	13a	<i>Single study-based economic evaluation:</i> Describe approaches used to estimate resource use associated with the alternative interventions. Describe primary or secondary research methods for valuing each resource item in terms of its unit cost. Describe any adjustments made to approximate to opportunity costs.	p4/line 100-110 and Appendix Table 1
	13b	<i>Model-based economic evaluation:</i> Describe approaches and data sources used to estimate	N/A

Section/item	Item No	Recommendation	Reported on page No/ line No
		resource use associated with model health states. Describe primary or secondary research methods for valuing each resource item in terms of its unit cost. Describe any adjustments made to approximate to opportunity costs.	
Currency, price date, and conversion	14	Report the dates of the estimated resource quantities and unit costs. Describe methods for adjusting estimated unit costs to the year of reported costs if necessary. Describe methods for converting costs into a common currency base and the exchange rate.	pP4/line 100-102
Choice of model	15	Describe and give reasons for the specific type of decision-analytical model used. Providing a figure to show model structure is strongly recommended.	Appendix Figure 1
Assumptions	16	Describe all structural or other assumptions underpinning the decision-analytical model.	p4/line 104-121 and Appendix Table 2
Analytical methods	17	Describe all analytical methods supporting the evaluation. This could include methods for dealing with skewed, missing, or censored data; extrapolation methods; methods for pooling data; approaches to validate or make adjustments (such as half cycle corrections) to a model; and methods for handling population heterogeneity and uncertainty.	N/A
<b>Results</b>			
Study parameters	18	Report the values, ranges, references, and, if used, probability distributions for all parameters. Report reasons or sources for distributions used to represent	p4/line 104-121 and Appendix Table 2



Section/item	Item No	Recommendation	Reported on page No/ line No
		uncertainty where appropriate. Providing a table to show the input values is strongly recommended.	
Incremental costs and outcomes	19	For each intervention, report mean values for the main categories of estimated costs and outcomes of interest, as well as mean differences between the comparator groups. If applicable, report incremental cost-effectiveness ratios.	Table 1
Characterising uncertainty	20a	<i>Single study-based economic evaluation:</i> Describe the effects of sampling uncertainty for the estimated incremental cost and incremental effectiveness parameters, together with the impact of methodological assumptions (such as discount rate, study perspective).	N/A
	20b	<i>Model-based economic evaluation:</i> Describe the effects on the results of uncertainty for all input parameters, and uncertainty related to the structure of the model and assumptions.	Table 1
Characterising heterogeneity	21	If applicable, report differences in costs, outcomes, or cost-effectiveness that can be explained by variations between subgroups of patients with different baseline characteristics or other observed variability in effects that are not reducible by more information.	N/A
<b>Discussion</b>			
Study findings, limitations, generalisability, and current knowledge	22	Summarise key study findings and describe how they support the conclusions reached. Discuss limitations	p7-8

Section/item	Item No	Recommendation	Reported on page No/ line No
		and the generalisability of the findings and how the findings fit with current knowledge.	
<b>Other</b>			
Source of funding	23	Describe how the study was funded and the role of the funder in the identification, design, conduct and reporting of the analysis. Describe other non-monetary sources of support.	p9
Conflicts of interest	24	Describe any potential for conflict of interest of study contributors in accordance with journal policy. In the absence of a journal policy, we recommend authors comply with International Committee of Medical Journal Editors recommendations.	P8

For consistency, the CHEERS statement checklist format is based on the format of the CONSORT statement checklist

Review only

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46