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Digital interventions for STI and HIV partner notification: a scoping review

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► Additional supplemental material is published online only. To view, please visit the journal online (https://doi.org/10.1136/sextrans-2023-056097).

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Received 20 December 2023
Accepted 21 April 2024
Published Online First
16 May 2024

To cite: Woodward C, Bloch S, McInnes-Dean A, *et al*. *Sex Transm Infect* 2024;**100**:242–250.

ABSTRACT

Background Partner notification (PN) is key to the control of sexually transmitted infections (STIs) and human immunodeficiency virus (HIV). Digital interventions have been used to facilitate PN. A scoping review was conducted to describe the interventions used, user preferences and acceptability of digital PN interventions from patient and partner perspectives.

Methods A systematic literature search was conducted of eight databases for articles published in English, available online with digital PN outcome data. Articles were assessed using the Mixed Methods Appraisal Tool. Quantitative and qualitative data were synthesised and analysed using thematic analysis.

Results Twenty-six articles met the eligibility criteria. Articles were heterogeneous in quality and design, with the majority using quantitative methods. Nine articles focused solely on bacterial STIs (five on syphilis; four on chlamydia), one on HIV, two on syphilis and HIV, and 14 included multiple STIs, of which 13 included HIV. There has been a shift over time from digital PN interventions solely focusing on notifying partners, to interventions including elements of partner management, such as facilitation of partner testing and treatment, or sharing of STI test results (between index patients and tested sex partners). Main outcomes measured were number of partners notified (13 articles), partner testing/consultation (eight articles) and treatment (five articles). Relationship type and STI type appeared to affect digital PN preferences for index patients with digital methods preferred for casual rather than established partner types. Generally, partners preferred face-to-face PN.

Conclusion Digital PN to date mainly focuses on notifying partners rather than comprehensive partner management. Despite an overall preference for face-to-face PN with partners, digital PN could play a useful role in improving outcomes for certain partner types and infections. Further research needs to understand the impact of digital PN interventions on specific PN outcomes, their effectiveness for different infections and include health economic evaluations.

KEY MESSAGES

What is already known on this topic:
⇒ PN is potentially advantageous in reaching partners not currently reached by traditional PN but may continue to be used as a secondary option where face-to-face PN is available

What this study adds:
⇒ Digital partner notification (PN) is a poorly defined concept, which includes various digital interventions for notifying partners, facilitating partner testing and/or supporting partner treatment (comprehensive partner management).
⇒ Most current digital PN focuses on notification rather than comprehensive partner management.

How this study might affect research, practice or policy:
⇒ Existing evidence suggests that digital PN could increase the number of partners notified but robust evidence of effectiveness is lacking.
⇒ Studies are needed to determine how best to use digital PN within a wider menu of PN options, which include in-person approaches.

INTRODUCTION

Partner notification (PN), also known as contact tracing, is a complex intervention involving contacting, testing and sometimes treating partners of people with diagnosed sexually transmitted infections (STIs) including HIV.[1 2] PN is an important strategy for identifying asymptomatic infection in people at risk of STIs. This can prevent adverse health consequences through early treatment of infection and can be an opportunity for the provision of prevention interventions, such as vaccinations, HIV pre- and post-exposure prophylaxis as well as behavioural interventions and health counselling.[3 4]

The two main types of PN are (1) patient referral, where the index patient informs their sexual partner/s about the infection and advises them to access testing and treatment[2] and (2) provider referral, where a healthcare professional (HCP) informs the sexual partner/s about the infection and facilitates testing and treatment. Provider referral often anonymises the index patient's identity.[5]

Digital technologies could improve the effectiveness and efficiency of PN by reducing the time to notify partners, such as through short message service (SMS), email or instant messaging. If combined with remote self-sampling for STI and HIV testing,[6] digital interventions could also facilitate partner testing and treatment access via electronic prescriptions or vouchers. Since 2007, improved access to mobile internet[7] makes digital

Box 1 Inclusion and exclusion criteria

Inclusion criteria
⇒ Full-text available online.
⇒ Available in English.
⇒ Digital partner notification and/or management.
⇒ Patient or provider initiated.
⇒ Outcome data for digital partner notification (PN) (including hypothetical).
⇒ Peer-reviewed articles.

Exclusion criteria
⇒ Type of digital PN intervention not specified.
⇒ Non-digital PN.
⇒ Telephone call PN where this was the only digital PN intervention offered.
⇒ Data collected prior to 2010.

health interventions feasible across many settings and could improve PN outcomes.[8]

Although several digital PN technologies have been evaluated,[9–11] there are no published reviews systematically synthesising findings from the peer-reviewed evidence base, across multiple health systems, and including STIs and HIV. To inform the design of a novel online STI PN and comprehensive partner management system, we conducted a scoping review to: (1) summarise the types of digital PN technologies used and describe the study designs; (2) describe the outcomes measured; (3) to understand the acceptability of and (4) preferences for digital PN in comparison to non-digital PN for index patients and partners.

METHODS

Design

A systematic scoping review was conducted, as the nature and content of available literature suggested considerable heterogeneity of study design and outcomes assessed. The review is reported in accordance with the Preferred Reporting Items for Systematic Review and Meta-analysis extension for Scoping Reviews guidelines (online supplemental appendix A).[12]

Eligibility

As digital health is a developing field, broad inclusion criteria were set to ensure all relevant articles were sourced, including hypothetical preference studies (see box 1). Digital PN was defined as PN occurring through SMS, emails, purpose-built PN websites, smartphone apps and websites for geosocial networking (GSN)/dating/social networking/instant messaging and online sexual health clinics. When used for the purposes of PN, this paper will refer to these technologies as digital interventions. There was a step change in digital technology and internet access from 2007, with the introduction of smartphones, and as there is a lag between the introduction, uptake and evaluation of interventions utilising these technologies, articles that collected data from January 2010 were reviewed.

Search strategy

A systematic search and data extraction were conducted on three occasions (4 March 2021, 3 December 2021 and 27 July 2023), across eight databases: CINAHL Plus, Cochrane Library, Embase, Medline, NHS Evidence, PsycINFO, Scopus and Web of Science. Additional papers were sourced via an institutional database, Google Scholar and manual reference list searching. Detailed search terms are listed in online supplemental appendix B.

Source selection

Search results were exported to Endnote and duplicates were removed. Titles and abstracts were screened, and full-texts were assessed for eligibility. The screening of the articles was led by one person (CW, SB, AM-D) and was done in conjunction with the research team (JG, KCL, JS). Where there was uncertainty, full-texts were reviewed by at least one other member of the team and consensus was reached through discussion. A data extraction table was used to summarise study characteristics, the digital PN intervention, study design and outcomes. Findings were organised into themes describing acceptability of and preferences for digital PN in comparison to non-digital PN.

Appraisal and analysis

Articles were appraised by CW using the Mixed Methods Appraisal Tool (MMAT),[13] which accounts for study heterogeneity (online supplemental appendix C). Quantitative and qualitative data were synthesised and analysed thematically using an inductive approach, where themes were iteratively defined and refined throughout the analysis.

RESULTS

Search results

In total, 146 articles were identified (144 from database searches and 2 through other sources). Full-text review was conducted on 42 articles, of which 14 met eligibility criteria and were retained for analysis (figure 1).[14] An additional 11 articles were identified in the second search and one additional article in the third search. Tables 1–3 summarise study characteristics. Studies were grouped into implemented digital PN interventions (including pilot interventions), hypothetical and a mixture of implemented and hypothetical interventions.

Overview of included studies and types of digital intervention used

Nineteen of 26 studies were quantitative,[15–33] including one randomised controlled trial (RCT),[21] four were qualitative[34–37] and three were mixed methods studies.[38–40] Most explored established interventions (13/26),[16 21–26 28–30 32 38 39] nine explored hypothetical interventions,[15–19 35–37 40] five explored a mixture of implemented PN and hypothetical interventions,[20 27 31 33 34] detailed in tables 1–3 and online supplemental appendix C. The majority explored digital PN methods designed for use by the index patient (21/26).[15–23 25 27 30–32 34–38 40] In five US-based studies,[24 26 28 29 39] PN is delivered by disease investigation specialists (DIS), who receive reports of new infections (infection type varies depending on the local regulations), interview the index patient and contact any reported partners. When reviewed with the MMAT,[13] the majority of the studies sourced were of a good standard (online supplemental appendix C). A minority displayed multiple methodological weaknesses that may have biased their results.[28 36 39]

There was heterogeneity in the type of digital intervention proposed or used. The interventions included SMS, purpose built PN websites, purpose built PN apps, email, internet, GSN apps/websites, or PNs and treatment integrated within an online sexual health clinic. Some studies explored multiple interventions. There was little consensus on how digital PN was defined. This review distinguished internet PN from PN websites, where PN websites are purpose-built online PN websites, which triggers the sending of PN via various communication methods, such as

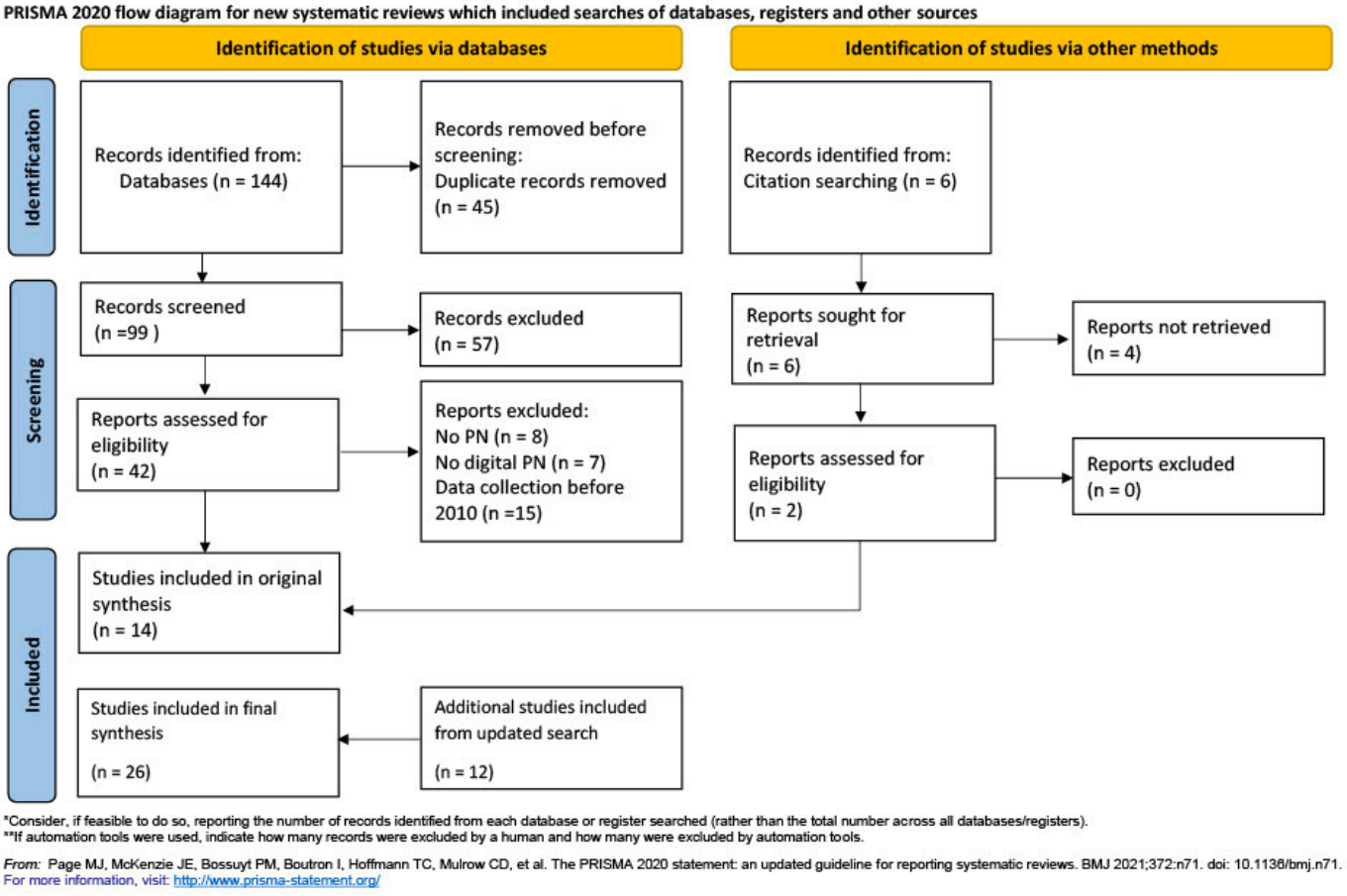

Figure 1 Adapted PRISMA diagram. PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

email and SMS. Many studies refer to multiple internet-based technologies under the same category of 'internet PN'. Some studies did not define internet PN.

Although one study mentioned that digital PN could be more cost-effective than traditional methods of PN,[25] no studies included economic evaluations.

Outcome measures used

Half the studies (13/26) measured the number of partners notified[15 17 21–26 29–32 39]; of these three used index patient-reported data.[15 17 21] Of these, 10/13 also included partner-related outcomes.[21–24 26 28–30 32 39] Of the 10/13 including partner outcomes, 8/10 reported on partner testing (sometimes only including reports of new infections[24 39]) or consultations[21 23 24 26 28–30 39] and 6/10 on partner treatment.[21 22 24 26 32 39]

In addition to evaluating interventions against partner outcomes, some of the digital interventions included facilitation of partner services. In 6/26 studies, the digital intervention facilitated partner evaluation/testing.[18 23 26 29 34 39] Partner treatment was facilitated via the digital intervention for 2/26 studies.[22 32]

Digital PN acceptability

Results are presented as integrated quantitative and qualitative findings. Quotes have been selected to illustrate the key themes being described. Acceptability of digital PN was assessed in 13/26 articles.[15–20 27 31 33–35 37 40] For index patients, themes of privacy and confidentiality concerns[34–36 40] and fear of misuse[34 35 40] were identified.

Privacy and confidentiality concerns

Qualitative hypothetical studies reported that privacy concerns may affect the acceptability of digital PN.[34–36 40] Discussing a hypothetical smartphone (native) app for HIV/syphilis PN, caution when sharing results was identified as a theme, where one participant said: *[Y]ou know people's always trying to get into your phones or your apps or stuff like that, stuff goes in the wrong hands…*[40] An exploratory qualitative study with 49 smartphone owners suggested that the notifications remain within the PN mobile app and a secure log-in be required for greater privacy.[36]

Fear of misuse/malicious use

Three hypothetical qualitative studies reported concerns about potential misuse[34 35 40] and four concerning verifying PN message authenticity.[17 34 35 40] Safeguards to ensure authenticity was identified as a theme: *It would need to be some kind of thing that's hard to fake …How do I know you didn't just cut and paste this from someone else?*[40] This was also supported by a study reviewing a prototype app providing HIV and syphilis testing and results sharing.[34] Authenticity concerns extended to health department profiles: *It could be a fake profile out trying to scare people*.[35]

Preferences for digital PN

Several factors seemed to influence index patient preferences for different types of digital PN intervention, and for use of digital versus non-digital PN interventions. These included relationship

Table 1 Summary of implemented interventions

Author(s), year country	Participants, design, infections	Study aim	Digital PN intervention	Outcomes measured				
				Partners notified	Partners tested	Partners treated	Acceptability	Other
Clark *et al*[21] Peru	N= 370 ► MSM with symptomatic primary or secondary syphilis Quantitative randomised controlled trial Syphilis infections	Evaluate two PN technologies (web-based PN and referral cards) and their effect on notification outcomes	Web application 'inspot.org'	✓	✓	✓		
Estcourt *et al*[22] UK	N= 221 ► 116 from genitourinary clinics ► 105 from NCSP online postal testing service Quantitative non-randomised study Chlamydia infections	Assess the safety, feasibility and potential of an eSexual health clinic	eSexual health clinic/ web application	✓		✓		
Götz *et al*[23] Netherlands	N=2295 ► Diagnosed with an STI in one of two clinics ► 1184 web-application codes, with 988 linked to index patient records Quantitative descriptive study ► Pilot Multiple STIs including HIV	Pilot of 'suggetatest.nl' to evaluate use and partner response linked to clinical data	Web application 'suggestatest.nl' (requires a log in code generated from the STI clinic)	✓	✓			
Guy *et al*[38] Australia	N=164 ► Family planning doctors and nurses involved in chlamydia management in non-government clinics Mixed-methods study ► Survey and focus groups Chlamydia infections	Evaluate PN practices of family planning clinicians following a patient's chlamydia diagnosis and assess how often patients are referred to the PN website	Web application 'Let Them Know' ► Anonymous ► SMS, email or letter					HCP perspective
Hightow-Weidman *et al*[24] USA	N=524 ► 362 internet PN 2011-2012 ► 133 internet PN 2010 ► 29 SMS PN Quantitative non-randomised study Syphilis and HIV infections	Service evaluation comparing PN outcomes from PN using closed and open email systems, internet PN and a pilot SMS PN	Internet and SMS	✓	✓*	✓		DIS initiated
Htaik *et al*[25] Australia	N=148,256 ► Web application users between 2011 and 2019 Quantitative descriptive study Multiple STIs excluding HIV	Determine the number of messages sent on 'Let Them Know' and whether this improved PN	Web application 'Let Them Know' ► SMS	✓				
Hunter *et al*[39] USA	N=55 ► Individuals identified in a syphilis infection cluster Mixed-methods study ► Anecdotal reports Syphilis infections	Describe the experience of using Facebook as a complementary approach to traditional PN methods	Facebook ► Investigate ► PN ► Elicit partners	✓	✓*	✓		DIS initiated
Mobley *et al*[26] USA	N=3414 ► MSM with early syphilis Quantitative non-randomised study Syphilis infections	Assess the association of PN and use of internet-based applications for meeting sex partners	Internet app	✓	✓	✓		DIS initiated
Pennise *et al*[28] USA	N=97 ► MSM within a multi-infection investigation Quantitative non-randomised study Multiple STIs including HIV	Describe a multi-infection STI investigation and how the use of smartphone technologies assisted	Smartphone app GSN app	✓	✓			DIS initiated
Udeagu *et al*[29] USA	N=3319 ► Partners receiving HIV PN Quantitative non-randomised study HIV infections	Compare internet and SMS PN with traditional PN outcomes to guide	Internet and SMS	✓	✓			DIS initiated
Van Aar *et al*[30] Netherlands	N=105 ► MSM who are newly diagnosed with an STI/ HIV, reporting 612 partners at risk Quantitative descriptive study ► Pilot Multiple STIs including HIV	Assess current PN practices, effectiveness and determinants of being notified among MSM	Internet	✓	✓			
Willetts, Cowper & Cameron[32] UK	N=168 ► Partner issues a voucher from a chlamydia positive partner Quantitative descriptive study Chlamydia infections	Evaluate the use of a novel electronic voucher treatment service	Electronic prescription voucher	✓		✓		

*Reports on positive cases or number of partners with unknown status.
†Index patient perspective.
‡Both Index patient and partner perspectives.
DIS, disease investigation specialist; GSN, geosocial networking; HCP, healthcare professional; MSM, men who have sex with men; NCSP, National Chlamydia Screening Program; PN, partner notification; SMS, short message service; STIs, sexually transmitted infections.

Table 2 Summary of mixed implemented and hypothetical interventions

Author(s) country	Participants, design, infections	Study aim	Digital PN intervention	Outcomes measured				
				Partners notified	Partners tested	Partners treated	Acceptability	Prototype preferences
Balán *et al*[34] USA	N=60 ► HIV negative MSM or TGW ► Excludes PrEP users Qualitative study ► Interviews and focus groups Mini pilot ► N=9 participant pilot Syphilis and HIV infection	Develop a SMARTtest app to facilitate HIV and syphilis self and partner testing. Explores components wanted in an application and uses user feedback to incorporate and mini pilot the app.	Smartphone app 'SMARTtest' ► Self and partner testing ► PN				✓*	✓
Mokgatle *et al*[33] South Africa	N=1616 ► University students ► Out of school youth Quantitative descriptive study ► Survey Multiple STIs including HIV	Investigate preferred PN methods	SMS				✓*	
Mokgatle *et al*[27] South Africa	N=918 ► University students Quantitative descriptive study ► Survey Multiple STIs including HIV	Explore preferences for SMS PN sending and receiving, including when sent from a doctor	SMS				✓*	
Van Rooijen *et al*[20] Netherlands[20]	N=112 ► Newly diagnosed with STI ► N=163 partners receiving online PN Quantitative descriptive study Multiple STIs including HIV	Evaluate the acceptability and usability of a PN website from the perspective of the index patient and partners who have experience in using it	Web application 'suggestatest.nl'				✓†	
Wang *et al*[31] China[31]	N=372 ► MSM attending an STI clinic Quantitative descriptive study Syphilis infection	Examine willingness and preferences for PN among MSM to measure feasibility and optimise uptake	Email and QQ/MSN messenger				✓†	

*Index patient perspective.
†Both index patient and partner perspectives.
‡Reports on positive cases or number of partners with unknown status.
MSM, men who have sex with men; NCSP, National Chlamydia Screening Program; PN, partner notification; PrEP, pre-exposure prophylaxis; SMS, short message service; STIs, sexually transmitted infections; TGW, transgender women.

type, availability of partner contact details and infection type. Additional factors specific to anonymous PN were also identified.

Relationship type

Multiple studies found a preference for face-to-face PN across all partner types,[15 31 33 41] while others reported different preferences depending on partner type.[15 16 35] One hypothetical preference study reviewing different PN methods found 96% (1110/1158) participants reported preferences for face-to-face or phone PN for stable partners compared with 75% (853/1116) for casual partners (p<0.001).[15] Relationship type similarly affected HIV PN; 96% (946/1012) of participants were more likely to use face-to-face PN with stable partners compared with 80% (743/953) for casual partners.[15] This study reported a statistically significant difference (p<0.001) between casual and stable partners for all six digital PN interventions (table 1), across STIs including HIV.[15] A survey assessed the acceptability and potential uptake of a PN website (referred to as internet PN in this study) in 397 men who have sex with men (MSM) and transgender women (TGW) with recent diagnosis of HIV and/or an STI. Participants reported that they would use a PN website for partners who would be unlikely to be notified with existing interventions.[16] Improvements in anticipated PN were greater for casual and commercial partners compared with main partners.[16]

These findings were supported by qualitative interview data around hypothetical scenarios for sending and receiving digital notifications from health departments. One study found that PN methods would depend on the relationship type: *I think I would almost prefer that [app-based PN from a health department] over in person for the stranger who I've hooked up with, but if I had been seeing a few people consistently, I think I would say it face-to-face to them.*[35]

Lack of partner contact details

Preferences for PN methods may be affected by the contact details available to the index patient. Lack of contact details was reported as the main reason for not notifying partners.[15 31] Similarly, 57% of 791 MSM who had met a partner on a GSN app reported deleting the app in the past year, removing the ability to be contacted through the app.[17]

Infection type

Multiple studies explored hypothetical patient-led HIV PN[15–17 19 20 27 35 40] and this was implemented in three studies in the Netherlands.[20 23 30] A hypothetical study of 397 MSM and TGW found no significant difference in anticipated PN through a PN website for HIV compared with other STIs.[16] In addition, no statistically significant differences were found in the use of digital PN between STI/HIV during a pilot study offering PN through a website (p=0.14).[23] HIV PN in this study was provider referral.[23] A study of an implemented digital PN intervention found that digital PN for HIV was rated significantly less acceptable than for other STIs (p<0.001). However, the study was limited by low numbers of participants with HIV (4/112) or notified of an HIV exposure (3/120).[20]

Table 3 Summary of hypothetical interventions

Author(s) country	Participants, design, infections	Study aim	Digital PN intervention	Outcomes measured					
				Partners notified	Partners tested	Partners treated	Acceptability	Prototype preferences	Other
Carnicer-Pont *et al*[15] Spain	N=1337 ► MSM Quantitative descriptive study ► Survey Multiple STIs/HIV	Describe current PN practices and assess the intention to use new information and communication technologies for notifying partners of STIs/HIV	Hypothetical web application	✓			✓*	✓	
Clark *et al*[16] Peru	N=397 ► MSM and TGW with a partner diagnosed with syphilis, genital herpes, genital ulcer disease, proctitis and/or urethritis in the last 30 days Quantitative descriptive study ► Survey Multiple STIs including HIV	Assess acceptability of internet PN interventions in MSM and TGW who'd recently been diagnosed with an STI	Internet				✓*		
Contesse *et al*[35] USA[35]	N=28 ► Cisgender MSM who have used GSN apps to meet a partner in the last 12 months Qualitative ► Four focus groups Multiple STIs including HIV	Examine how MSM use GNS apps and their perspective regarding delivery of HIV/STI PN and health services through these apps	GSN app				✓†	✓	
Contesse *et al*[17] USA	N=791 ► MSM who have met a partner on a GSN app in the last year Quantitative descriptive study ► Online survey Multiple STIs including HIV	Understand attitudes toward app-based PN, health department presence and sexual health services help inform delivery and development of GSN app	GSN app	✓			✓†	✓	
Gkatzidou *et al*[36] UK	N=49 ► 16–24 years old who own a mobile phone Qualitative study ► Nine focus groups Chlamydia	Understand the requirements and acceptability of an eSTI mobile application	Mobile app ► Self-testing ► Results ► Access to treatment ► PN					✓	
John *et al*[18] USA	N=786 ► Gay and bisexual men who self-tested HIV negative Quantitative descriptive study ► Survey Multiple bacterial STIs including HIV	Determine willingness to use HIV self-testing (HIVST), use PDPT and to use GSN app PN after a hypothetical bacterial STI diagnosis	GSN app				✓†		
Kutner *et al*[40] USA	N=59 ► HIV negative MSM and TGW with concurrent sexual partners with three or more episodes of condomless anal sex in the last three months Mixed-methods ► Survey and interview HIV and syphilis infections	Explore the interest in disclosing test results through a smartphone app dedicated to self- and partner testing for HIV/syphilis	Smartphone app ► Partner screening ► Sharing of results				✓*	✓	
Lessard *et al*[37] France	N=40 ► 21 PrEP users ► 10 community mediators ► 5 PrEP prescribers ► 4 HIV/STI management decision-makers Qualitative ► Focus groups and interviews Multiple STIs including HIV	Describe stakeholders' perspectives on the acceptability of a digital smartphone STI PN tool (WeFLASH)	Smartphone app 'WeFLASH' ► STI screening reminders ► Automatic anonymous PN (with connected app users)				✓‡	✓	HCP and decision-maker perspective
Mokgatle and Madiba[19] South Africa	N=722 ► Minibus taxi drivers Quantitative descriptive study ► Survey Multiple STIs including HIV	Assess the perceived use of patient-initiated PN by using referral slips and measure the level of acceptability of provider-initiated PN by using SMS to the personal mobile phones of sexual partners	SMS				✓*		

*Index patient perspective.
†Both Index patient and partner perspectives.
‡HCP/decision-maker perspective.
§Reports on positive cases or number of partners with unknown status.
GSN, geosocial networking; HCP, healthcare professional; HIVST, HIV self-testing; MSM, men who have sex with men; NCSP, National Chlamydia Screening Program; PDPT, patient delivered partner therapy; PN, partner notification; PrEP, pre-exposure prophylaxis; SMS, short message service; STIs, sexually transmitted infections; TGW, transgender women.

Anonymous notification (index patient and partner findings)

Four hypothetical studies[15 17 35 37] and one pilot study[23] reviewed index patient preferences for anonymous PN. A study of 1337 MSM participants reported that 81% of participants would prefer an anonymous PN option.[15] In one qualitative study, participants described the benefits of an app facilitating anonymous PN; *It is not easy to talk about STIs…with certain people*, another participant stated *[…] I think that if someone slept with only one guy, if one has an infection, then it is sure that it comes from the other. So it is more difficult to notify*.[37] Another qualitative study noted similar benefits in their findings: *Being anonymous might encourage the guy [partner] to reveal it [his HIV/STI diagnosis]*.[35] In contrast, hypothetical acceptability of app-based PN found that while 74% of 791 MSM participants were comfortable using anonymous PN, only 24% reported preference for using this method.[17] Similarly, in a pilot study where 988/1717 index patients accepted a code for a PN website, 88% (444/505) of notifications were non-anonymous.[23]

Contrastingly, hypothetical studies exploring partner views on anonymous PN reported that non-anonymous PN was significantly preferred ($p<0.001$).[20] Lack of trust in anonymous digital PN affected decisions around accessing care. Conversely, a survey of 786 HIV-negative MSM reported 92.5% of participants reported that they would obtain counselling if anonymously notified about STI/HIV exposure, 92.8% would engage in HIVST and 93.4% would obtain treatment for a bacterial STI.[18] However, in a pilot study of 505 partners notified via a PN website (444/505 anonymously notified), only 20% attended the study clinics, with no significant difference across STIs ($p=0.5$).[23]

As an alternative to anonymous PN initiated by index patients, one hypothetical study in 791 MSM compared testing intentions after receiving anonymous app-based notification for STIs and HIV versus health department notification of an exposure via a dating app. Participants reported they were more likely to test whether the message came from the health department (95%) rather than in-app anonymous messaging (85%).[17] Qualitative data findings concluded mixed views with some hypothetically preferring health department PN; *A health department has some credibility rather than an anonymous person who may or may not be real*. Whereas another participant reported privacy concerns with this method; *I wouldn't want to hear it from the health department here. Everyone knows everyone. This is a small town Tennessee*.[35]

Sex partner PN preferences

Acceptability from partner perspective was explored in seven studies.[17 18 27 31 35 40 42] The majority focused on acceptability of receiving digital PN, while a minority explored hypothetical intention to seek counselling/testing or treatment.[17 18 31] In a quantitative study exploring hypothetical scenarios, 70% of 791 participants reported a preference for notification directly by their partner's GSN profile (the index patient).[17] A survey evaluating hypothetical preference found 52.7% (435/826) of partners reported a preference for face-to-face PN, compared with 31.7% (262/826) preferring SMS and 15.6% (129/826) PN slip, a paper notification from the health provider.[27]

Despite generally preferring to be notified non-digitally, a hypothetical study found 95% of participants reported they would get tested if notified by health department notification via dating/hook-up apps and 85% if notified by an anonymous in-app message.[17] Similar intention to test, regardless of PN method, was concluded among participants in a qualitative hypothetical study: *[Getting tested] is the most logical thing to do. If you have an entity telling you that you may have been exposed to something, are you willing to take the risk that it is false?*[35] In contrast, results from an implemented DIS initiated HIV PN found that participants were more likely to test if they received phone or post-PN (referred to as traditional PN), with 69% of participants (805/1175) testing after traditional PN compared with 34% (31/92) using internet-based contact information for PN: email, GSN application names or profiles (internet PN) and 45% (105/233) with SMS PN.[29]

DISCUSSION

This paper is the first to systematically synthesise findings related to digital PN across STI and HIV service delivery systems. This review updates and expands previous reviews of digital PN, which were limited by the available literature, poor generalisability[10 11] and weaker search strategy methods.[9] Included studies were heterogeneous and mainly conducted in high-income countries. Many hypothetical preference studies were found. Digital PN was a poorly defined concept, covering a wide range of interventions including SMS, email, purpose-built PN websites and apps, with anonymous and index patient identifiable PN options. Most studies focused (and reported outcomes) on enhancing notification of partners about their risk of STIs/HIV and partner acceptability of receiving this notification, with fewer studying partner testing and treatment. Additionally, the majority of partner-related outcome data were sourced from provider-led PN, specifically DIS in the USA.

Few studies considered partner perspectives or outcomes on index patient-initiated PN. Many studies included hypothetical preference designs, which may not translate into real-world choices. Indeed, there was a contrast in findings between hypothetical PN interventions and implemented interventions in the type of PN used. Few studies separated digital PN for bacterial STIs from HIV PN, which is conducted differently in many healthcare settings.[3]

In general, index patients preferred face-to-face PN,[15 31 41] but might choose digital PN for casual partners[15 16 21 35] and particular infections.[16 20] However, a lack of partner contact details guided the choice by reducing feasible options.[17 19 41] Two studies concluded that digital PN was preferable from a partner perspective[17 27] and two studies suggested that an anonymous function would increase PN rates.[15 42] Nevertheless, anonymous PN was not preferred by partners.[17 20] Few studies reviewed differences in partners' intention to seek consultation/testing following different PN types.[17 18] For HIV PN,[15–20 23 24 27–30 34 35 40 42] acceptability and uptake of digital interventions were inconclusive; a single study showed no statistically significant differences in use of the digital PN intervention versus other options.[23]

Overall, the finding that digital PN is potentially advantageous in reaching partners not currently reached by traditional PN but may continue to be used as a secondary option where face-to-face PN is available, is consistent with the conclusions from a previous review.[9] As reported in previous reviews,[10 11] the evidence base has continued to report improved PN success with HCP/DIS-initiated PN, where digital PN is mostly used when traditional methods are not available. This review adds that available contact information may influence partner-initiated PN as well. Anonymous notification was not preferred by partners,[17 20] however the effect on partner outcomes remains unclear. This finding is consistent with a previous review,[9] despite the increase in acceptability studies. A novel finding in this review is that privacy concerns and fear of misuse of digital PN are important

influencers of digital PN acceptability. The lack of standard definitions for digital PN, such as internet PN, and partner types and the limited descriptions of the digital interventions provided, made comparisons between studies challenging in this and previous reviews.

Strengths and weaknesses

This study uses robust methodology to review a disparate evidence base.[13] Findings could assist countries grappling with STI control and those seeking to achieve HIV transmission elimination.[3 4] To our knowledge, this is the first systematic scoping review of digital PN for STIs including HIV, in diverse population groups, from any healthcare and income setting, However, the literature on which this review is based remains limited. Restricting the search strategy to articles written in English and available online may have excluded useful studies.

Future interventions

Although digital PN is acceptable and may be preferable in certain circumstances, most reported interventions focused solely on notification did not offer facilitation of sex partner management and did not assess sex partner or health economic outcomes.[22 24 39] As with non-digital PN, choices and outcomes may be more related to partner type than demographics and/or sexual behaviours.[43]

Index patient and sex partner acceptability and preferences for different types of PN both digital and non-digital did not always overlap. Hypothetical acceptability suggested that anonymous PN would increase PN rates. However, anonymous notification was not preferred by partners[17 20] and, therefore, might not increase partner testing or treatment, partly due to legitimacy concerns. This highlights the importance of considering both index patient and partner perspectives when providing PN services.

Blended interventions with both digital and non-digital components might increase acceptability for a wide range of partner types, for example, index patients could inform their established partners in person and then link them to digital interventions to help them access testing and treatment, such as electronic treatment vouchers[32] and prescriptions[22] or providing clinic information and the ability to share results directly to clinicians.[34] Whilst digital interventions may improve accessibility and effectiveness of interventions, integrating these with preventative services is necessary.

Future research

A standard classification of partner types would help determine which PN methods work best for whom.[44] A common set of PN outcome measures would enable more robust comparison of outcomes between studies.[45] This level of understanding will be essential to inform optimal partner management in 'high stakes' bacterial infections such as multidrug resistant *Neisseria gonorrhoeae*, and *Mycoplasma genitalium*, where partner management and intensity of PN effort may vary depending on partner characteristics.

Internet PN should be clearly defined to be inclusive of different technologies used to enable comparison of the associated strengths, weaknesses and acceptability.

The place of digital PN in HIV PN is unclear. The appropriateness of digital interventions could vary substantially across countries, reflecting factors such as HIV criminalisation.[45] Future research is needed to assess the suitability of digital PN interventions across different settings.

A cost-effectiveness analysis of digital PN is required, particularly when digital PN is used in combination with traditional services.

CONCLUSIONS

Although index patients and their sex partners expressed an overall preference for non-digital (face-to-face) PN, digital PN interventions could play a useful role in improving PN and partner outcomes for one-off or casual partners and for bacterial STIs rather than HIV. To improve PN outcomes more broadly, digital PN should be offered as part of a menu of options, which include interventions which may require tailoring to different partner types and to different infections (bacterial infections as compared with HIV). Current digital PN interventions could be enhanced to incorporate sex partner testing, sharing of results with prospective partners, reminders for vaccines/screening and linkage to sexual health services. However, to understand how best to provide digital PN, high-quality evidence is needed from prospective studies of implemented digital PN interventions, which consider multiple perspectives (index patient, HCP, partner), include health economic evaluations and provide detailed descriptions of the PN interventions studied.

Handling editor Laith J Abu-Raddad

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Contributors CW conducted the original scoping review to fulfil the requirements of CW's masters dissertation, supervised by JG and KCL. JG, KCL and CW conceived of the original idea. CW, JG and KCL contributed to the design of the review. The screening of the first search was conducted by CW in conjunction with JG and KCL. The screening of the second search was conducted by SB in conjunction with CW, JG, and KCL. The screening of the third search was conducted by AM-D in conjunction with JG. Additional articles found in the second search were screened by SB, CW and JS. The original article review and data analysis were led by CW, with contribution from KCL and JG. The updated article review and data analysis were led by CW, with contribution from SB, AM-D and JG. All authors have made significant contributions to the drafting and revising of the article, and have approved the final version. JG is the guarantor.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests CSE and JG report receiving NIHR funding to research digital sexual health (NIHR129157 (JG) and NIHR200856 (CSE, JG)). CSE is an associate editor and JG is on the Editorial Board for STI journal. No other conflicts to declare.

Patient consent for publication Not applicable.

Ethics approval Not applicable.

Provenance and peer review Not commissioned; externally peer-reviewed.

Data availability statement Data sharing not applicable as no datasets generated and/or analysed for this study.

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