HIV testing intervention development amongst MSM in the developed world

Flowers. P[1]., Estcourt, C[2]., Sonnenberg, P[3] and Burns, F[3,4].

Affiliations:

[1] Institute for Applied Health Research, Glasgow Caledonian University , Scotland, UK
[2] Blizard Institute, Barts and the London School of Medicine and Dentistry, Barts Sexual Health Centre, UK
[3] Research Department of Infection & Population Health, University College London, UK
[4] Royal Free London NHS Foundation Trust, UK

Corresponding author
Paul Flowers

Email: P.Flowers@gcu.ac.uk

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Abstract

HIV testing is a 'gateway' technology – enabling access to treatment and HIV prevention. Biomedical approaches to prevention, such as Pre-exposure prophylaxis (PrEP) and Treatment as prevention (TasP), require accurate and regular HIV test results. HIV testing also represents a powerful 'teachable moment' for behavioural prevention. An increasing range of HIV tests and the emergence of self-managed diagnostic technologies (e.g., self-testing) means there is now considerable diversification of when, where, how results are available to those who test. These changes have profound implications for intervention development and indeed health service redesign. This paper highlights the need for better ways of conceptualizing testing in order to capitalize on the health benefits that diverse HIV testing interventions will bring. We propose a multidimensional framework to capture on-going developments in HIV testing amongst MSM. We focus on the intersection of i) the growing variety of HIV testing technologies and the associated diversification of their pathways into care, ii) psychosocial insights into the behavioural domain of HIV testing, iii) better appreciation of population factors associated with heterogeneity and concomitant inequities. We propose that by considering these three aspects of HIV testing in parallel, it is possible to identify gaps, limitations and opportunities in future HIV testing-related interventions. Moreover, it is possible to explore and map how diverse interventions may work together having additive effects. We believe that only a holistic dynamic framework that captures the increasing complexity of HIV testing can deliver the maximum public health benefit of HIV testing for 2020.

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Background

We propose that HIV testing has become *the* central health technology for HIV prevention for both those testing positive and negative. Pre-exposure prophylaxis (PrEP) and wider treatment as prevention (TasP) highlight the growing challenges of understanding the relationship between condom-less sex and HIV transmission risk. The value of condom use as the primary focus of prevention and behavioural surveillance is rapidly diminishing particularly in countries where PrEP is available. We suggest that HIV testing now supersedes condom use as the behavioral focus of future HIV prevention interventions amongst MSM in the developed world. Testing presents a relatively future-proof 'common denominator' an ever-diversifying portfolio of prevention approaches implemented in different ways across national settings. HIV prevention approaches which rely on HIV testing range from PrEP (which requires accurate and regular HIV testing), across the cluster of behavioural interventions based around sero-status (including sero-sorting and partner notification interventions), to more psychological interventions in which testing may represent a 'teachable moment' (by using HIV status to galvanize the adoption and commitment to behavior change.[1] Wherever treatments are widely available, HIV incidence is likely to be driven by the undiagnosed fraction of people living with HIV and most HIV morbidity and mortality is increasingly associated with late diagnosis[2,3]. There is a growing need to recognize the central part HIV testing plays in diverse prevention interventions.

Because HIV testing sits at the nexus of a range of approaches to prevention and care it has been the focus of both increased international scrutiny [4,5,6] and product development win

74 the commercial sector. At its core, all HIV testing remains fundamentally concerned with
75 diagnosis (see Table 1 for an overview of the function of HIV testing). However, recent
76 innovations have focused on developing diversity in the processes that accompany this
77 central diagnostic function. Variations for example, in the ability to detect recently acquired
78 infections, who administers the test, how long to wait for the test results, the ways in which
79 test results are delivered and the combination of other tests which may accompany the HIV
80 test (e.g., tests for other sexually transmitted infections (STI) and blood borne viruses (BBV)).
81 Perhaps associated with the focus on HIV testing as a preventative technology, and in
82 relation to the economic context of HIV service delivery in much of the developed world,
83 there has also been a marked turn towards the self-management of HIV testing in recent
84 years, for example self-testing and self-sampling.
85
86 These approaches differ in that in self-testing the testee receives and interprets the result
87 themselves in minutes of testing themselves. In contrast, in self-sampling, the testee collects
88 their sample but then sends the kit away to another setting where a professional interprets
89 the results and contacts the testee with their test result some time later. This move to self-
90 managed testing has happened at the same time as a notable historical and cultural shifts in
91 both the economic context of much of the developed world and in the mediation of MSMs'
92 sexual cultures away from solely physical worlds to embrace intersections with the digital
93 world (e.g., the availability of the test through internet sites or mobile phone apps).[7] In this
94 way testing interventions in general, and self-managed testing interventions in particular,
95 are increasingly being delivered on-line and outwith traditional 'bricks and mortar' services.
96 In many national contexts, from the perspectives of those who are testing, direct contact
97 with health professionals administering the test or sharing test results is reducing.

Over the short history of the HIV epidemic many different disciplines have focused on HIV testing highlighting considerable behavioral, social and historical variation. Since effective antiretroviral therapies have become available, there has been a shift in thinking of the HIV test as a relatively infrequent, one-off event, perhaps confirming suspected HIV status, to ideas associated with the HIV treatment cascade and getting people living with HIV on treatment as quickly as possible to minimize harm to their immune system and reduce population viral load.[8] Equally, since the 'normalization' of HIV testing[9] there has been a change in considering those who test frequently, from being pathological 'repeat testers' (with pejorative associations and assumptions relating to on-going problematic behavior) to focusing more on the salutogenic aspects of those people who test regularly. People who test regularly minimize HIV transmission risk and their accurate test results scaffold biomedical approaches such as PrEP.

In light of these technological, social and historical changes and the profusion of technologies, choices, processes, and behaviors associated with HIV testing, we believe it is no longer useful to talk about HIV testing interventions or HIV testing policy in any unitary or simplistic fashion. There will be no single testing intervention that represents a panacea to the on-going problems of HIV prevention in any single population such as MSM. It is highly likely that multiple testing interventions, delivered simultaneously to different populations at different times may offer the most sustainable and effective ways of preventing HIV transmission. There is a growing need for clarity and shared language in thinking about HIV testing and to acknowledge the increasing heterogeneity of testing. We believe that in order to deliver the best of what HIV testing can offer to HIV prevention we need to understand

HIV testing in multidimensional ways that capture key differences in technology, behavioural domain and population. In this way it is possible to consider the tailoring and targeting of diverse HIV testing interventions enabling much better purchase on issues such as effectiveness and cost-effectiveness. In this way, further clarity regarding the heterogeneity of HIV testing interventions will enable us to develop cumulative knowledge and make more use of existing evidence.

Table 1 about here

The growing variety of HIV tests and the diversification of pathways into care

The first commercially available HIV test, an enzyme-linked immunosorbent assay (ELISA) test, entered the market in 1985. It was a blood-based test that often took two weeks before results were available. As no effective treatment existed all testing was accompanied by extensive pre and post-test counselling and was primarily conducted in the domain of HIV 'specialist centres' or blood banks. Although identifying primary HIV infection was not a prime focus then, the window period, the term given to the maximum time between HIV virus acquisition and the ability of the test to detect the infection, would have been three months. Since then the implications of a positive diagnosis have changed dramatically, and that, coupled with the expansion of testing modalities, has enabled HIV testing to move beyond the remit of specialists into the broader health community and finally directly into the control of the end user. Table 2 provides an overview of the increasingly diverse range of tests currently available and many of their key features. The first home testing kit was actually licensed in the USA in 1996. However scale up of testing beyond traditional health care settings has been evolving from solely being offered within traditional testing services,

146 to a wider range of settings (such as within community settings or sex on premises testing
147 sites). This trend of increasing testing sites has been further expanded following recognition
148 of the key role undiagnosed infection has in potentiating HIV transmission [10] and because
149 biomedical prevention interventions have been shown to be so effective. [8] International
150 findings suggest linkage to care may be influenced by site of diagnosis, with people testing
151 positive in community setting, as opposed to clinic and other formal health care settings,
152 being less likely to be linked into and retained in care.[11] In the UK, preliminary data from the
153 national self-sampling pilot does suggest that only 77.4% of people with reactive tests are
154 linked to care for confirmatory testing[12]. The relative benefit of these innovations (in that
155 they may reach new populations) is offset by higher attrition in the cascade of care. Equally
156 the psychological impact of living with an incorrectly assumed HIV positive status is unknown
157 and for positive people who do not start treatment there are on-going risks to their own
158 health and increased risks of onwards transmission.
159
160 Testing options accessible via the Internet may be cheaper to provide and from the testee's
161 perspective may avoid the need to access sexual health services which can be inconvenient
162 and stigma laden. Equally the use of any face-to-face testing service may raise fears around
163 confidentiality for some MSM who may not have disclosed their sexual conduct with other
164 men to a health care professional. Equally digital options to access testing will be avoided by
165 those who value the more holistic care received via face-to face interventions (see section
166 below). Service providers also value choice, and the range of testing modalities enables
167 provision of tests best suited to their practice and the presentation of individual cases. Point
168 of care tests are used routinely in sexual health services, however Primary Care clinicians
169 may feel they lack the infrastructure or service flexibility to manage the unexpected reactive

results and prefer instead methods where they have more control of when and how to deliver results. Currently in the UK, the only self-managed testing options on the market are 3rd generation tests which makes them less suitable for detecting recently acquired infections than fourth generation tests which are not available through self-managed routes. For MSM this current state of affairs limits the usefulness of self-testing in diagnosing very recent infection.

Table 2. around here

Psychosocial insights into the behavioural domain of HIV testing

There have been problems with attempts to synthesize evidence regarding the role of HIV testing in relation to risk behavior with inconsistent accounts of the relationship between testing and sexual behavior change. [13, 10] Arguably, these problems relate primarily to a lack of attention to the historical, social and psychological heterogeneity of HIV testing behaviours and a rather unitary focus on the test's diagnostic function. At the population level, in many counties, HIV testing has changed over time, with increases reported particularly amongst high-risk populations such as MSM.[14, 15] These trends reflect changes in the meaning of HIV testing for example in light of ART and PrEP. Currently, for example, people may seek HIV testing in order to access treatment for HIV infection, or conversely to access PrEP to avoid HIV infection. Equally, more psychologically, for the individual, across *their* life span and in relation to their sexual careers, HIV testing can mean very different things. Deeper understandings of the behavioural domains of HIV testing (e.g., the range of testing behaviours and their associated antecedents) and specificity in relation to measuring HIV testing (e.g., how often and for what reason) may enable more useful attempts to build cumulative knowledge in relation to HIV testing in order to develop new conceptual and analytic approaches to data analysis, evidence synthesis and future intervention development. In the sections below and within Table 3 we explore from a psychological perspective the importance of the psychosocial, technical and temporal context of HIV testing.

The psychosocial context of HIV testing behaviours

Understanding and responding to the psychosocial aspects of HIV testing is vital to develop a range of behavioural interventions in the future. In the UK for example on a population

level, HIV risk perception is low. Most people who perceive themselves as at risk of HIV have not recently tested, including MSM. [16] Population level social epidemiology regarding HV testing, with its focus on population means, fails to appraise the heterogeneity of testing from the perspectives of those seeking or indeed being offered a test. For the individual person seeking an HIV test there are differences in the meaning of HIV testing depending on their perception of the likelihood, and the implications of, a positive diagnosis for them at that time in their life. Fear of a positive test result remains a major barrier to seeking HIV testing and this is patterned by perceived likelihood of positive results[17]. Testing following a perceived risk event, for example, is considerably different from testing which is regular or habitual. It may present very different psychological processes than those that preceded an individual's previous HIV tests. Testing that was initiated by a health professional, for example, may have required little conscious thought or decision-making for the person getting tested. Increasing testing such as this can be achieved through interventions that focus upon increasing opportunities for these kinds of interactions. In contrast, following perceived risk events, interventions may be more effective if they focus on the deliberate, pro-active, reflective decision-making to seek, or to avoid, an HIV test (akin to 'opt-in' testing).

In this way even a superficial exploration of the psychosocial context of HIV testing behaviours highlights the need for diverse approaches to testing interventions in relationship to their target population (e.g., patient vs healthcare or community worker), their mechanism of action (e.g., capability approaches vs motivational approaches), anticipated positivity (e.g., high vs low), cost effectiveness (e.g., tolerance for high resource per test vs low) and the selection of testing technology according to the immediacy of

receiving test results (e.g., rapid vs slower pace) and the location in which a person prefers testing to take place (e.g., if it's a routine, expected-to-be-negative test, home testing may be appropriate but if positive results are expected, a person may well want to test where face to face support and access to holistic care is readily available).

Technological contexts of testing behaviour

As the previous section described, technological variation in HIV testing is growing. This brings with it increases in the choice of testing but also an increase in the scope and complexity of what the respective tests demand from both the testee and the test provider. Increasing choice of test is important as it relates to potential reductions in barriers to testing by increasing opportunities to test and enables the tailoring of different tests to specific psychosocial, cultural or service-provision contexts. We believe facilitating choice in tailoring testing technology represents a novel and viable locus of intervention development for MSM.

Interventions that focus upon choice and increasing opportunities to test must also address issues of capability as different tests demand different levels of skills, health literacy and in some national contexts material resources. With regard to self-managed tests, dry blood spot approaches demand a distinct behavioral repertoire (i.e. drawing and managing blood samples) when compared to those associated with tests that use saliva for example. Equally, online ordering of test kits to be delivered to the home requires a set of different skills, behaviours and resources than those needed to travel to a testing site, book appointments and interact with a health professional. The interplay of psychosocial issues with the demand dimensions of the range of testing technologies remains under explored, yet vital to

harnessing future HIV testing interventions. It also highlights the importance of attending to health, social and economic inequalities and the structural determinants of testing. The heterogeneity of health care contexts, and the varying accessibility of the range of testing approaches across national settings provide an interesting natural experimental design for monitoring choice-based testing interventions.

Temporal contexts

The historical nature of evidence concerning HIV testing interventions may limit its transferability to current contexts. However, we would argue it is also important to focus upon the temporal aspects of an individual and what could be termed their testing career. The utility of population-level testing surveillance will be increasingly compromised if the temporal dimensions of individual testing patterns are not adequately addressed. The effectiveness of ART in reducing transmission amongst those living with HIV and those who take PrEP has stressed the importance of considering the temporal dimensions of HIV testing in the life context. Only test results that accurately reflect recent infection, or lack of infection, are useful to enable these biomedical preventative approaches. Older ways of thinking about testing that centred on diagnosis and access to treatment alone increasingly limit our thinking of testing interventions. This vestigial thinking which focuses upon the dichotomy and durability of positive and negative test results, limits our insights into the undiagnosed fraction of positive people, especially in those who have had a previous negative HIV test result[18]. Measurement tools, data analysis, and lay understandings often continue to focus on the dichotomy of 'ever vs never' tested rather than focusing on testing rates amongst those at on-going risk. Equally studies which conflate recency of testing with regularity of testing obscure the focus on regular, time-bound, repeat testing as a key

behavioural goal necessary for fully utilizing HIV testing for 2020. A deeper understanding of the frequency of testing, or inter test intervals is required [19] to consolidate testing interventions for the future. Behavioural interventions must focus on specific aspects of the HIV testing domain (for example, in the UK targeting frequent self-sampling approaches amongst MSM at high risk (e.g., every 12 weeks) rather than annual testing through self-testing amongst the whole MSM population).

Table 3 around here

Population factors: the heterogeneity of the MSM population and associated inequities

Social epidemiology tends to aggregate groups of people at the population level, for example, in the UK 'MSM' vs 'Black African' as two primary populations at most risk of HIV. However, an appreciation of the heterogeneity of the MSM population in relation to HIV testing, across a range of dimensions, may lead to effective targeting of limited resources. As evidence of effectiveness of testing interventions develops, sub-population specificity, or concerns about transferability in the MSM population should be systematically highlighted. This 'granular' understanding of the MSM population would enable consideration of a range of simultaneous testing interventions each addressing specific sub-populations, this enables consideration of developing testing interventions in relation to inequalities and the social determinants of testing. Such a pluralistic approach to understanding MSM and diverse testing interventions may ensure that testing interventions do not amplify health inequities in the MSM population as a whole. Instead a range of acceptable and effective testing interventions could be available which can be tailored via user preference, capability and sub-population specificity. Considerations of population segmentation highlight the stratification of effectiveness and cost-effectiveness. In as much as what works for one group of men (e.g., those that use the internet and phone apps regularly) may not work for others (MSM in rural communities with no 4G coverage), or indeed for the MSM population as a whole (e.g., social marketing or mass media approaches [20]). Furthermore, sub-population segmentation illuminates cost effectiveness in relation to those that can only be reached by particularly expensive interventions.

306

307 *Focus on barriers to testing*

308 Barriers to testing represent a key way of considering population specificity. Amongst those
309 who can acknowledge their vulnerability to HIV infection, grouping individuals according to
310 their perceived barriers to testing can enable a useful and tailored repertoire of testing
311 interventions. Targeting motivation-based testing interventions which focus on persuading
312 those who are fearful of testing need to be distinct from opportunity-based interventions
313 which target people who wish to seek testing but struggle to utilize current testing provision
314 for example. Equally, where testing is readily available, not testing may also relate to a failure
315 to recognize risk exposure[16] thus highlighting the need for educational approaches delivered
316 to the whole population for example. These different intervention targets demand
317 interventions with different mechanisms of action and different modes of delivery.

318

319 *Lifespan perspectives*

320 Key differences exist in relation to testing with regard to a persons' life context. These are
321 reflected the international literature demonstrating strong positive correlations between
322 age and testing[21]. Irrespective of perceived risk, testing for the first time may be associated
323 with increased anxiety when compared to repeat, habitual or routine testing later within
324 sexual careers (e.g., as a necessary precursor to accessing PrEP). These lifespan perspectives
325 may offer purchase to designing particular interventions for particular groups, for example,
326 considering targeted interventions for young MSM that fostered routine testing behaviours
327 (including HIV) coupled with HPV vaccination for example or a focus on MSM in
328 relationships[22]

329

330 *Health and digital literacy*

331 Many of the preceding sections have touched on issues relating to health literacy, for
332 example, the ability to recognize prior or potential risk through an understanding of the
333 sometimes-complex factors associated with HIV transmission. Addressing issues of health
334 literacy is likely to be of fundamental importance to consolidating the opportunities available
335 for HIV testing interventions[23] Equally, the various testing technologies available present a
336 range of user demands differentially requiring degrees of literacy, numeracy and manual
337 dexterity. Moreover, as some of the self-managed tests lend themselves to digital
338 distribution it is important to acknowledge that whilst this approach removed barriers for
339 some (those seeking to test in rural areas with little alternative testing provision for example)
340 it may create barriers for others[24]. Such approaches necessitate a viable Internet connection
341 and assume material and technical resources in order to be effective. In this way, even at a
342 rural population level, whilst on-line self-testing interventions may prove a pragmatic and
343 effective way of increasing testing they are likely to so do only in a specific sub-population
344 (those with digital literacy a particular level of material and technological resources). They
345 may poorly serve those who may need HIV testing most.

346

347 *Intersectionality, syndemics and social vulnerability*

348 Finally, it is important to consider the specificity of sub-populations by traditional socio-
349 demographic features and their intersections. The particular vulnerabilities of black and
350 minority ethinic MSM are well documented in some national contexts [25, 26, 27, 28] Yet how
351 these vulnerabilities intersect with other important markers such as age and poverty are not
352 well documented. Equally, the relationship between vulnerabilities and testing technology
353 and the behavioural domain of HIV testing remain under explored to date.

354

355 Table 4 around here

356

357 **Discussion**

358 If we are to maximize the individual and public health benefits presented by HIV testing
359 interventions we must think beyond the HIV test's diagnostic function and consider the
360 technological, psychosocial and sociocultural contexts of HIV testing. The increasing
361 diversification of the tests available demand systematic consideration of the right test for
362 particular circumstances and particular sub-populations and recognize that over time the
363 same person may well require different testing methods & settings. This multidimensional
364 understanding of HIV testing will be important for patient preference, yet scaled up, it is
365 equally important for considering the distribution of resources to support intervention
366 design and indeed to make the most of available evidence detailing the effectiveness of
367 testing intervention.

368

369 There is a danger that by not grasping the complexity of HIV testing and harnessing its
370 emerging pluralities, that we only reach the low hanging fruit; designing, evaluating and
371 implementing testing interventions that work for limited groups of people but do not impact
372 on the actual drivers of HIV transmission. There is a concern that if we only invest in one or
373 two testing interventions and remove others, we may not impact on HIV incidence and
374 indeed we may be doing harm. For example, investing solely in interventions that work for
375 urban gay men who use the internet may systematically fail to provide testing interventions
376 for men with low levels of health and digital literacy; amplifying health inequities. Embracing
377 the complexity and plurality of testing interventions, leads to the development of a
378 programmatic and systemic approach to HIV testing interventions. Subsequent research

379 questions focus on how best to use available evidence from specific interventions with clear
380 population parameters, and how best to offer combinations of a range of interventions
381 concurrently.
382
383 In Table 5 we summarise the key dimensions of HIV testing that we have identified within
384 the paper; these are not exhaustive. We hope that these will prove useful in retrospectively
385 considering the ways we describe HIV testing interventions and their effectiveness in order
386 to build useful knowledge for future service provision through evidence synthesis. Moreover,
387 we think these dimensions may also be useful for considering new ways of conceptualizing
388 future interventions and understanding the opportunities and limitations of current
389 interventions. We believe that better interventions can be developed and described if we
390 engage with this level of specificity, for example, rather than describing 'internet delivered
391 testing interventions' we can suggest 'using self tests to target those mid-sexual career men
392 who are seeking to test because of on-going risk behavior and who live in areas well served
393 by internet connections'. This is useful because it helps consolidate an evidence base but
394 also because it indicates who is likely to be excluded from engaging with the specified
395 intervention and encourages us to think about who may require alternative interventions.
396 For example, a complementary intervention may be needed that uses point of care testing
397 in primary care and targets those who are in need of persuasive interventions to test in
398 response to a 'one off' perceived high risk event or those who lack the material or
399 psychological resources to use an HIV self test kit. The dimensions facilitate an understanding
400 of the differences in the economic, legislative and cultural context of nations, states, or
401 provinces that also constrain the possible parameters of these dimensions.

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