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Evidence Check

General practice engagement: STI, HIV and viral hepatitis care

An Evidence Check rapid review brokered by the Sax Institute for the NSW Ministry of Health—June 2023

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This report was prepared by: Jane Goller, Stephanie Munari, Cassandra Caddy, Teralynn Ludwick, Jacqueline Coombe, Meredith Temple-Smith, Lena Sanci, Jane Hocking. University of Melbourne.

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Executive summary

Background

General practice is a key setting in Australia for the testing and treatment of sexually transmitted infections (STIs), HIV and viral hepatitis (hepatitis B (HBV) and hepatitis C (HCV)). Early detection and timely treatment are vital to reduce transmission and prevent progression to adverse sequelae. Barriers to STI, HIV, HBV and HCV screening in general practice are well established. Facilitating general practitioners (GPs) to engage in screening where appropriate is an important aspect of the management of these infections. However, general practice is facing unprecedented hardships, including significant workload burden, workforce burnout, administrative burdens and inadequate remuneration for services provided. Initiatives aimed at general practice to improve testing and management **must** be cognisant of these ongoing challenges.

Purpose

This Evidence Check, commissioned by the NSW Ministry of Health, aims to identify effective initiatives that engage and support the general practice setting and workforce in NSW to increase testing for STI, HIV, HBV and HCV. A further aim is to identify the effectiveness of modifications to the practice management software (termed electronic medical record (EMR) throughout) in increasing GP engagement in screening and care for these conditions.

Evidence Check questions

Question 1: What types of change initiatives (including new/ innovative/ emerging initiatives) targeting the general practice setting and workforce have been shown to be most effective and sustainable in increasing testing for STI, HIV, hepatitis B and C **and comparable conditions** for priority patient populations?

Question 2: What is the evidence for the effectiveness of modifications to practice management software in increasing GP engagement in preventive screening activities for all aspects of care for STI, HIV and hepatitis B and C (prevention, testing, treatment and care) and for preventive screening activities for other comparable conditions?

Methods

The research team conducted a rapid literature review. We used a systematic search of peer-reviewed articles in MEDLINE, CINAHL, CENTRAL (Cochrane) and Embase databases plus a targeted grey literature search of key organisation websites to identify relevant articles for each question. The search targeted STI, HIV, HBV and HCV primarily, but also human papillomavirus (HPV) and diabetes mellitus as comparable conditions. Given the large volume of articles, we limited the analysis to articles published within the past five years and countries with similar health systems to Australia (see Methods and Appendices). We assessed the quality of studies using the National Health and Medical Research Council (NHMRC) Level of Evidence framework. Data extracted from included articles covered study characteristics, description of change initiatives, EMR modification and outcomes (impact on testing uptake and sustainability of testing uptake).

Key findings

Overall, 62 articles were deemed relevant; 50 for Question 1 (42 focused on STI, HIV, HCV and HBV, eight focused on HPV or diabetes mellitus) and 26 for Question 2 (21 focused on STI, HIV, HCV and HBV, and five focused on diabetes mellitus or mental health) (fourteen on both questions). Most studies were conducted in the US, followed by Australia. Most used quantitative methods and three-quarters provided evidence from non-randomised studies. For Question 1, most studies focused on STIs and for Question 2 most on HCV. A summary of change initiatives and an assessment of their effectiveness and sustainability is provided in Table 1.

Question 1: Change initiatives to improve STI, HIV, HBV and HCV testing

We identified a wide range of change initiatives. Most (n=38) targeted the **GP workforce** through provider education (n=12), quality improvement (audit and feedback) (n=19) and use of financial incentives (n=8); or the **general practice setting** (n=47) by targeting clinic workflow and efficiency through streamlined clinic processes (n=13) and innovative testing methods (n=8), or involved EMR modifications (n=24). Eight reported on **innovative models of care** (nurse-led n=5, hub-and-spoke n=1) or **service-level funding** (n=2) and nine involved strategies to increase patient engagement such as by creating lesbian, gay, bisexual, trans, intersex and queer (LGBTIQ+) welcoming spaces. Many studies (n=25) reported on multiple initiatives (e.g. provider education, quality improvement, streamlined processes, EMR alerts). Included studies assessed the impact on testing over time periods ranging from four months to four years.

Increased testing was observed with most initiatives; overall increases ranged from 4.9%–85% for HIV and STIs and by 3–4-fold for the cumulative proportion of patients ever tested for HBV and HCV. The quality of evidence was mixed. For most studies it was not possible to establish a direct association between a single initiative and its impact on testing and many studies did not have a control group or control time period, with only 16 randomised controlled trials (RCTs). Reported testing outcomes were also not directly comparable between many studies. The available evidence suggested the most effective initiatives were multifaceted and targeted both the **GP workforce** and the **general practice setting**, with several also involving **innovative models of care**. Nurse-led

models for HIV and STI testing were acceptable to patients and increased testing by 85% in a UK study. A large cluster RCT in Australian general practice showed quality improvement (audit and feedback) was more effective in sustaining GP engagement in chlamydia testing than financial incentives, but sustainability of change decreased with increasing trial duration. Brief education activities offered in isolation from other initiatives were acceptable to providers but had a limited impact on testing. Evidence for innovative testing methods was mixed: i) specimen self-collection (STI, HPV) was acceptable to patients; ii) point-of-care (STI) or rapid testing (HIV) reduced consultation time; iii) point-of-care STI testing reduced time to treatment in remote primary health services caring for largely Aboriginal patients (76% of the intervention group was treated in seven days vs. 47% for standard care); and iv) a government-funded hub-and-spoke model for sexual healthcare in Australian general practice (n=3 clinics) increased STI testing over one year (average monthly increase of 11 chlamydia, 11 gonorrhoea, four syphilis and six HIV tests). The most effective initiative for increasing testing for HPV was self-collected specimens.

Question 2: EMR modifications to improve care

Most EMR modifications involved testing alerts (n=20) that were often used with other initiatives such as quality improvement, provider education and opt-out testing. Positive effects on testing were reported over four to 24 months. Multifaceted initiatives that included EMR alerts appeared to have a greater impact. Alerts for **HCV screening** of specific birth cohorts (n=12) were largely effective and for **HBV screening** of high-prevalence populations (n=4) showed modest increases. EMR alerts were effective in increasing aged-based **HIV screening** and opt-out **STI testing** among US adolescents and comprehensive STI testing among Australian men who have sex with men (MSM). EMR alerts appeared to help reduce STI testing inequities and supported HCV and diabetes care. Clinician response to **EMR alerts** declined over time in some studies.

Eight studies (HCV=2, HBV=1, STI=2, diabetes or mental health=3) involved clinical decision support systems (CDSS) that integrated resources (testing protocols, orders, patient fact sheets, follow-up plans, audit and feedback reports) to support testing and care. There was limited evidence for the impact of CDSS on HBV and HCV testing and clinician engagement was poor to moderate. CDSSs for STIs (one with inbuilt audit and feedback) had substantial impacts on STI testing (>two-fold increase) for adolescents and MSM. CDSSs for mental health and/or diabetes demonstrated improved treatment and quality of life outcomes. Two studies provided evidence of the potential for natural language processing (NLP), a method that extracts information from the EMR clinical notes to identify patients for testing or care. NLP supported improved HIV risk assessment and identification of mental illness.

Multifaceted initiatives that target the knowledge and capacity of the general practice workforce and **improved workflow efficiencies** within the clinic setting are most effective at increasing testing for STI, HIV, HBV and HCV in general practice.

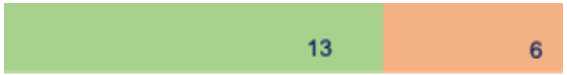
Any initiative must be cognisant of the general practice setting and priority population groups.

Conclusions

Initiatives that appeared to offer the most benefit to increasing STI, HIV, HBV or HCV screening in primary care included a mix of provider education or quality improvement that was complemented by clinic-level initiatives that helped identify and engage at-risk patients in testing (e.g. EMR alerts, self-collected specimens, nurse-led testing, a welcoming environment). Models of care that increased the role of nurses or linkages to specialist support offered a mechanism to expand testing opportunities and build capacity in busy general practice environments and were acceptable to patients. There was limited evidence about the sustainability of change initiatives and most studies did not involve randomisation. The quality of evidence is mixed, with few RCTs highlighting the ongoing need for further well designed research.

Australian general practice is facing unprecedented hardships including workload burden and inadequate remuneration. While such factors are largely beyond the influence of NSW Health, initiatives aimed at general practice must be cognisant of these challenges and engage GPs in their design and delivery. Initiatives should complement the general practice workflow and help to streamline testing, particularly for priority populations. EMR alerts with integrated resources (such as guidelines or patient fact sheets) can help support GPs to discuss testing in an unrelated consultation. Provider education and quality improvement can act synergistically with other initiatives to identify new testing opportunities and evaluate the impact of change initiatives.

Table 1—Summary of change initiatives and their impact on testing and/or management

Level	Initiative type	HBV	HCV	HIV	STI	HPV	DM	Proportion of studies and impact (n)
GP	**Provider education** n=12	n=3	n=3	n=4	n=2	n=2	n=1	
	Largely offered with other initiatives (e.g. quality improvement, updated clinic processes, EMR alerts) that were mostly associated with modest to substantial increases in testing but with limited evidence for sustainability. Brief education initiatives offered in isolation had a limited impact on testing.							
	Quality improvement n=19	n=2	n=2	n=4	n=10	n=3	n=2	
	Associated with modest to substantial increases or reduced declines in testing over 6–12 months. When reported, audit and feedback was more effective in sustaining GP engagement in testing than financial incentives.							
	Financial incentives n=8	n=1	n=1	n=1	n=5	n=1	NA	
	Financial incentives were less effective than audit and feedback and small financial incentives offered little value.							
Practice	**Streamlining clinic processes** n=13	n=1	n=2	NA	n=8	n=2	n=1	
	A range of initiatives (e.g. opt-out testing, computer-assisted self-interviews, confidential booking and appointments, patient-held reminder cards) demonstrated moderate to substantial increases in testing. Often used alongside education, quality improvement and patient engagement initiatives.							

Level	Initiative type	HBV	HCV	HIV	STI	HPV	DM	Proportion of studies and impact (n)
	Risk stratified test invitation n=1	n=1	n=1	NA	NA	NA	NA	
	Public health service initiative inviting patients to attend their GPs for HBV or HCV testing, with moderate uptake. Unsuited to low-prevalence countries.							
	Innovative testing methods n=8	NA	NA	n=1	n=5	n=2	NA	
	Evidence was mixed and largely included self-collected specimens, which demonstrated good acceptability to patients. Point-of-care testing reduced consultation time and time to treatment. Rapid on-site and postal testing shortened notification times and decreased the mean cost per episode.							
	Increasing patient engagement n=9	NA	n=3	n=1	n=5	n=1	NA	
	Financial incentives to patients were a key motivating factor to increase testing. Mailed invitation letters with pathology forms and patient reminders largely resulted in improved testing.							
	EMR modification: alerts n=20^	n=4	n=12	n=2	n=4	NA	n=1	
	Alerts for specific birth cohorts were largely effective in increasing HCV and HIV testing, and for specific population groups for HBV testing there were modest increases. Declines in HCV and HBV positivity occurred with some testing increases. Multifaceted initiatives with EMR alerts appeared to have a greater impact. STI testing alerts increased opt-out testing. Some evidence for reduced STI testing inequities and for supporting HCV and diabetes care.							
	EMR modification: CDSS n=8	n=1	n=2	NA	n=2	NA	n=3#	

Level	Initiative type	HBV	HCV	HIV	STI	HPV	DM	Proportion of studies and impact (n)
	There was limited evidence for the impact of CDSS on HBV and HCV testing and clinician engagement was poor to moderate. CDSSs for STIs (one with inbuilt audit and feedback) had substantial effects on testing rates (two-fold increases) for adolescents or comprehensive testing in MSM. CDSSs for mental health and/or diabetes provided diagnosis and care advice and demonstrated improved treatment and quality of life outcomes.							
System	**Models of care** n=9	NA	n=1	n=2	n=3	n=2	n=2	
	Models involving non-medical practitioners (nurses, outreach workers) that included education or updated work processes resulted in increased testing.							
	Service level funding n=2	NA	NA	NA	n=2	NA	NA	
	State government funded hub-and-spoke model for sexual healthcare in general practice with specialist support increased STI testing over one year.							

HBV = hepatitis B virus, HCV = hepatitis C virus, HIV = human immunodeficiency virus, STI = sexually transmitted infections, HPV = human papillomavirus, DM = diabetes mellitus, EMR = electronic medical record, CDSS = clinical decision support system, MSM = men who have sex with men.
GP-level initiatives focused on GP knowledge, willingness and confidence; practice-level initiatives focused on workflow and efficiency; system-level initiatives focused on models of care and service-level funding.
= showed an increase in testing and/or management, = equivocal or did not report a change in testing and/or management, = showed a decrease in testing and/or management.
^ Total does not equal the sum for each disease as some studies focused on more than one condition.
# Of the three studies, one focused on diabetes, one focused on diabetes and mental health and one focused on mental health.

Background

General practice is a key setting in Australia for the testing and treatment of sexually transmitted infections (STIs), HIV and viral hepatitis (hepatitis B (HBV) and hepatitis C (HCV)). Early detection and timely treatment are vital to prevent progression to adverse sequelae. The past decade (2012–21) has seen substantial declines in notification rates for HIV, HBV and HCV.[1] Availability and uptake of pre-exposure prophylaxis (PrEP), direct-acting antivirals (DAAs) for HCV, and HBV vaccination have and can continue to play an important role in furthering such declines. At the same time, however, STI notification rates for chlamydia, gonorrhoea and infectious syphilis have increased or remained high.[1-3] Notably, some priority populations experience significantly higher rates of many of these infections, including Aboriginal and Torres Strait Islander (hereby referred to as Aboriginal) people and gay and bisexual men.[1-3]

Barriers to STI, HIV, HBV and HCV screening in general practice are well established and include time and workload constraints, lack of knowledge and capacity, misperceptions that patients are not receptive to discussing testing in an unrelated consultation, and patient knowledge.[4-7] These barriers are compounded for priority populations, including Aboriginal people and people from the LGBTIQ+ community who report stigma and poor patient–provider relationships.[8, 9]

Facilitating and supporting general practice to engage in screening where appropriate is an important component of STI, HIV, HBV and HCV management and is a priority under the NSW Health HIV, STI and hepatitis B and C strategies. However, general practice is facing unprecedented hardships, including significant workload burden, burnout among a significant portion of the workforce, substantial administrative burdens and inadequate remuneration for services provided.[10] The COVID-19 pandemic has only compounded these issues. Additionally, a significant shortage of general practitioners (GPs) is expected in the next decade.[11] Thus, any initiative aimed at general practice **must** be cognisant of these ongoing challenges.

In its recent HIV, STI and hepatitis B and C strategies, NSW Health cites regular testing and innovative testing interventions as key components of the overall goal to reduce the burden of these conditions in the NSW population. The stated aim of this Evidence Check is to identify effective initiatives that engage and support the general practice setting and workforce in NSW to increase testing for STI, HIV, HBV and HCV. A further aim is to identify the effectiveness of modifications to practice management software (termed electronic medical record (EMR) throughout) in increasing GP engagement in screening and care for STI, HIV, HBV and HCV.

Methods

Evidence Check questions

In response to the questions set out by NSW Health, we conducted a rapid review to identify effective change initiatives targeted at the general practice setting and workforce, to engage and support NSW general practice to increase testing for STI, HIV, HBV and HCV.

Question 1
What types of change initiatives (including new/ innovative/ emerging initiatives) targeting the general practice setting and workforce have been shown to be most effective and sustainable in increasing testing for STI, HIV, hepatitis B and C **and comparable conditions** for priority patient populations?

Question 2
What is the evidence for the effectiveness of modifications to practice management software in increasing GP engagement in preventive screening activities for all aspects of care for STI, HIV and hepatitis B and C (prevention, testing, treatment and care) and for preventive screening activities for other comparable conditions?

Search strategy

We conducted separate searches for each question and included sets of terms related to: i) the GP setting; ii) health conditions of interest; iii) change initiatives focused on testing uptake; iv) initiatives targeting the GP, practice and systems levels; and v) countries with comparable health systems to Australia (New Zealand, UK, Canada, Sweden, Norway, Denmark, the Netherlands). The US was also included given it is the source of much research on this topic. For Question 2, we also included terms related to the EMR and management. Comparable conditions for Question 1 included diabetes and human papillomavirus (HPV) and for Question 2 included diabetes, HPV and mental health.

The search strategy was run in four databases (MEDLINE, CINAHL, CENTRAL and Embase) for peer-reviewed English-language publications in the past 10[1] years. We also conducted a grey literature search of websites of key organisations for evaluations and reports of relevant initiatives. The full search strategy and inclusion criteria are presented in Appendices 1 and 2.

[1] The initial search strategy generated a larger volume of articles than anticipated. To reduce the volume for full review, the time frame for inclusion was reduced to five years.

Study selection and data extraction

Articles for Questions 1 and 2 were uploaded as discrete searches in Covidence Review Software and subject to two stages of review. First, two reviewers screened the title and abstract of each article. Second, one reviewer screened the full texts of articles deemed relevant. Disagreements about inclusion were resolved by team discussion. We extracted data for both questions into an Excel spreadsheet, including study characteristics, description of change initiative, EMR modification and outcomes. Priority populations as outlined in the NSW Health HIV, STI and HBV and HCV strategies were noted, including Aboriginal people, men who have sex with men, pregnant people, sex workers, LGBTIQ+ people, people from culturally and linguistically diverse (CALD) backgrounds, people living with HIV, people who inject drugs or people in custodial settings.

Data synthesis

For Question 1, we categorised change initiatives by initiative type under three broad levels, synthesising the data for the effectiveness, sustainability, barriers and enablers of initiatives.

i. **GP knowledge, willingness and confidence**—*includes provider education[2], quality improvement[3] and financial incentives*

ii. **Workflow and efficiency**—*includes streamlining clinic processes, EMR modifications, risk-stratified invitations sent by a public health service, innovative testing methods and increasing patient engagement*

iii. **Structural interventions**—*includes models of care and service-level funding.*

Outcomes of interest were:

i) Testing uptake assessed as the impact of the initiative on testing uptake

ii) Sustainability assessed as the time frame over which the impact of test uptake was assessed.

For Question 2, we categorised EMR modifications as:

i. **EMR prompts**—*an alert or prompt within the EMR that is based on identifying patients meeting specific criteria, for example, aged-based screening guidelines*

ii. **Clinical decision support**—*a digital tool integrated within the EMR that supports decision making through providing access to guidelines and consumer information within the clinical workflow*

iii. **Natural language processing**—*use of computers to extract information from clinical notes in the EMR.*

[2] The term provider education encompasses education and training for primary care clinicians.
[3] The term quality improvement refers to initiatives aimed at improving the safety, effectiveness and experience of patient care and encompasses activities such as audit and feedback.

Quality appraisal

The level of evidence for each quantitative study was assessed using the National Health and Medical Research Council (NHMRC) Levels of Evidence hierarchy (see Table 3). One member of the review team conducted the quality appraisal, with team discussion as needed.

Findings

In total, 50 articles were included for Question 1 and 26 for Question 2 (fourteen studies for both questions). The PRISMA diagrams of included studies are presented in Appendix 3. Table 2, below, summarises the characteristics of the included studies. Detailed descriptions of included studies, change initiatives and findings are presented in Appendix 4.

Table 2—Summary of characteristics of included studies

	Question 1[1] **n=50 (100%)**	**Question 2[2]** **n= 26 (100%)**
Publication type		
Research paper	48 (96%)	25 (96%)
Report	2 (4%)	1 (4%)
Study location[3]		
Australia	14 (28%)	2 (8%)
New Zealand	1 (2%)	0
Canada	3 (6%)	0
UK	5 (10%)	2 (8%)
US	20 (40%)	18 (69%)
Netherlands	4 (8%)	2 (8%)
Norway	1 (2%)	0
Multiple countries	2 (4%)	2 (8%)
Methods		

	Question 1[1] n=50 (100%)	Question 2[2] n= 26 (100%)
Quantitative	44 (80%)	25 (96%)
Qualitative	3 (6%)	1 (4%)
Mixed methods	3 (6%)	0
Disease of focus[3]		
Hepatitis B	6 (12%)	4 (15%)
Hepatitis C	14 (28%)	13 (50%)
HIV	11 (22%)	3 (12%)
STIs	18 (36%)	4 (15%)
Diabetes	2 (4%)	3 (12%)
HPV	6 (12%)	0
Mental health[4]	NA	2 (8%)

1. Question 1 focused on GP engagement strategies to increase STI, blood-borne virus (BBV), HPV and DM testing.
2. Question 2 focused on EMR modifications to improve STI, BBV, HPV, DM and mental health care.
3. Total does not equal the sum in Q1 and Q2 as some studies were relevant to both questions, reported multiple conditions and/or focused on multiple countries.
4. Mental health was not a part of the search for Q1.

Summary of evidence grading

A breakdown of the level of evidence for included studies using the NHMRC framework is provided in Table 3. Only quantitative and mixed-methods studies underwent an evidence assessment. About three-quarters of studies provided evidence from non-randomised studies.

Table 3—NHMRC Levels of Evidence

Level of evidence	Study design	Q1 (n=47)	Q2 (n=25)
I	A systematic review of level II studies	0 (0%)	0 (0%)
II	A randomised controlled trial	10 (21%)	7 (28%)
III-1	A pseudo-randomised controlled trial	1 (2%)	0 (0%)
III-2	A comparative study with concurrent controls	8 (17%)	5 (20%)
III-3	A comparative study without concurrent controls	10 (21%)	9 (36%)
IV	Case series with either post-test or pre-test/post-test outcomes	18 (38%)	5 (20%)

Question 1: Change initiatives to improve testing

A detailed overview of each change initiative is provided in Appendix 5. We identified a wide range of change initiatives to improve testing. Most directly targeted the **GP workforce** (32 for STIs, HIV, HBV and HCV; six for HPV and diabetes) through provider education (n=12), quality improvement (n=19), financial incentives (n=8), or targeted the **workflow and efficiency of the general practice setting** (42 for STIs, HIV, HBV and HCV; five for HPV and diabetes) by streamlining clinic processes (n=13), innovative testing methods (n=8), increasing patient engagement (n=9), or involved EMR modifications (such as alerts) (n=24, refer to Q2). Eight studies (eight for STIs, HIV, HBV and HCV, three for HPV and diabetes) reported on **innovative models of care** (nurse-led n=5, hub-and-spoke n=1) or **service-level funding** (state government n=1, telehealth n=1). Many studies involved multifaceted interventions and reported on multiple initiatives (e.g. quality improvement, streamlined processes and EMR alerts). Most studies reported increased testing, but it is difficult to assess the impact of individual initiatives as many were employed concurrently with other initiatives. The sustainability of change initiatives was largely unreported.

GP knowledge, willingness, and confidence

Provider education and training

Eleven studies reported on provider education and training to increase STI, HBV, HCV and HIV testing, such as e-learning modules, interactive workshops, discussion groups, case-based telemedicine and senior clinical support**.** Nine of these studies reported an increase in testing (HBV=3[12, 13), (14)]; HCV=3[12, 15, 16] HIV=3[17-19] STIs=2[18, 20]). The largest increases were for HCV testing, the proportion of ever-tested patients born between 1945 and 1965 increased from 16% to 82% in one study[15] and from 18% to 54% in another[16], noting that EMR alerts were also used in

these studies. HBV screening coverage increased from 15 to 24 tests per month over two years in one study[13] and HBV and HCV screening rates were higher in UK general practices receiving provider education, financial incentives and EMR alerts (1.7% in control clinics vs 19.5% in interventions clinics).[12] Monthly STI and HIV testing rates increased by 4 to 11 tests per month in Australian general practices receiving education as part of a hub-and-spoke model of care that also involved specialist support.[18] One study reported a decrease in a pre-existing decline in the HIV testing rate.[21] Only one study (on chlamydia) explored the sustainability of the increase, finding an increase in testing was not maintained past the third year post-education and recommended that education be provided regularly.[20]

Two studies focused on provider education to increase diabetes and HPV screening. One showed an increase in HPV and diabetes screening[22] while the other showed a modest increase in HPV testing rates.[23] Neither reported on sustainability.

Quality improvement

Studies that focused on quality improvement reported mixed results and included initiatives such as practitioner and clinic audit and feedback cycles, developing and implementing quality improvement plans and plan-do-study-act (PDSA) cycles. While 10 of the 15 studies related to STIs, HIV, HBV and HCV demonstrated a significant increase in testing (HBV=2, HCV=2[28, 43], HIV=1[24] STIs=6[7, 24-28], one demonstrated a modest increase in syphilis testing (and only during quality improvement cycles) and two showed a decrease in declines or a stabilisation in HIV testing.[29, 30] [21] Two studies reported findings from a cluster randomised controlled trial (the ACCEPt study) of a multifaceted chlamydia testing intervention (including provider education, financial incentives, feedback on test performance, computer alerts and reminders) in regional Australian primary care that examined sustainability over time. One study[26] demonstrated an increase in chlamydia testing before a decline in the final year of the study (year three). A later study in which the intervention clinics had financial incentives and/or audit and feedback initiatives retained or removed, showed audit and feedback was more effective than financial incentives in sustaining GP engagement.[31]

Three studies reported on quality improvement initiatives to increase HPV screening.[32-34] One study[34] reported no change in the number of people screened 10 years post-intervention. In terms of implementation, this study[34] noted that working in a setting where the workforce valued the use of clinical data for service delivery was important. Two studies[22, 32] reported on improved HbA1C levels for diabetic patients, but did not report on testing rates. .

Financial incentives

Financial incentives were designed to encourage the practitioner to increase testing; for example in one study US$400 was given to practitioners and US$2500 to practice champions if chlamydia testing project goals were met.[25] These studies were largely reported to have a positive impact on testing rates, with six of the seven studies demonstrating an increase in testing during the intervention period (HBV=1, HCV=1, HIV=1, STIs=4). One study reported a slight reduction in chlamydia testing when financial incentives were removed.[31] Overall, it was unclear whether the use of financial incentives to maintain testing rates was sustainable.

One study examined financial incentives to improve HPV screening. While higher physician fees did increase screening among patients receiving care from these clinicians, this study was undertaken in the US where the primary care context is not directly translatable to the context in Australia.

Facilitators and barriers

This Evidence Check identified a range of barriers and facilitators in relation to initiatives focusing on the **knowledge, willingness and confidence of the GP workforce** to undertake STI, HBV, HCV and HIV testing. For provider education, short interactive face-to-face training aimed at increasing chlamydia testing was highly acceptable for practice nurses.[20] For HIV, a brief self-directed education program focusing on HIV screening recommendations, risk groups and patient/provider resources led to practitioners feeling more able to integrate routine HIV testing into their practice workflow[17] although some providers were reluctant to order HIV tests that would incur costs for their patients.[17] Another provider noted training helped address concerns that providers might embarrass their patients by discussing HIV testing.[19] Conversely, high turnover and a largely part-time workforce were challenges in achieving sufficient training coverage in an HBV-focused initiative.[13]

For quality improvement, one study found involving multiple levels of the care team, such as by using a daily huddle sheet, assisted in sharing the responsibility among practitioners to create change.[14] Another study noted leadership by senior practice staff was an important enabler to implementing initiatives focusing on appropriate and inclusive STI and HIV screening, sexual history taking, streamlined workflows and PDSA cycles.[24] For HBV, one study noted that lack of prioritisation among GPs caring for a low-prevalence population was a barrier to HBV testing[13] For initiatives involving patients from non-English-speaking backgrounds, cultural and education barriers likely posed challenges to communication about HBV.[14]

Workflow and efficiency

Forty studies reported on change initiatives targeting general practice workflow and efficiency related to STIs, HIV, HBV and HCV and five studies reported on HPV and diabetes testing.

Streamlining clinic processes

Eleven studies focused on streamlining clinic processes for STI, HIV, HBV and HCV testing, including confidential booking appointments for HIV and STI testing, a patient-held reminder card for clinicians for HBV testing, standing orders for HCV testing, opt-out universal chlamydia testing, posted pathology forms with an invitation letter for HCV testing, computer assisted self-interviews (CASI) for HIV testing and the use of telehealth and express testing with no examination required for STIs. Nine of these studies showed an increase in testing rates (HBV=1, HCV=2, STIs=6), with patient-held reminder cards for HBV testing demonstrating the greatest increase in testing.[13] The invitation letter with a pathology form demonstrated a greater increase in HCV screening compared with a letter only[35], and two studies showed CASI was useful for identifying eligible patients for HIV testing but did not comment on a change in testing.[36, 37] Regarding sustainability, universal opt-out urine collection showed a slight reduction in the increase in chlamydia screening at 18 months compared with 12 months[25], though the reasons for this were not stated. The remaining studies did not report on sustainability over time.

Two studies reported on streamlining clinic processes related to HPV testing. One study involved a chronic disease risk assessment survey, which resulted in increased HPV screening tests.[22] The other study extended clinic opening hours, and also showed an increase in HPV screening.[33] There were no studies reporting on streamlining clinic processes related to diabetes testing.

EMR modifications to support screening and care

Studies found in the Question 1 search pertaining to EMR modifications are reported in the findings for Question 2, below, and described in detail in Appendix 4.

Risk stratified test invitations

One study in the Netherlands looking at HCV testing reported on invitation letters sent by a public health service encouraging testing at local general practices[38] and demonstrated a modest test uptake, noting this strategy is not recommended for countries with low HCV prevalence.

Innovative testing methods

Six studies focused on innovative testing methods, including patient specimen self-collection, point-of-care testing and postal and rapid tests (HIV=2, STIs=5). We did not identify any studies focusing on innovative HBV or HCV testing methods. Some studies reported on patient preferences for self-collection rather than the impact of self-collected testing on screening rates.[36, 37] One study demonstrated an increase in STI testing for self-sampling[39] and another showed an increase in negative STI samples via postal testing kits.[40] While none of these studies reported on sustainability, one study that examined point-of-care testing in remote primary health services that largely service Aboriginal patients reported a significant decrease in time to treatment for diagnosed STIs (76% in the intervention group treated in seven days vs. 47% for standard care).[41]

Two studies looked at innovative testing methods to increase HPV testing, both focused on patient self-collection. One study reported a significant increase in the likelihood of women receiving HPV screening via self-collection (compared with clinician-collected).[42] The other reported on the acceptability of self-collection among key stakeholders but did not report changes to testing rates.[43] There were no studies that looked at innovative testing methods for diabetes.

Increasing patient engagement

Eight studies looked at strategies to increase patient engagement related to STI, HIV, HBV and HCV testing, including mailed invitation letters with pathology forms; patient specimen self-collection; community-based testing and awareness campaigns employing on-the-spot testing and financial incentives for patients; and establishing welcoming clinical environments for LGBTIQ+ individuals. Five of the eight studies reported an overall increase in testing (HCV=2, HIV=1, STIs=3); mailed letters with a pathology form was the most effective strategy for increasing HCV screening rates compared with other initiatives tested in one study.[35] Two studies did not comment on a change in testing related to patient engagement initiatives (HIV=1, STIs=2), and one study reported a possible increase for patients involved in a testing campaign (HCV=1).[44]

One study reported on increasing patient engagement related to HPV testing and found an increase in screening over the intervention period.[45] There were no studies on patient engagement methods related to diabetes testing.

Facilitators and barriers

Innovative modalities for STIs and HIV screening, such as patient specimen self-collection, point-of-care, postal and rapid tests were acceptable to patients and providers, including Aboriginal patients[41], with ease-of-use of self-collection an important facilitator.[37] Smaller practices often had better program exposure to training over a shorter period of time[32], and use of clinical data for

service delivery was valued by clinic staff in another study.[34] Prescheduling of patient appointments was a facilitator for HPV and diabetes screening and monitoring.[22, 32] However, limited availability of tests and laboratory processing capacity were barriers to implementation.[43] One study reported patient and provider discomfort at asking sensitive questions related to HCV screening[46], while another noted the increased provider time needed to use a sexual history screening tool.[37] Opt-out testing was viewed as a facilitator in one study as it may reduce bias and stigmatisation experienced by patients when undergoing screening.[27] Poor labelling of patient self-collected specimens and disruptions to clinic flow were noted in another study looking at chlamydia and gonorrhoea point-of-care testing.[41] Short appointment times, difficulty focusing on HCV screening when providing care for patients with co-morbidities and failure of the EMR system to capture testing by outside providers were identified as additional challenges to HCV screening.[46] One study found financial incentives for providers for quality improvement initiatives for STI testing were seen as having little added value as they represented a marginal proportion of the clinic operating budget.[28] [43]

For patient engagement, one study noted small financial incentives for patients was a facilitator for HCV screening[44] while creating culturally affirming environments for LGBTIQ+ patients was a facilitator for sexual identity recording.[24]

Structural interventions

Eight studies reported on structural interventions to increase STI, HIV, HBV and HCV testing, and three studies looked at HPV and diabetes testing.

Innovative models of care

For STI, HIV, HBV and HCV testing, six studies reported on innovative models of care, including nurse-led models (n=5) and a hub-and-spoke model (n=1) whereby three Australian general practices (the spokes) received sexual health training and specialist support from a central specialist sexual health centre (the hub). There was an increase in testing for three of the nurse-led models and the hub-and-spoke model (HIV=1, STIs=3), while the remainder reported good acceptability among patients and nurse-practitioners without reporting the impact on testing (HCV=1, HIV=1). Regarding sustainability, one study found a nurse-led model achieved similar HIV testing rates to trial intervention practices when the initiative was extended to implementation practices[47], while another found a nurse-led model increased chlamydia testing that was not sustained at year three and recommended regular training updates be provided to maintain behaviour change.[20]

Three studies reported on innovative models of care related to HPV and diabetes, including case conferencing with a specialist, a nurse-led model and outreach services. Case conferencing with specialist support for diabetes screening showed mixed results[32], while nurse-led models[33] and outreach services[42] demonstrated an increase in HPV testing.

Service-level funding

Two studies looked at service-level funding to increase STI testing. One study, in Victoria, Australia, received state government funding to establish sexual health services in general practice (n=3 clinics) in a hub-and-spoke model (with specialist support from the Melbourne Sexual Health Centre) and found a statistically significant rise in testing for at least one year.[18] The average number of tests increased by 11 for chlamydia, 11 for gonorrhoea, four for syphilis and six for HIV, with qualitative

findings showing staff at the spoke clinics had an increased interest and confidence in offering and providing sexual health services. The second study, in NSW, Australia, showed higher uptake of Medicare Benefits Scheme (MBS) rebatable telehealth consultations by patients for STI-related consultations compared with face-to-face only, and both telehealth and face-to-face consultations.[48] There were no studies reporting on service-level funding for HPV or diabetes testing.

Facilitators and barriers

Facilitators to implementing a hub-and-spoke model for sexual healthcare in general practice included staff engagement and a committed principal GP with a specific interest in sexual health and relationships with target communities.[18, 32] While local ownership of the initiative was important for adoption, this could lead to variation in service quality across the primary care services within the model.[18] Findings from studies reporting on both hub-and-spoke and nurse-led models highlight the importance of ongoing training and addressing staff turnover.[20] In the case of diabetes, one study[32] noted that while visiting specialist teams could provide important capacity building, such initiatives in Australia do not address systematic issues related to fragmented state and federal funding.

Question 2: EMR modifications to support care

We classified initiatives involving EMR modifications into three categories: EMR alerts, clinical decision support systems (CDSSs) and natural language processing. In summary, most EMR modifications related to EMR alerts or prompts for screening (three for HIV, four for STIs, 12 for HCV, four for HBV, one for diabetes). EMR alerts were often used in combination with other initiatives including quality improvement (often audit and feedback), provider education, patient resources, opt-out testing, and clinical decision support. Eight studies reported on a CDSS—for example, links to pathology order templates and testing protocols (two for STIs, one for HCV, one for HBV, two for diabetes, one for mental health)—or natural language processing (one for HIV, one for mental health).

EMR alerts

Twenty studies reported on EMR alerts or prompts triggered from practice management software, of which most reported a positive impact on testing and/or management. As multiple initiatives were often used at the same time, the specific contribution of the EMR alert was often unclear.

Most EMR alerts (n=12) focused on **HCV** screening of baby boomers (born 1945–65) in the US according to Centers for Disease Control recommendations. Several of these alerts linked to pathology order templates, patient fact sheets and testing protocols.[21, 49-52] Nine reported increased screening coverage over one-to-four years[16, 49, 51-57] and there was variation in the level of increase[16, 49, 51-57] [58] and uptake among clinicians.[49] For **HBV,** EMR alerts were used in two US studies[59, 60] to identify patients from high-prevalence countries or populations (Asian and Pacific Islanders) for HBV screening and, in one study[60], integrated pathology orders and patient information. In both studies testing rates were higher for patients for whom the EMR alert was used, although in one study clinician response to the HBV EMR alert declined over time.[60] A systematic review of 80 studies across the US, Europe, Australasia and Asia[53] found EMR alerts to prompt **HCV and HBV** screening in primary care and hospital settings were effective in increasing screening rates in target populations compared with standard care. A UK study[12] provided alerts alongside GP education and financial incentives as well as letters to patient to prompt HBV and HCV screening of adult migrants, reporting that screening rates were 3.7 fold higher in intervention than control clinics.

For **HIV,** two US studies[56, 61] used EMR alerts to identify patients for age-based (13–64 years) screening and reported a substantial increase over one year. For **STIs,** in an Australian study in general practice[26] and a US study in primary care[27], EMR alerts were used as part of a multifaceted intervention to prompt annual chlamydia or gonorrhoea testing among young people. Testing increased to 20.1% of eligible people in the Australian study and 81% in the US study, which also reported reductions in testing inequities by gender and language.

For other conditions, a UK study[62] focused on **diabetes care** and involved an EMR alert to identify multiethnic patients with type 2 diabetes who were at increased risk of complications. The initiative did not achieve improvements in risk-factor management.

Clinical decision support

Eight studies reported on CDSSs that were integrated with practice management software. Overall, these studies reported increases in testing where the CDSS was used, although study design was variable and statistical analyses were not always conducted.

For **HCV**, a US study[50] of a CDSS with links to testing protocols and patient resources and prompts for testing the age cohort born 1945–65 reported that 11.5% of eligible patients were tested. No before measure was provided. Also in the US, a CDSS for **HBV**[60] identified unscreened patients from countries with high HBV prevalence and provided an alert linked to pathology orders; it found HBV tests were ordered for 15.7% of eligible patients compared with 12.6% of patients where an alert without the pathology order was used. No statistical analysis was performed.

For **STIs**, an Australian study[63] in high caseload general practices involved a CDSS comprising EMR alerts and routine audit and feedback reports to prompt STI testing and recording of sexual orientation. This study reported substantial increases in comprehensive STI testing among patients tested for HIV or other STIs (by 89%) and a twofold increase for patients living with HIV along with improved recording of patient sexuality. A systematic review[39] of STI screening approaches reported adolescent girls in one study were more than twice as likely to be screened with a CDSS.

Three studies reported on use of CDSS for **diabetes and mental health**. A US study[64] provided decision support for allocating **diabetic patients** in primary care to the correct setting (e.g. to hospital outpatients or to remain in primary care) but showed minimal impact on whether patients were in the correct treatment setting and high levels of non-adherence by clinicians to advice—mainly in response to alternative options preferred by patient and clinicians. Another US study[65] reported on findings from multiple studies of a CDSS to support chronic care outcomes for more than 20 clinical domains (including **mental health and diabetes**) in a primary care network. The study, drawing from multiple RCTs, found that the CDSS was associated with significant improvements in glucose and blood pressure control in patients with diabetes and that there was good engagement with the system by clinicians. However, minimal study data were provided to understand the improvements in glucose and blood pressure control. For **mental health,** a study set in general practices in the Netherlands[66] involved a CDSS that provided treatment decision support for patients with mental health problems. Quality of life was higher in the CDSS group at 12 months compared with the control group and costs were similar between groups.

Natural language processing

One study[67] explored the potential impact of natural language processing (NLP) to improve predictive models of HIV diagnosis. Algorithms based on structured data (refers to fields in the EMR where data are entered in a pre-defined format) and key words (e.g. ‘MSM’, ‘unprotected’, ‘HIV’) in unstructured clinical notes were compared with algorithms based on structured data. The key finding was that NLP improved HIV risk assessment.

Another study[68] involved development of NLP algorithms using key words in the clinical notes (e.g. ‘depression’, ‘bipolar’, ‘anxious’) to detect mental illness and substance use in those living with HIV. NLP algorithms had high positive and negative predictive values in identifying mental illness and substance use that was often not documented in structured EMR fields.

Facilitators and barriers

Few studies looked at barriers and enablers to implementing EMR modifications. One identified difficulty integrating and exporting new fields to and from the EMR along with a lack of vendor support when needed as challenges to .[24]

Discussion

This Evidence Check identified many change initiatives and EMR modifications targeted at increasing STI, HIV, HBV and HCV screening and management in primary care. Many initiatives had a positive impact on testing during the study period, but because multiple initiatives were often implemented at the same time, it is difficult to identify one single initiative that had the greatest impact. Indeed, it is likely the most effective initiatives are multifaceted, and co-designed and implemented with the specific clinical context and patient population in mind—principles well established in health services research.

Question 1 focused on change initiatives targeted at improving STI, HIV, HBV or HCV testing. The most effective initiatives were multifaceted. For example, initiatives that involved strategies that targeted the **GP workforce** combined with initiatives such as opt-out testing, EMR alerts or clinical decision support that targeted **workflow and efficiency of the general practice setting** were most effective. Innovative testing methods such as self-collection (STI, HPV), point-of-care (STI) or rapid testing (HIV) were largely acceptable to patients and reduced time to STI treatment, but did not always increase testing rates. Models of care that increased the nurse's role or linked to specialist support offered a mechanism to expand testing opportunities and build capacity in busy general practice environments and were acceptable to patients. A UK study[47] reported on transitioning a nurse-led model for HIV testing from a research to a real world setting and demonstrated strong engagement and increased testing that can provide valuable evidence to inform models of care that may engage priority populations.

Question 2 focused on EMR modifications to support STI, HIV, HBV and HCV testing and care. EMR alerts were often used in combination with other initiatives. Positive impacts (to varying degrees) on testing were reported where EMR alerts were used to prompt HCV or HIV testing for specific birth cohorts, HBV testing for specific population groups, opt-out STI testing and reduced inequities in testing. Multifaceted initiatives with EMR alerts appeared to have a greater impact. CDSSs involving prompts and integration of resources such as protocols or pathology orders had a modest or limited impact on HBV and HCV testing. For STI CDSS, testing more than doubled for adolescents (when combined with opt-out testing) and for comprehensive testing for men who have sex with men (MSM) when audit and feedback reporting was built into the CDSS. There was some evidence that clinician engagement with EMR alerts and CDSS declined over time or varied among clinicians.

Few studies reported on sustainability and longevity. Audit and feedback was more effective than financial incentives in sustaining chlamydia testing practices, although testing reduced over time, highlighting the need for research to understand how to sustain change.[31] Continuous quality improvement cycles were associated with increasing syphilis testing[69] although there is a need to better understand the optimum timing, frequency and duration of such initiatives. Similarly for EMR modifications, an important consideration is whether alerts or CDSS can sustain clinician behaviour over time. For any initiative, both how it is implemented and in what context can have a significant bearing on its effectiveness. Studies in this Evidence Check provided limited insights into implementation strategies. Drawing on implementation science literature, it is likely a combination of

initiatives would have a synergistic effect and the most impact, with initiatives that become normalised and routine having greater potential for sustainability. Critically, effective testing initiatives need a conducive environment for implementation. Leadership and staff engagement from the outset are crucial to ensure testing initiatives align with clinical and patient priorities. The reviewed studies raised the importance of working within a clinical context that values improvement initiatives involving education, quality improvement and on building culturally affirming environments for priority populations. Given the demands on primary care, it is crucial new tools are easy to use and recognise the time constraints of GPs.

Studies in this Evidence Check highlighted barriers to HBV, HCV, HIV and STI testing such as knowledge gaps, time constraints and other care priorities, all reported previously.[4-6, 70] In endeavours to bridge these gaps, a range of organisations offer professional development and quality improvement programs to support general practice in skill development and auditing practices.[71-73] Such initiatives speak to workforce engagement, but evidence of their impact is limited. Other research in progress may add evidence here. For example, the Management of Chlamydia Cases in Australia (MoCCA) study[74] focuses on strengthening chlamydia management in general practice. While not specifically focused on testing, MoCCA integrates resources, guidelines and work processes (www.mocca.org.au) to support partner management, retesting and pelvic inflammatory disease diagnosis and is working with general practices in Victoria, NSW and Queensland to understand their implementation. Resources such as documentation shortcuts in the EMR may be applicable to other aspects of STI, HIV, HBV and HCV testing and care. Aligning initiatives with professional development requirements[75] may also be a mechanism to support GP engagement in screening.[76]

Future Health Today (FHT) (https://futurehealthtoday.com.au/) is another program to note. FHT is a multifaceted clinical decision support tool integrated with practice management software and co-designed with primary care[77] with modules for non-communicable conditions including diabetes. FHT goes beyond simple prompts reminding clinicians to test, and links to guidelines to assist decision making and patient resources, and provides quality improvement functionality. The University of Melbourne has developed a FHT syphilis module for general practice that prompts syphilis testing of pregnant women or people having an asymptomatic check (https://sti.guidelines.org.au/) and links to guidelines and patient fact sheets (unpublished data Goller JL, et al.). Work in 2023 will involve understanding the usability and acceptability of the tool in general practice. Such a tool aligns with the Australian Primary Health Care 10 Year Plan that prioritises decision-support tools[78] and Australian STI strategy priorities for building general practice capability.[79]

This Evidence Check has several limitations to consider when interpreting the findings. First, few studies met the criteria for a high level of evidence, with three-quarters of included studies providing level III or IV evidence and many not providing baseline measures for comparison. As it is not practical to run RCTs in all contexts, many used a pre and post design that relied on routinely collected data for outcome measurement. Of note, this design is used widely for assessing the effectiveness and implementation of STI and blood-borne virus (BBV) initiatives. Second, for many studies it was difficult to establish direct impacts of a single initiative on testing or management outcomes. It is likely a combination of initiatives contributed to positive results. Third, most studies focused on quantifying changes in testing rather than implementation outcomes. As such, evidence on sustainability, barriers and enablers is limited and should not be considered a comprehensive overview of implementation considerations. Fourth, the included articles maybe subject to publication bias, where positive results are more often reported than neutral or negative findings. Fifth, many

studies were from the US and reported on initiatives to increase HCV testing for specific birth cohorts. Hepatitis case finding in Australia takes more of a risk-based approach and a birth cohort approach may not be applicable. Finally, the review team is involved in and aware of work under way that would meet this Evidence Check's criteria but is as yet unpublished. It is clear there are initiatives that have not been included because of the delay between research and publication.

Conclusion

Initiatives that appeared to offer the most benefit in increasing STI, HIV, HBV or HCV screening in primary care included a mix of provider education or quality improvement that was complemented by clinic-level initiatives that helped identify and engage at-risk patients in testing (e.g. EMR alerts, self-collected specimens, nurse-led testing, welcoming environment). Models of care that increased the role of nurses or linkages to specialist support offered a mechanism to expand testing opportunities and build capacity in busy general practice environments and were acceptable to patients. There was limited evidence about the sustainability of change initiatives and most studies did not involve randomisation. The quality of evidence is mixed, with few RCTs, highlighting the ongoing need for further well designed research.

Australian general practice is facing unprecedented hardships including workload burden and inadequate remuneration. While such factors are largely beyond the influence of NSW Health, initiatives aimed at general practice must be cognisant of these challenges and engage GPs in their design and delivery. Initiatives should complement the general practice workflow and help to streamline testing, particularly for priority populations. EMR alerts with integrated resources (such as guidelines or patient fact sheets) can help support GPs to discuss testing in an unrelated consultation. Provider education and quality improvement can act synergistically with other initiatives to identify new testing opportunities and evaluate the impact of change initiatives.

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Appendix 1—Search strategies

Question 1

Database search for MEDLINE, run 21 April 2023

Row	Search terms
1	General Practice/
2	Health Services, Indigenous/
3	((‘primary care’ or ‘primary health care’ or gp or ‘general practi*’ or ‘family physician’ or ‘family medicine’ or ‘community health service’ or ‘family planning clinic’ or‘family planning service’ or ‘sexual health clinic’ or ‘sexual health service’) not ‘emergency’ not ‘hospital’).tw.
4	1 or 2 or 3
5	Sexually Transmitted Diseases/
6	Hepatitis B/ or Hepatitis C/ or HIV/
7	Hepatitis, Viral, Human/
8	(“sexually trans* infection*” or “sexually trans* disease*” or “sti” or “std*” or “chlamydia” or “chlamydia trachomatis” or “C trachomatis” or “syphilis” or “treponema pallidum” or “T pallidum” or “hiv” or “human immunodeficiency virus*” or “hepatitis b” or “hbv” or “hep b” or “hepatitis c” or “hcv” or “hep c”).tw.
9	5 or 6 or 7 or 8
10	Mental Health/ or Depression/ or Anxiety/
11	Diabetes Mellitus/
12	Human Papillomavirus Viruses/ or Uterine Cervical Neoplasms/ or HPV.tw.
13	10 or 11 or 12
14	(test* or screen* or diagnos* or detect* or monitor*).tw.

Row	Search terms
15	(initiative* or intervention* or action* or program* or polic* or strateg* or engag*).tw.
16	Health policy/ or health planning/ or health promotion/
17	(knowledge* or willingness or confidence or capability or opportunity or motivation or skill* or train* or educate* or awareness or placement* or mentor* or “behavio* change” or “quality improvement” or qi or audit or communicat* or cpd or “prof* development” or ability or competence or feedback or “self reflection”).tw.
18	(workflow* or “clinical tool*” or “clinical resource*” or “clinical guideline*” or “practice management software*” or “management software” or “clinic* software” or reminder* or emr or “decision support” or “practice champion” or “practice manager” or “practice nurse” or “software provider” or prompt or “pop up” or “electronic health record” or “electronic medical record” or digital).tw.
19	(“whole of system” or “whole system*” or “integrated model*” or “interdisciplinary model*” or “interdisciplinary team*” or “interdisciplinary care” or “multidisciplinary team” or “multidisciplinary care” or “primary care team*” or “hub and spoke” or “evidence based practice” or outreach or “nurse led”).tw.
20	Australia/ or New Zealand/ or United Kingdom/ or Canada/ or Sweden/ or Norway/ or United States/ or Netherlands/ or Denmark/
21	4 and (9 or 13) and 14 and 20 and (15 or 16 or 17 or 18 or 19)
22	limit 21 to (human and english language and yr=“2013 -Current”)

/ = MeSH term | .tw. = title and abstract

Database search for EMBASE, run 21 April 2023

Row	Search terms
1	General Practice/
2	Health Services, Indigenous/
3	((‘primary care’ or ‘primary health care’ or gp or ‘general practi*’ or ‘family physician’ or ‘family medicine’ or ‘community health service’ or ‘family planning clinic’ or ‘family planning service’ or ‘sexual health clinic’ or ‘sexual health service’) not ‘emergency’ not ‘hospital’).tw.
4	1 or 2 or 3
5	Sexually Transmitted Diseases/
6	Hepatitis B/ or Hepatitis C/ or HIV/
7	Hepatitis, Viral, Human/
8	(“sexually trans* infection*” or “sexually trans* disease*” or “sti” or “std*” or “chlamydia” or “chlamydia trachomatis” or “C trachomatis” or “syphilis” or “treponema pallidum” or “T pallidum” or “hiv” or “human immunodeficiency virus*” or “hepatitis b” or “hbv” or “hep b” or “hepatitis c” or “hcv” or “hep c”).tw.
9	5 or 6 or 7 or 8
10	Mental Health/ or Depression/ or Anxiety/
11	Diabetes Mellitus/
12	Human Papillomavirus Viruses/ or Uterine Cervical Neoplasms/ or HPV.tw.
13	10 or 11 or 12
14	(test* or screen* or diagnos* or detect* or monitor*).tw.
15	(initiative* or intervention* or action* or program* or polic* or strateg* or engag*).tw.
16	Health policy/ or health planning/ or health promotion/
17	(knowledge* or willingness or confidence or capability or opportunity or motivation or skill* or train* or educate* or awareness or placement* or mentor* or “behavio* change” or “quality improvement” or qi or audit or communicat* or cpd or “prof* development” or ability or competence or feedback or “self reflection”).tw.
18	(workflow* or “clinical tool*” or “clinical resource*” or “clinical guideline*” or “practice management software*” or “management software” or “clinic* software” or reminder* or emr or “decision support” or “practice champion” or “practice manager” or “practice nurse” or “software provider” or prompt or “pop up” or “electronic health record” or “electronic medical record” or digital).tw.
19	(“whole of system” or “whole system*” or “integrated model*” or “interdisciplinary model*” or “interdisciplinary team*” or “interdisciplinary care” or “multidisciplinary team” or

Row	Search terms
	“multidisciplinary care” or “primary care team*” or “hub and spoke” or “evidence based practice” or outreach or “nurse led”).tw.
20	Australia/ or New Zealand/ or United Kingdom/ or Canada/ or Sweden/ or Norway/ or United States/ or Netherlands/ or Denmark/
21	4 and (9 or 13) and 14 and 20 and (15 or 16 or 17 or 18 or 19)
22	limit 21 to (human and english language and yr=“2013 -Current”)
23	limit 22 to embase

/ = MeSH term | .tw. = title and abstract

Database search for CINAHL, run 21 April 2023

Row	Search terms
1	(MH “Health Services, Indigenous”) or (MH “Family Practice”) or “primary care” or “primary health care” or gp or “general practi*” or “family physician” or “family medicine” or “community health service” or “Indigenous health service” or “family planning clinic” or “family planning service” or “sexual health clinic” or “sexual health service” not emergency not hospital
2	(MH “Sexually Transmitted Diseases”) or (MH “Hepatitis B”) or (MH “Hepatitis C”) or (MH “Human Immunodeficiency Virus”) or (MH “Hepatitis, Viral, Human”) or “sexually trans* infection*” or “sexually trans* disease*” or “sti” or “std*” or “chlamydia” or “chlamydia trachomatis” or “C trachomatis” or “syphilis” or “treponema pallidum” or “T pallidum” or “hiv” or “human immunodeficiency virus*” or “hepatitis b" or “hbv” or “hep b” or “hepatitis c” or “hcv” or “hep c” or (MH “Mental Health”) or (MH “Depression”) or (MH “Anxiety”) or (MH “Diabetes Mellitus”) or (MH “Papillomavirus Infections”) or (MH “Cervix neoplasms”) or hpv
3	test* OR screen* OR diagnos* OR detect* OR monitor*
4	(MH “Health policy”) or (MH “Health and Welfare Planning”) or (MH “Health Facility Planning”) or (MH “Health Promotion”) or initiative* or intervention* or action* or program* or polic* or strateg* or engag* or “health policy” or “health planning” or “health promotion” or knowledge OR willingness OR confidence OR capability OR opportunity OR motivation OR skill* OR train* OR educat* OR awareness OR placement* OR mentor* OR “behavio* change” OR “quality improvement” OR QI OR audit* OR communicat* or CPD or “prof* development” or ability or competence or feedback or “self reflection” or workflow* OR “clinical tool*” OR “clinical resource*” OR “clinical guideline*” OR “practice management software*” OR “management software” OR “clinic* software” OR reminder* OR “EMR” or “decision support” or “practice champion” or “practice manager” or “practice nurse” OR “software provider” or prompt or “pop-up” or “electronic health record” or “electronic medical record” or digital or “whole of system” OR “whole system*” OR “integrated model*” OR “interdisciplinary model*” OR “interdisciplinary team*” OR “interdisciplinary care” OR “multidisciplinary team” OR “multidisciplinary care” OR “primary care team*” OR “hub and spoke” OR “evidence based practice” OR “outreach” OR “nurse led”
5	(MH “Australia”) or (MH “New Zealand”) or (MH “United Kingdom”) or (MH “Canada”) or (MH “Sweden”) or (MH “Norway”) or (MH “Denmark”) Or (MH “Netherlands”) or (MH “United States”)
Limits	2013 – 2023 Abstract available Exclude MEDLINE records English language Human
6	1 and 2 and 3 and 4 and 5 + limits

AB = abstract, MH = CINAHL subject heading

Database search for Cochrane Library, run 21 April 2023

Row	Search terms
1	(“primary care” or “primary health care” or GP or “general practi*” or “family physician” or “family medicine” or “community health service” or “Indigenous health service” or “family planning clinic” or “family planning service” or “sexual health clinic” or “sexual health service” not emergency not hospital):ti,ab,kw
2	(“sexually trans* infection*” OR “sexually trans* disease*” OR STI* OR STD* OR chlamydia OR “chlamydia trachomatis” OR “C trachomatis” OR gonorr* OR syphilis OR “treponema pallidum” OR “T pallidum” OR HIV OR “human immunodeficiency virus*” OR “hepatitis B” OR HBV OR “hep B” OR “hepatitis C” OR HCV OR “hep C” or “mental health” or diabetes or “diabetes mellitus” or depression or anxiety or “human papilloma virus*” or HPV or “cervical cancer*” or “uterine cervical neoplasm*”):ti,ab,kw
3	(test* OR screen* OR diagnos* OR detect* OR monitor*):ti,ab,kw
4	(initiative* or intervention* or action* or program* or polic* or strateg* or engag* or “health policy” or “health planning” or “health promotion” or knowledge OR willingness OR confidence OR capability OR opportunity OR motivation OR skill* OR train* OR educat* OR awareness OR placement* OR mentor* OR “behavio* change” OR “quality improvement” OR QI OR audit* OR communicat* or CPD or “prof* development” or ability or competence or feedback or “self reflection” or workflow* OR “clinical tool*” OR “clinical resource*” OR “clinical guideline*” OR “practice management software*” OR “management software” OR “clinic* software” OR reminder* OR “EMR” or “decision support” or “practice champion” or “practice manager” or “practice nurse” OR “software provider” or prompt or “pop-up” or “electronic health record” or “electronic medical record" or digital or “whole of system" OR “whole system*" OR “integrated model*” OR “interdisciplinary model*” OR “interdisciplinary team*” OR “interdisciplinary care” OR “multidisciplinary team” OR “multidisciplinary care” OR “primary care team*” OR “hub and spoke” OR “evidence based practice” OR “outreach” OR “nurse led”):ti,ab,kw
5	(Australia or “New Zealand” or “United Kingdom” or Canada or Sweden or Norway or “United States” or Netherlands or Denmark):ti,ab,kw
6	#1 and #2 and #3 and #4 and #5
7	#1 and #2 #3 and #4 and #5 with Cochrane Library publication date Between Jan 2013 and Apr 2023, in Cochrane Reviews, Trials

ti,ab,kw: Title, Abstract, and Keywords

Question 2

Database search for MEDLINE, run 21 April 2023

Row	Search terms
1	General Practice/
2	Health Services, Indigenous/
3	((primary care) or (primary health care) or GP or (general practice) or (general practitioner) or (family physician) or (family medicine) or (community health service) or (family planning clinic) or (family planning service) or (sexual health clinic) or (sexual health service) not emergency not hospital).tw.
4	(1 or 2 or 3)
5	Sexually Transmitted Diseases/
6	Hepatitis B/ or Hepatitis C/ or HIV/
7	Hepatitis, Viral, Human/
8	((sexually trans* infection*) OR (sexually trans* disease*) OR (STI*) OR (STD*) OR (chlamydia) OR (chlamydia trachomatis) OR (C trachomatis) OR (gonorr*) OR (syphilis) OR (treponema pallidum) OR (HIV) OR (human immunodeficiency virus*) OR (hepatitis B) OR (HBV) OR (hep B) OR (hepatitis C) OR (HCV) OR (hep C)).tw.
9	(5 or 6 or 7 or 8)
10	Mental Health/ or Depression/ or Anxiety/
11	Diabetes Mellitus/
12	Human Papillomavirus Viruses/ or Uterine Cervical Neoplasms/ or HPV.tw.
13	(10 or 11 or 12)
14	(9 or 13)
15	((test*) OR (screen*) OR (diagnos*) OR (detec*)).tw

Row	Search terms
16	((treat*) OR (manage*) OR (care) OR (prevent*) OR (monitor*) OR (follow up)).tw
17	15 or 16
18	((workflow*) or (clinical guideline*) or (practice management software*) or (management software*) or (electronic medical record) or (electronic medical system*) or (EMR) or (medical records software) or (decision support) or (clinical software) or (clinical decision support) or (decision algorithm) or (clinical algorithm) or (audit*) or (clinical management software) or (medical practice software) or (prompt*) or (electronic health record) or (pop-up*) or (digital).tw.
19	Australia/ or New Zealand/ or United Kingdom/ or Canada/ or Sweden/ or Norway/ or United States/ or Netherlands/ or Denmark/
Limits	2013 – current (last 10 years) Humans , English only
20	4 AND 14 AND 17 AND 18 AND 19 GP setting + STIs/BBVs and comparable conditions + test or treat + practice management software + country + (humans, last 10 years, English)

Database search for CINAHL, run 21 April 2023

Row	Search terms
1	(MH “Health Services, Indigenous”) or (MH “Family Practice”) or “primary care” or “primary health care” or “gp” or “general pract*” or “family physician” or “family medicine” or “community health service” or “Indigenous health service “ or “family planning clinic” or “family planning service” or “sexual health clinic” or “sexual health service” not emergency not hospital
2	(MH “Sexually Transmitted Diseases”) or (MH “Hepatitis B”) or (MH “Hepatitis C”) or (MH “Human Immunodeficiency Virus”) or (MH “Hepatitis, Viral, Human”) or “sexually trans* infection*” or “sexually trans* disease*” or “sti” or “std*” or “chlamydia” or “chlamydia trachomatis” or “C trachomatis” or “syphilis” or “treponema pallidum” or “T Pallidum” or “hiv” or “human immunodeficiency virus*” or “hepatitis b” or “hbv” or “hep b” or hepatitis c” or “hcv” or “hep c” or (MH “Mental Health”) or (MH “Depression”) or (MH “Anxiety”) or (MH “Diabetes Mellitus”) or (MH “papillomavirus Infections”) or (MH “Cervix neoplasms”) or “hpv”
3	test* OR screen* OR diagnos* OR detec* OR treat* OR manage* OR care OR prevent* OR monitor* OR “follow up”
4	“workflow*” or “clinical guideline*” or “practice management software*” or “management software*” or “electronic medical record” or “electronic medical system*” or “EMR” or “medical records software” or “decision support” or “clinical software” or “clinical decision support” or “decision algorithm” or “clinical algorithm” or “audit*” or “clinical management software” or “medical practice software” or “prompt*” or “electronic health record” or “pop-up*” or “digital”
5	(MH “Australia”) or (MH “New Zealand”) or (MH “United Kingdom”) or (MH “Canada”) or (MH “Sweden”) or (MH “Norway”) or (MH “United States”) or (MH “Netherlands”) or (MH “Denmark”)
Limits	2013–2023 Abstract available, Exclude MEDLINE records, English language, Human
6	1 and 2 and 3 and 4 and 5 + limits

Database search EMBASE

Row	Search terms
1	General Practice/
2	Health Services, Indigenous/
3	((‘primary care’ or ‘primary health care’ or ‘GP’ or ‘general practice’ or ‘general practitioner’ or ‘family physician’ or ‘family medicine’ or ‘community health service’ or ‘family planning clinic’ or ‘family planning service’ or ‘sexual health clinic’ or ‘sexual health service’) not ‘emergency’ not ‘hospital’).tw.
4	(1 or 2 or 3)
5	Sexually Transmitted Diseases/
6	Hepatitis B/ or Hepatitis C/ or HIV/
7	Hepatitis, Viral, Human/
8	(‘sexually trans* infection*’ or ‘sexually trans* disease*’ or ‘STI*’ or ‘STD*’ or ‘chlamydia’ or ‘chlamydia trachomatis’ or ‘C trachomatis’ or ‘gonorr*’ or ‘syphilis’ or ‘treponema pallidum’ or ‘HIV’ or ‘human immunodeficiency virus*’ or ‘hepatitis B’ or ‘HBV’ or ‘hep B’ or ‘hepatitis C’ or ‘HCV’ or ‘hep C’).tw.
9	(5 or 6 or 7 or 8)
10	Mental Health/ or Depression/ or Anxiety/
11	Diabetes Mellitus/
12	Human Papillomavirus Viruses/ or Uterine Cervical Neoplasms/ or HPV.tw.
13	(10 or 11 or 12)
14	(9 or 13)
15	(‘test*’ or ‘screen*’ or ‘diagnos*’ or ‘detec*’).tw.
16	(‘treat*’ or ‘manage*’ or ‘care’ or ‘prevent*’ or ‘monitor*’ or ‘follow up’).tw.

Row	Search terms
17	15 or 16
18	(‘workflow*’ or ‘clinical guideline*’ or ‘practice management software*’ or ‘management software*’ or ‘electronic medical record’ or ‘electronic medical system*’ or ‘EMR’ or ‘medical records software’ or ‘decision support’ or ‘clinical software’ or ‘clinical decision support’ or ‘decision algorithm’ or ‘clinical algorithm’ or ‘audit*’ or ‘clinical management software’ or ‘medical practice software’ or ‘prompt*’ or ‘electronic health record’ or ‘pop-up*’ or ‘digital’).tw.
19	Australia/ or New Zealand/ or United Kingdom/ or Canada/ or Sweden/ or Norway/ or United States/ or Netherlands/ or Denmark/
Limits	2013 – current (last 10 years) Humans English only “Remove Medline records”
20	4 AND 14 AND 17 AND 18 AND 19 GP setting + STIs/BBVs and comparable conditions + test or treat + practice management software + country + (humans, last 10 years, English)

Database search for Cochrane Library, run 21 April 2023

Row	Search terms
1	(“primary care” or “primary health care” or GP or “general practice” or “general practitioner” or “family physician” or “family medicine” or “community health service” or “family planning service” or “family planning clinic” or “sexual health service” or “sexual health clinic” NOT emergency not hospital):ti,ab,kw
2	(“sexually trans* infection*” OR “sexually trans* disease*” OR STI* OR STD* OR chlamydia OR “chlamydia trachomatis” OR “C trachomatis” OR gonorr* OR syphilis OR “treponema pallidum” OR HIV OR “human immunodeficiency virus*” OR “hepatitis B” OR HBV OR “hep B” OR “hepatitis C” OR HCV OR “hep C” OR “mental health” or depression or anxiety or “diabetes mellitus” or “human papillomavirus virus*” or “cervical cancer” or “uterine cervical neoplasm*” or HPV):ti,ab,kw
3	(test* OR screen* OR diagnos* OR detect* OR monitor* or treat* OR manage* OR care OR prevent* or “follow up”)):ti,ab,kw
4	(workflow* or “clinical guideline*” or “practice management software*” or “management software” or “electronic medical record” or “electronic medical system*” or EMR or “medical records software” or “decision support” or “clinical software” or “clinical decision support” or “decision algorithm” or “clinical algorithm” or audit* or “clinical management software” or “medical practice software” or prompt* or “electronic health record” or “pop-up*” or digital):ti,ab,kw
5	(Australia or “New Zealand” or “United Kingdom” or Canada or Sweden or Norway or “United States” or Netherlands or Denmark):ti,ab,kw
6	#1 and #2 and #3 and #4 and #5
7	#1 and #2 #3 and #4 and #5 with Cochrane Library publication date Between Jan 2013 and Apr 2023, in Cochrane Reviews, Trials

ti,ab,kw: Title, Abstract, and Keywords

Grey literature

We conducted a grey literature search of websites of organisations relevant to STI, HIV, HBV and HCV primary care, as well as other evidence sources noted in the project brief, and we manually searched studies eligible for inclusion. Given the focus on effective change initiatives, our search focused on evaluations and program reports. We also reviewed news reports, policy briefs and guidelines for relevant information, but included them only if they reported results of interventions We searched websites for the following organisations:

- Centre for Excellence in Rural Sexual Health (CERSH)
- Royal Australian College of General Practitioners (RACGP)
- Australian College of Rural and Remote Medicine (ACRRM)
- Primary Health Networks (PHNs)
- National Aboriginal Community Controlled Health Organisation (NACCHO)
- Family Planning NSW
- Melbourne Sexual Health Centre
- New Zealand Sexual Health Society (NZSHS)
- British Association for Sexual Health and HIV (BASHH)
- Royal College of General Practitioners—UK
- College of Family Physicians of Canada (CFPC)
- World Health Organization (WHO)
- National Institute for Health and Care Excellence (NICE)
- US Centers for Disease Control and Prevention (CDC)
- American Sexually Transmitted Diseases Association (ASTDA)
- Media outlets: AusDoc and newsGP
- Australasian Society for HIV, Viral Hepatitis and Sexual Health Medicine (ASHM)

Appendix 2—Study eligibility criteria

Question	Inclusion criteria	Exclusion criteria
1. What types of change initiatives (including new/ innovative/ emerging initiatives) targeting the GP setting and workforce have been shown to be most effective and sustainable in increasing testing for STI, HIV, HBV, HCV and comparable conditions for priority patient populations?	Focus on ➢ A change initiative ➢ GP setting or workforce engagement ➢ STI or HIV or HBV or HCV testing rates or diabetes mellitus, HPV or cervical screening rates ➢ Country of interest (Australia, New Zealand, UK, Sweden, Norway, Netherlands, Denmark, Canada, US).	➢ Hospital or emergency department setting ➢ Does not focus on country of interest ➢ Not published in English ➢ Does not focus on humans ➢ Published before 1/1/2018# ➢ Modelling, editorial, commentary, conference abstract, or no full-text article available ➢ Focuses on treatment or care of listed conditions.
2. What is the evidence for the effectiveness of modifications to practice management software in increasing GP engagement in preventive screening activities for all aspects of care for STI, HIV, HBV and HCV (prevention, testing, treatment and care) and for preventive screening activities for other comparable conditions?	Focus on: ➢ Modifying EMR software ➢ GP or clinician engagement ➢ STI or HIV or HBV or HCV testing rates, OR mental health (incl depression or anxiety) or diabetes mellitus or HPV or cervical screening rates as an outcome. ➢ Country of interest (Australia, New Zealand, UK, Sweden, Norway, Netherlands, Denmark, Canada, US).	➢ Does not focus on country of interest ➢ Not published in English ➢ Does not focus on humans ➢ Published before 1/1/2018# ➢ Editorial, commentary or conference abstract, or no full-text article available ➢ Surveillance, audit or feedback.

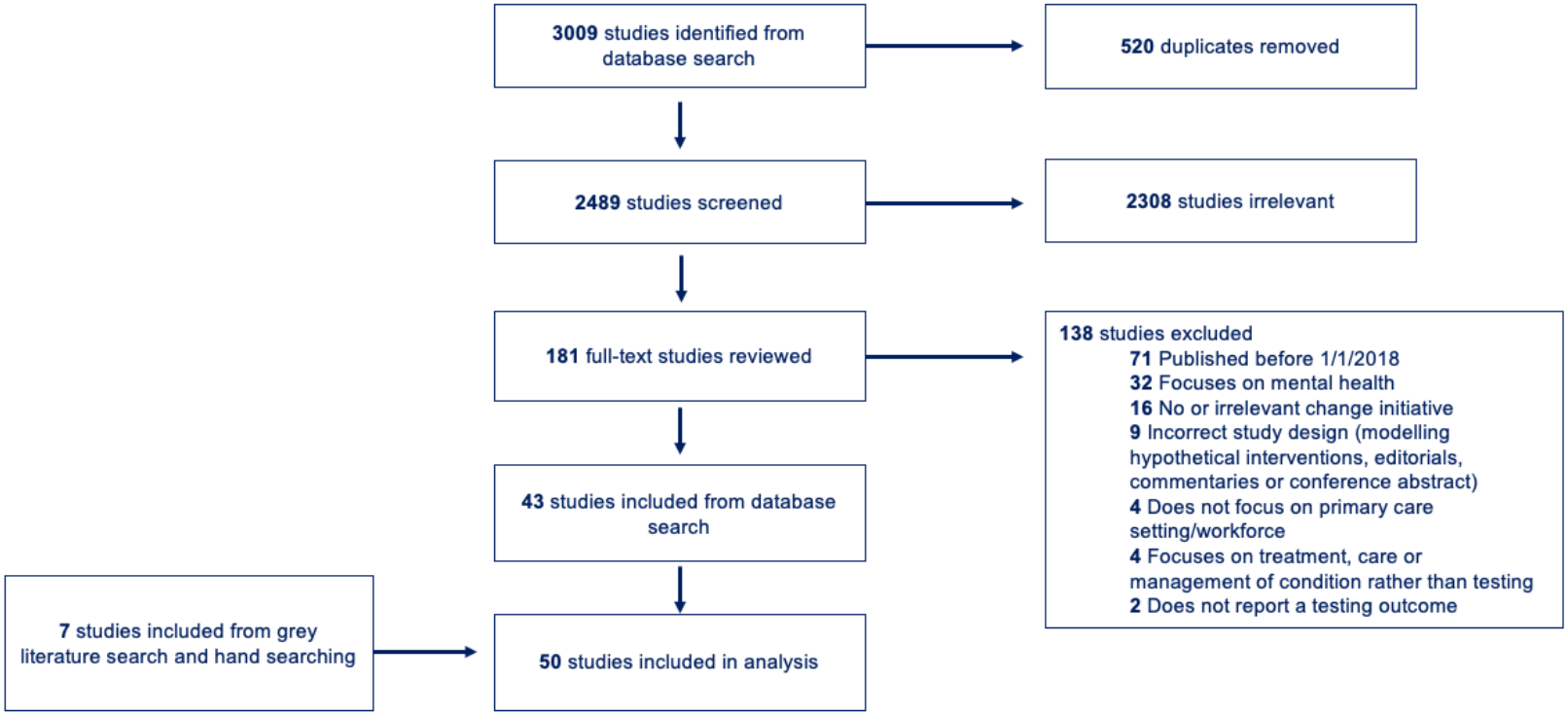
Question 1—studies were excluded if they reported on patient or provider *intent* to test or screen rather than *testing outcomes,* or reported on initiatives *conducted outside primary care* including home or online testing. Self-testing and self-sampling were included if the initiative involved engagement with primary care.

Question 2—EMR modifications were considered to include: recalls, use of artificial intelligence, qualitative studies exploring the use and acceptability of aspects of EMR for GPs and nurses, virtual care, telehealth / video consultations, automated SMS from clinic sending reminders to patients, e-prescriptions and e-referrals.

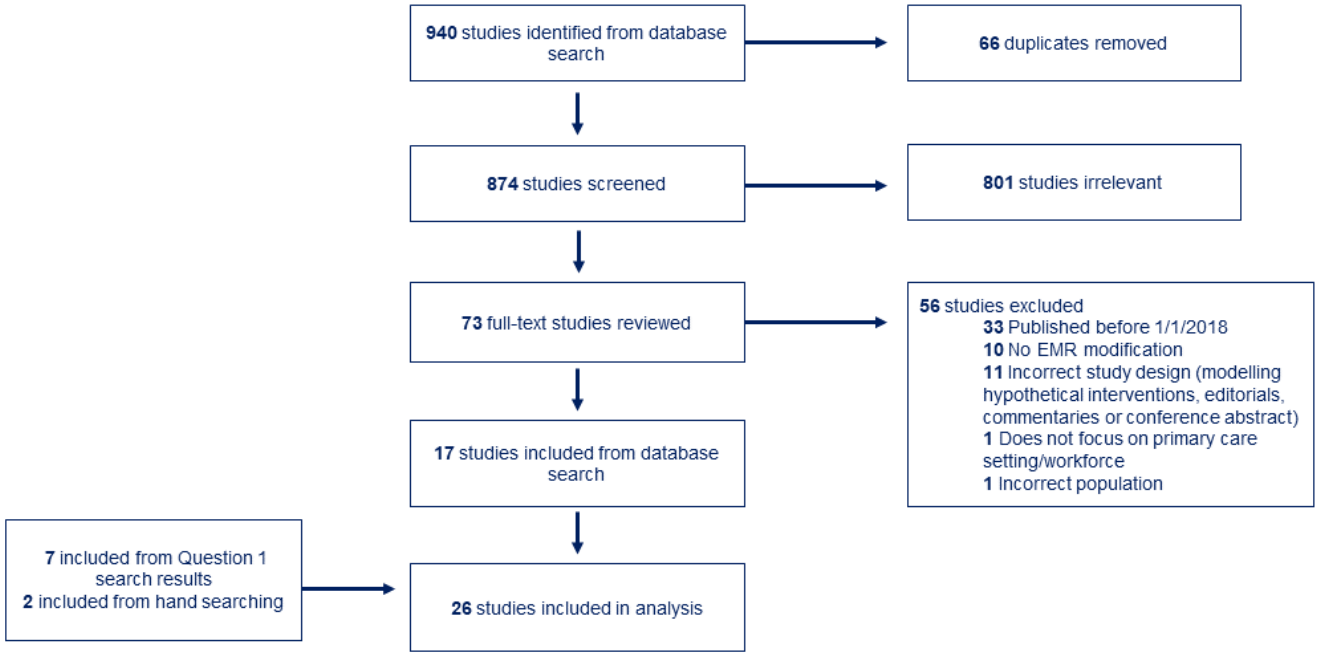
#The search strategy generated a larger volume of articles than anticipated. Therefore the time frame for inclusion was reduced from 10 to five years.

Appendix 3—PRISMA diagrams

Question 1



Question 2


940 studies identified from database search
66 duplicates removed
874 studies screened
801 studies irrelevant
73 full-text studies reviewed
56 studies excluded
33 Published before 1/1/2018
10 No EMR modification
11 Incorrect study design (modelling hypothetical interventions, editorials, commentaries or conference abstract)
1 Does not focus on primary care setting/workforce
1 Incorrect population
17 studies included from database search
7 included from Question 1 search results
2 included from hand searching
26 studies included in analysis

Grey literature

The grey literature search identified 98 potentially relevant sources from manually searching the websites of identified organisations. Most results identified were best practice guidelines, strategic initiatives, educational opportunities for clinicians, news articles, clinical decision tools and quality improvement planning initiatives. Of these, 15 were reviewed by two members of the team and one article met inclusion criteria and was added to the analysis. All other records were excluded as they did not include appropriate outcome measures or were not specific to primary care.

Appendix 4—Summary of included studies for Question 1 and Question 2

Author, year, country, disease, *Question*	Design	Setting (target patient population)	Type of change initiative and description	Study outcomes and main findings
STIs, HIV, HBV and HCV				
Adily[69] **2020** Australia (syphilis) *Question 1*	Pre-post intervention Quantitative	Aboriginal Medical Services (n=110) (Aboriginal people aged 15–54 years)	**Quality improvement** (Target—GPs) Aim: To explore the impact of continuous quality improvement (CQI) on syphilis testing over time. Elements: Preventive health module (including syphilis testing) as part of the Audit and Best Practice for Chronic Disease (ABCD) CQI program. Repeated clinic self-audit of clinical records to assess syphilis testing performance. Funding: NA	Outcomes: Syphilis testing performance (STP) (tests conducted/ offered) over time. Findings: Modest improvement in STP. Compared with CQI cycle one, patients in CQI cycles 2–6 were more likely to receive or be offered a syphilis test (OR range 1.16–1.46), but no clear trend of increasing STP with increasing CQI cycles. A reduction in the number of clinics participating in CQI over time was noted and may bias results.
Bagchi[17] **2018**	Pre-post intervention	Primary care clinicians (n=11) (representing	**Provider education**	Outcomes: Self-reported increase in CDC guideline adherent HIV screening.

Author, year, country, disease, ***Question***	Design	Setting (target patient population)	Type of change initiative and description	Study outcomes and main findings
US **(**HIV) *Question 1*	Mixed methods	solo, group & federally qualified health centres) Patients aged 13–64 years	Aims: To identify and address barriers to HIV screening. Elements: Baseline survey on barriers to HIV screening followed by a brief self-directed recorded education package (approx 15–20 minutes) comprising testing recommendations, risk groups, patient / provider resources. Follow-up survey to ascertain percentage of patients screened and whether barriers were addressed. Funding: NA	Findings: Guideline-adherent HIV screening increased (27%to–34%) but was not statistically significant. Intentions to screen across all encounter types increased and was largest during annual physicals at 82% (a 46% increase) but was not statistically significant. A small sample size and self-reporting is likely to reduce the internal validity of this study.
Bogers 2023[29]* and **Bogers 2021[30]*** Netherlands (HIV, chlamydia and gonorrhoea)	Pre-post intervention	General practitioners (n=229/504 Amsterdam GPs participated)	**Quality improvement** Aim: To improve HIV and STI (chlamydia and gonorrhoea) testing by Amsterdam GPs. Elements: HIV/STI education program (delivered by an organisation that facilitates integrated healthcare in primary care): comprising i) repeat education sessions	Outcomes: Laboratory data analysis to assess HIV, gonorrhoea and chlamydia test frequency, rates and positive test proportions. Findings: Bogers 2021: During 2011–14 (pre-intervention) HIV testing rates declined by

Author, year, country, disease, ***Question***	Design	Setting (target patient population)	Type of change initiative and description	Study outcomes and main findings
*two articles on the same initiative, but different outcomes *Question 1*			(included resources such as STI testing flow charts), ii) audit and feedback, iii) quality improvement plans, and iv) regular digital newsletters with HIV / STI updates. Funding: NA	31% from 175 to 116 per 10,000 person years (IRR 0.69) then stabilised during 2014–17 (intervention years) (IRR 1.06). STI testing rates for: • Men were stable (chlamydia IRR 1.06; gonorrhoea IRR 1.00) in the pre- and intervention period. • Women were declining pre-intervention (chlamydia IRR 0.77; gonorrhoea IRR 0.70) pre-intervention and increased slightly during the intervention years. Good acceptability by GPs attending the sessions. Updated results from Bogers 2023: Between 2015 and 2020 there was an increase in HIV and chlamydia testing by 7% and 6% respectively and a slight decrease in gonorrhoea testing (2%). Changes in testing were sustained a year post intervention.

Author, year, country, disease, *Question*	Design	Setting (target patient population)	Type of change initiative and description	Study outcomes and main findings
Callander[63] **2018** Australia (STIs) *Question 2*	Pre-post intervention Obser-vational	General practice (n=7) (Gay and bisexual men)	**EMR modification (EMR alert and clinical decision support)** Aim: To improve delivery of sexual healthcare. Elements: Computerised clinical decision support system built into existing software (PrimaryCare Sidebar) that queries the patient EMR and generates prompts and assessments or triggers recalls. Categorises patients into risk categories based on testing frequency, number of new partners and condom use. Biannual feedback reports to clinics on testing trends, positivity and sexual orientation recording within the clinic. 24-month intervention. Types of general practices: High caseload general practices in Sydney and Melbourne and four comparison clinics. Funding: NA	Outcomes: Pre and post intervention HIV and STI testing and detection rates. Findings: At intervention clinics there was a 19% increase in sexual orientation recording compared with pre-intervention. There did not appear to be a difference in sexual health testing uptake between the pre- and intervention periods (SRR 0.97, 95% CI 0.94–1.00, P=.2). For patients tested for HIV or other STI there was an 89% increase in comprehensive sexual health testing (26.3% to 48.8%, SRR 1.38, 95%CI 1.28–1.46) (P<.001). Comprehensive testing doubled among patients living with HIV (94/560 [16.8%] to 240/665 [36.1%], P<.001). In clinics that received the intervention, there was an increase in chlamydia and gonorrhoea detection not observed in comparison sites.

Author, year, country, disease, *Question*	Design	Setting (target patient population)	Type of change initiative and description	Study outcomes and main findings
Chak[59] **2018** US (HBV) *Question 2*	Randomised controlled trial	Primary care clinics (Target >18, Asian and Pacific Islander (API) ethnicity, private health insurance)	**EMR modification (EMR alert)** Aim: To measure the effectiveness of an EHR alert on hepatitis B surface antigen (HBsAg) screening of API-born patients. Elements: EHR alert that was activated for patients of self-identified or an imputed API background based on surname, language or country of origin. The alert prompted clinicians to complete Hep B screening (HBV surface antigen). A completed HBsAg test automatically changed the alert status from due to done. At-risk API patients were randomised to the alert or not (control). Type of general practices: Uni of California Davis health system. Funding: N/A	Outcomes: Hep B screening completed and number of positive cases. Findings: HBsAg testing was completed in 8.0% (119/1484) patients in the alert group vs. 3.2% (48 /1503) in the control group (OR 2.64; 95%CI, 1.88–3.73). In the alert group 3.4% tested HBsAg positive vs 10.4% in controls (p=0.12).
Chan[44] **2021** Australia (HCV)	Evaluation Quantitative	Primary healthcare services	**Patient engagement** Aim: To engage new and existing clients in HCV testing in primary care services with high caseloads of PWID.	Outcome: HCV testing uptake. Findings: 91 participants received an incentivised HCV test, 24 (26%) were RNA positive. No comparator was used. Across all four services, regular clients were retained in the care cascade at a higher

Author, year, country, disease, *Question*	Design	Setting (target patient population)	Type of change initiative and description	Study outcomes and main findings
Question 1		(Target—people who inject drugs (PWID))	Elements: A pilot HCV testing and awareness campaign (from Eliminate Hepatitis C Victoria Partnership–EC Vic) that was run as an event to coincide with World Hepatitis Day in four primary care, three community health services and one private general practice with a high caseload of opioid substitution therapy. At campaign sites, nurses provided promotional materials, on-the-spot testing and financial incentives for patients to test. Funding: Eliminate Hepatitis C Victoria: provided nursing and project staff, merchandise and AUD$500 per service to support testing financial incentives.	proportion compared with non-regular clients of the service, although low numbers prohibited formal statistical comparison. Health service staff and campaign nurses affirmed that financial incentives were key motivating factors for patient participation.
Cheng[48] **2021** Australia (STIs) *Question 1*	Post-intervention Mixed-methods	Family Planning NSW	**Service level funding** Aim: To examine whether the use of telehealth increased the number of STI screening related consultations.	Outcome: Use of telehealth for STI including screening. Findings: Of 4681 patients who had MBS-subsidised consultations during Apr–Sep 2020, STIs were one of the most frequent reasons for telehealth presentations: telehealth only n=148 (13%), face-to-face

Author, year, country, disease, *Question*	Design	Setting (target patient population)	Type of change initiative and description	Study outcomes and main findings
			Elements: Use of telehealth (telephone and video) consultations compared with face-to-face or both. Funding: Telehealth consultations were MBS rebatable.	only n=167 (6%), both telehealth and face-to-face n=82 (10%). Most patients felt more comfortable discussing sexual and reproductive health in telehealth consultations, though two patients preferred face-to-face for sensitive topics and five believed quality of care was better during face-to-face.
Coppock[15] **2020** US (HCV) *Question 1 and Question 2*	Retrospective cohort study Quantitative	Primary care clinics (six primary care clinics affiliated with Drexel Uni, Philadelphia) (Target—individuals born 1945–65)	**Provider education, EMR modifications** (Target—providers, nurses and patient navigators) Aim: To increase HCV screening among baby boomers (born 1945–65) in line with CDC recommendations for universal screening. Elements: The C for Cure program was created by Drexel University's College of Medicine to target HCV screening for baby boomers at 6 urban primary care clinics. C for cure comprises provider education and EMR decision support to increase screening among target patients (no further detail provided).	Outcome: Change in HCV screening rates Findings: The cumulative HCV screening rate increased from 16% in 2012 to 82% in 2017 with a gradual increase for new and previously tested patients. Among 6717 patients screened, 18% had duplicate testing of which 14% were not clinically indicated by precious testing results. African American and Asian patients were more likely to be ever-screened.

Author, year, country, disease, *Question*	Design	Setting (target patient population)	Type of change initiative and description	Study outcomes and main findings
			Funding: NA	
Dale[80] **2022** Canada (HCV) *Question 1*	Interrupted time series Quantitative	Primary care clinics in Ontario, Canada (Target—risk-based and birth cohort born 1945–75)	**Models of care** Aim: To assess the feasibility of a nurse-led model for HCV testing, care and treatment in primary care. Elements: Six-hour training session on HCV care and treatment for nurse practitioners (NPs). NPs then developed and implemented a HCV screening approach for their clinic. NPs were provided with treatment algorithms. One clinic included mailouts based on birth cohort. Honorarium for NPs to support data collection. Funding: Research funding (Gilead, Viral Hepatitis Care network).	Outcomes: HCV screening numbers, antibody and RNA prevalence, and treatment. Findings: Over one year, 1026 patients were screened by 9 NPs (87.4% were birth cohort testing) with 1.66% antibody positivity, of which 76.5% were RNA positive. All RNA-positive treatment eligible individuals were treated by the NP and completed treatment.
Davies[19] **2018** UK	Stepped-wedge RCT	General practices	**Provider education** Aim: To increase provider HIV testing awareness.	Outcomes: Change in HIV testing rate. Findings: HIV testing rate increased from 17.4 to 19.1 per 1000 patients in

Author, year, country, disease, *Question*	Design	Setting (target patient population)	Type of change initiative and description	Study outcomes and main findings
(HIV) *Question 1*	Mixed methods	(with a high HIV prevalence) (Target—high-risk HIV population)	Elements: One-hour interactive workshop given to GPs and practice staff by a specialist registrar. Content adapted for local use from Medical Foundation for HIV and Sexual Health HIV (MEDASH) Testing in Practice education toolw). Note: MEDFASH closed 31 Dec 2016. A MEDFASH archive is available at https://www.nat.org.uk/publications?field_topic_tid=785 Funding: Research funding.	intervention clinics and from 15.3 to 17.6 per 1000 patients in control clinics. However the HIV testing rate increased more in control than in intervention clinics, mean difference 2.6 (95% CI 0.5,4.7) vs 1.9 (−0.5,4.3) per 1000 patients, respectively. High acceptability among providers.
DeSilva[60] **2020** US (HBV) *Question 1 and 2*	Two-arm, group randomised pilot study Quantitative	Primary care clinics (n=9 with > 450 non–English-speaking patients) (Target—non–US-born patients from countries with	**EMR modifications (EMR alert and clinical decision support)** (Target—clinicians) Aim: Increase HBV screening in non–US-born populations from high-HBV prevalence countries. Elements: A clinical decision support tool called Hepatitis B Best Practice Alert (BPA) (identifying patients from countries with >2% HBV prevalence and no recorded HBV	Outcome: HBV screening tests ordered and cases detected. Findings: During a nine-month pilot, the BPA was triggered for 2574 and 2117 patients in passive and active clinics respectively and HBV screening tests were ordered for 325 (12.6%) and 333 (15.7%) in passive and active clinics respectively. No statistical analysis was performed. Six patients tested positive. Clinician response to the alert was low and

Author, year, country, disease, *Question*	Design	Setting (target patient population)	Type of change initiative and description	Study outcomes and main findings
		≥2% HBV prevalence and no prior screening))	screen). BPA provided a i) pop-up alert recommending HBV testing (passive intervention), **or** ii) the pop-up alert linked to a pathology order set (called SmartSet) and follow-up plans for patients testing positive (active intervention). Types of general practices: Primary care clinics (family practice, internal medicine, paediatrics). Funding: Program for Health Disparities Research (University of Minnesota), Medtronic Foundation, CDC.	decreased over time (4.7% in 2012 to 2.0% in 2018).
Elattma[25] **2020** US (Chlamydia) *Question 1*	Review of CQI initiative Quantitative	Federally Qualified Health Center, San Francisco, providing primary care for paediatric and	**Quality improvement, financial Incentives and streamlining clinic processes** (Target—registered nurses, medical assistants and medical staff) Aim: To increase chlamydia screening rates for female patients aged 16–24 from 29.2% to 44%.	Outcomes: Annual chlamydia screening rates Findings: Annual chlamydia screening rate for 16–24-year-old female patients increased from 29.2% to 61.5% in 18 months and improved to 71.2% one year after the project.

Author, year, country, disease, *Question*	Design	Setting (target patient population)	Type of change initiative and description	Study outcomes and main findings
		adolescent patients (Target—females aged 16–24 years)	Elements: Universal opt-out urine collection, staff education and training, QI and feedback, visual reminders, financial incentives of $400 and $2500 for project champions if targets were met. Types of general practices: Primary care, urgent care and specialty care. Funding: Zuckerberg San Francisco General institution-wide 'Resident and Fellow Performance Improvement Incentive Program'.	
Feller[67] **2018** US (HIV) *Question 2*	Predictive modelling	Primary care (Target—individuals receiving care at Columbia University Medical Center)	**Natural language processing (NLP)** Aim: To examine whether NLP would improve predictive models of HIV diagnosis Elements: 181 HIV+ individuals and 543 HIV- controls and EHR data (demographics, laboratory tests, diagnosis codes and unstructured notes) were extracted. Three predictive machine-learning algorithms were developed: i) baseline model with structured	Outcomes: Predictive performance of NLP in HIV risk assessment. Findings: The baseline + NLP keyword model yielded the highest precision by including keywords (e.g. 'MSM', 'unprotected', HIV, methamphetamine) and structured EHR data indicative of other HIV risk factors. NLP improved the predictive performance of automated HIV risk

Author, year, country, disease, *Question*	Design	Setting (target patient population)	Type of change initiative and description	Study outcomes and main findings
			EHR data, ii) baseline plus NLP topics, and iii) baseline plus NLP clinical keywords. Type of general practice: Columbia University Medical Center (a large metropolitan medical centre that includes hospitals and outpatient clinics). Funding: Nil reported.	assessment by extracting terms in clinical text indicative of high-risk behaviour.
Fimmel[49] **2021** US (HCV) *Question 2*	Pre-post intervention	Primary care clinics (Target—birth cohort 1945–65)	**EMR modifications (EMR alert)** Aim: To assess the effect of a best practice alert (BPA) on HCV age-cohort screening. Elements: Previously unscreened patients born 1945–65 were automatically identified by the EMR during a clinic visit. The EMR alert was then displayed within the EMR and linked to an HCV antibody test order. Types of general practices: Clinics within the NorthShore University Health System Funding: Unclear.	Outcomes: Hep C screening levels pre- and post-EMR alert. Findings: HCV screening rates increased from 3.0% (CI 2.3%–3.8%) pre-alert to 13.6% (CI 11.3%–15.9%) at nine months post- alert and to 28.3% (CI 25.3%–31.3%) at one year later. HCV testing rates varied among physicians, with approx 35% of clinicians responsible for 80% of test orders.
Flanagan[(12)] **2019**	Randomised controlled trial	General practice (n=63 in areas with high migrant	**Provider education, financial Incentives, EMR modifications (EMR prompt)**	Outcomes: Uptake of HBV and HCV testing.

Author, year, country, disease, ***Question***	Design	Setting (target patient population)	Type of change initiative and description	Study outcomes and main findings
UK (HBV and HCV) *Question 1 and 2*	Quantitative	density, n=9 in areas with low migrant density) (Target—migrants)	Aim: To determine if incentives and support for GPs increases screening of adult migrants for HBV and HCV. Elements: GPs at control clinics received a one-hour education session and were asked to test all migrant patients (opportunistic screening). GPs at intervention clinics received £500 to set up record searches, received prompts to test when accessing records of eligible patients, received senior clinical support and were reimbursed £25 for each signed consent form. Eligible patients were sent a standard or enhanced letter inviting them to attend the practice for testing. Funding: NA	Findings: In control clinics, screening was taken up by 543 (1·7%) of 31,738 eligible patients. In the 50 clinics that used the intervention, screening was taken up by 11,386 (19·5%) of 58,512 eligible participants (IRR 3·70, 95% CI 1·30–10·51; p=0·014). The intervention was cost-effective. 720 (4·5%) of 15,844 patients who received a standard letter vs. 1032 (3·7%) of 28,095 patients who received the enhanced letter were tested (IRR 0·70, 0·38–1·31; p=0·26).
Footman[39] **2021** Australia, South Africa, Canada, UK, US	Systematic review	STI clinics, general practice, urgent care, primary care clinic, university clinic	**Streamlining clinic processes, innovative testing methods, EMR modifications (CDSS)** Aim**:** To review the implementation or evaluation of STI screening programs in clinical settings.	Outcomes: Change in STI testing rates, barriers and enablers, cost impacts Findings:

Author, year, country, disease, ***Question***	Design	Setting (target patient population)	Type of change initiative and description	Study outcomes and main findings
STIs *Question 1 and 2*			Elements: Opt-out testing policies, EMR CDSS —alerts for females who had not had an annual chlamydia screen, patient self-testing, express testing (patients with low-risk factors were able to forgo physical examination and receive STI/HIV testing), POC tests and sample-first approach (POC test before seeing clinician). Funding: NA	**Computer-generated lab order sheet** and change to **opt-out testing policy** increased STI testing from 5.5% to 45.2%. **EMR-based CDSS:** Adolescent girls were 2.143 times more likely to be screened. **Self-sampling** at HIV clinic—32% increase in pharyngeal testing from 444 to 586 tests performed and a 33% increase in rectal testing from 390 to 520 tests performed. There were 47% and 50% increased yields for the detection of chlamydia and gonorrhoea infections, respectively, compared with baseline data. **Express testing criterion**—significant increase in chlamydia, gonorrhoea and syphilis diagnosis compared with standard care, reduced consultation time by median of nine minutes per male visit and 13 minutes per female visit. **Same-day testing using GeneXpert**—decrease in reinfections from 20% before implementing this program to 12%

Author, year, country, disease, *Question*	Design	Setting (target patient population)	Type of change initiative and description	Study outcomes and main findings
				(prevalence ratio, 0.60; 95% CI, 0.33–1.09) after implementation. Asking physicians to alter their individual practices by identifying patients to screen for STI testing led to a decline in testing rates and negative physician feedback.
Furness[24] **2020** US (STIs and HIV) *Question 1*	Pre-post intervention Mixed methods	Federally Qualified Health Centers (n=10 in 123 clinical sites across nine states) (Target—lesbian, gay, bisexual and transgender (LGBTIQ+) people) FQHCs provide primary care	**Quality improvement and increasing patient engagement** Aim: To increase appropriate STI and HIV screening in LGBTIQ+ patients. Elements: One-year intervention titled Transforming LGBTIQ+ Care that drew on the Practice Improvement Collaborative and Project Extension for Community Health Outcomes (ECHO) models that help to apply guidelines and address barriers in real-world settings. Comprised coaching in appropriate and inclusive screening, documenting sexual identity and gender, resources, sexual history	Outcomes: Number of LGBTIQ+ patients receiving appropriate STI and HIV screening. Findings: Screening of LGBTIQ+ patients increased from 22.3% (95% CI, 4.9%–40.0%) to 34.6% (95% CI, 19.4%–48.6%) for syphilis (86.5% increase); from 25.3% (95% CI, 7.6%–43.1%) to 44.1% (95% CI, 30.2%- 58.1%) for chlamydia and gonorrhoea (109.0% increase); and from 14.8% (95% CI, 3.2%–26.5%) to 30.5% (95% CI, 26.7%–34.3%) for HIV (132.4% increase). Improved sexual identity and

Author, year, country, disease, *Question*	Design	Setting (target patient population)	Type of change initiative and description	Study outcomes and main findings
		and supportive services to medically underserved and priority populations	taking, workflows, PDSA cycles, videoconferencing. Funding: CDC and Federal grant from the US Health Resources and Services Administration (HRSA) Health Center Program.	gender recording increase from 13.5% to 50.8%. Good adoption, involvement in intervention increased from 10 clinical sites to 431 clinicians at 79 sites.
Geboy[50] **2019** **US** (HCV) *Question 1 and 2*	Retrospective cohort study Quantitative	Primary and specialty care clinics (Target—birth cohort 1945–65)	**EMR modifications (EMR alert and clinical decision support)** (Target—providers) Aim: To identify and prompt birth cohort patients for HCV screening and linkage to care. Elements: EMR prompt and clinical decision support for HCV testing with clickable links to testing protocols, printable patient handouts and a HCV test ordering for birth cohort patients. Funding: NA	Outcomes: HCV screening rates Findings: From Jul 2015 to Dec 2016 11.5% of eligible birth cohort patients (n = 9304) were HCV antibody tested among the 80,587 patients eligible for testing; links to testing protocols (38.5%, n=31,064) and HCV testing prompts (28%, n=22705) were accessed; resulting in HCV testing (n=9304 for 43% of occasions of the prompt) or provision of a handout about HCV testing (n=7467). No before measures for comparison.

Author, year, country, disease, *Question*	Design	Setting (target patient population)	Type of change initiative and description	Study outcomes and main findings
Guy[41] **2018** Australia (STI) Chlamydia and gonorrhoea *Question 1*	Randomised controlled trial – cluster crossover Quantitative	Primary care services in regional or remote Australia (n=12) (Target—Aboriginal people)	**Innovative testing methods** (Target—doctors, nurses and Aboriginal health workers) Aim: To assess the efficacy of point-of-care chlamydia or gonorrhoea tests for improving infection management in high STI prevalence communities. Elements: Molecular POC testing vs. standard laboratory-based testing. Training for intervention clinics on POC testing. Funding: Research funding.	Outcomes: Reinfection rates (retest positive at three weeks to three months) post treatment. Treatment within seven days. Findings: Among individuals with a positive test 14% (63/466) in the intervention group were retested within three weeks to three months after treatment compared with 17% (67/405) in the standard care group.
Haridy[53] **2021** North America (n=56), Europe n=10), Australasia (n=7), Asia (n=7) (HBV and HCV)	Systematic review Included studies (n=80): hep C (n=65), hep B (n=12),	Primary care clinics, hospital and emergency departments	**EMR modifications** Aim: To review evidence about e-health interventions for HBV and HCV screening, diagnosis and treatment outcomes. Elements: EMR alerts, universal screening.	Outcomes: HBV and HCV screening and diagnosis rates, sustained virologic response (SVR) after HCV treatment, HBV antiviral treatment rates, treatment adherence, or patient/clinician satisfaction with e-health technologies. Findings: Compared with standard care, EMR alerts significantly increased screening

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Question 1 and 2	hep B + C (n=3)		Types of general practices: Mostly primary care practices and some hospital settings. Funding: Author funded by an Australian Government Research Training Scholarship.	rates in target populations and had the lowest incremental cost per new HCV case. Direct messaging alerts to providers prior to an appointment had a larger effect than EMR alert. Multifaceted interventions (e.g. clinician education, audit and feedback) had an additive effect when combined with EMR alerts. EMR electronic referral alerts increased linkage to care. In HCV care, telehealth consultations had higher satisfaction than face-to-face but had no effect on SVR outcomes. Insufficient evidence for the impacts of CDSS.
Heil[38] **2018** Netherlands (HBV and HCV) *Question 1*	Prospective cohort Quantitative	General practices (n=11) in two high HCV prevalence areas in the Netherlands (Target—birth cohort 40–70 year-olds)	**Risk stratified test invitation sent by public health service** (Target—primary care physicians) Aim: To determine diagnostic yield (test uptake and rate of positive tests) from a public health and primary care birth cohort testing strategy in detecting hidden HCV and HBV infections.	Outcomes: HBV and HCV test uptake from invited tests and positivity. Findings: Test uptake of 50.9%. No active HCV infection diagnosed. HCV positivity = 0.2%, HepSAg positivity = 0.26%. Strategy not recommended for countries with low prevalence.

Author, year, country, disease, *Question*	Design	Setting (target patient population)	Type of change initiative and description	Study outcomes and main findings
			Elements: Invitation letter for HCV/HBV testing (from the regional public health service) to birth cohort patients of 11 clinics to access free testing at two local community centres or patient's GP. Intervention was not through the general practices but targeted their patients. Funding: Research funding (Abbvie, National Institute for Public Health and Environment).	
Hocking[26] **2018** Australia (Chlamydia) *Question 1 and 2*	Randomised controlled trial – cluster Quantitative	General practice (n=130 in regional Victoria, NSW, Queensland and South Australia) (Target—young people aged 16–29)	**Quality improvement, financial incentive and EMR modification (EMR alert)** (Target—GPs and nurses) Aim: To investigate the effect of opportunistic testing in primary care clinics on chlamydia prevalence in the population. Elements: Intervention group: education, payments for GPs (AUD$5, $7, or $8 per test when <20%, 20–40%, or >40% of eligible patients were tested) and nurses (AUD$10 per test), feedback on test performance, EMR	Outcomes: Chlamydia prevalence in patients 16–29 years. Yearly chlamydia testing rates and re-testing rate within six weeks to six months after a positive test. Findings: The yearly proportion of patients tested increased from 8·2% (95% CI 7·0–9·4) at 13–24 months pre-randomisation to 20·1% (18·4–21·8) at 25–36 months after randomisation in intervention clusters (difference 11·9%, 95% CI 10·3–13·4), and from 8·2% (95% CI 7·2–9·2) at 13–24 months pre-randomisation to 12·9% (11·2–

Author, year, country, disease, *Question*	Design	Setting (target patient population)	Type of change initiative and description	Study outcomes and main findings
			alert prompting testing of eligible patients, support to develop a reminder/recall system. Comparator: usual care. Funding: Australian Department of Health, NHMRC, Victorian Department of Health and Human Services, and NSW Ministry of Health.	14·5) at 25–36 months after randomisation in control clusters (difference 4·7%, 3·3–6·0). The increase was greater in intervention than in control clusters. The proportion retested within 10–15 months of a negative test and six weeks to six months of a positive test was higher in intervention than control clusters. The highest proportion was 10·4% (95% CI 8·7–12·1) after one year in intervention clusters; and declined to <4·0% in both groups by the final year.
Hocking 2022[31] Australia Chlamydia *Question 1*	Randomised controlled trial – cluster Quantitative	General practices n=60 in regional Victoria, NSW, Queensland and South Australia)	**Quality improvement and financial incentives** (Target—GPs) Aim: To determine if chlamydia testing in general practice is sustained after removal of financial incentives and/or audit and feedback. Elements: Intervention clinics from the ACCEPt trial (Hocking 2018) were randomised into one of four groups: financial	Outcomes: Annual chlamydia testing rate among 16–29-year-old patients. Findings: Annual testing decreased from 20.2% to 11.7% (difference −8.8%; 95% CI −10.5% to −7.0%) in clinics with financial incentives removed and decreased from 20.6% to 14.3% (difference −7.1%; 95% CI −9.6% to −4.7%) where incentives were retained. The adjusted absolute difference

Author, year, country, disease, ***Question***	Design	Setting (target patient population)	Type of change initiative and description	Study outcomes and main findings
		(Target—young people aged 16–29)	incentives removed but audit/feedback retained (group A), audit/feedback removed but incentives retained (group B), both removed (group C), or both retained (group D). Financial incentives were (AU$5–AU$8) for each chlamydia test conducted and quarterly audit/feedback comprised reports of testing rates. Funding: NA	in treatment effect was −0.9% (95% CI −3.5% to 1.7%; p = 0.2267). Annual testing decreased from 21.0% to 11.6% (difference −9.5%; 95% CI −11.7% to −7.4%) in clinics where audit/feedback was removed and decreased from 19.9% to 14.5% (difference −6.4%; 95% CI −8.6% to −4.2%) where audit/feedback was retained. The adjusted absolute difference in treatment effect was −2.6% (95% CI −5.4% to −0.1%; p = 0.0336). Audit feedback was more effective than financial incentives in sustaining GP chlamydia testing practices over time.
Jones[54] **2018** US	Prospective study Quantitative	Primary care (n=150) (Target—birth cohort 1945–65)	**EMR modifications (EMR alert)** Aim: To evaluate if an EMR reminder increased hepatitis screening, referral and cure. Elements: EMR screening reminder under both Health Maintenance and Best Practice	Outcomes: Number of patients screened and receiving hep C treatment. Findings: HCV screening increased from 1.9% (pre-alert) to 14% after 12 months. Positive case detection increased from two to 32 patients after 12 months. All 32

Author, year, country, disease, *Question*	Design	Setting (target patient population)	Type of change initiative and description	Study outcomes and main findings
(HCV) *Question 2*			Advisory tabs was added for patients born 1945–65. Type of general practices: Baylor Scott & White Central outpatient clinics in Texas. Funding: Nil reported.	patients were referred for care (19 treated, 16 cured).
Joore[21] **2018** Netherlands (HIV) *Question 1*	Pre-post intervention Prospective cohort study Quantitative	General practice	**Provider education and quality improvement** (Target—GPs) Aim: To assess the effects of a blended education program on HIV testing practices. Elements: Blended education program for GP trainers (who mentor resident GPs) to stimulate HIV testing behaviours. Comprised e-learning and multiple teaching strategies (e.g. interactive workshops / discussion groups about barriers and facilitators to using STI guidelines, reflection; developing QI targets). Type of general practice:	Outcomes: HIV testing rates for participating and non-participating GPs (analysis of laboratory data). Findings: For program-participants, the mean annual number of HIV tests declined by 13% before the program (2010–13), and by 1.8% after the program (2014–15). For non-participants, the mean annual number of HIV tests declined by 9.1% before the program (2010–13), and by 2.3% after the program (2014–15). After the program, participants had twice as many laboratory-documented HIV tests as did non-participant GPs. Weak evidence that the program contributed to a slowing in the decline of

Author, year, country, disease, *Question*	Design	Setting (target patient population)	Type of change initiative and description	Study outcomes and main findings
			An academic medical centre at the University of Amsterdam. Funding: NA	HIV testing. There was a continuing downward trend in GPs' laboratory-documented HIV testing.
Kershaw[61] **2018** US (HIV) *Question 1 and 2*	Pre- and post-intervention Retrospective cohort Quantitative	Hospital-based academic primary care practice, Boston Massachusetts	**EMR modifications (EMR alert)** (Target—residents and attending doctors) Aim: To promote universal HIV screening; to evaluate the impact of an EMR alert on HIV screening rates. Elements: A passive EMR reminder appeared on the EMR home screen for all patients (age 13–65 years) alongside other clinical reminders. The reminder disappears if testing is performed, or if the practitioner manually enters that a test has been done elsewhere or the patient has declined testing. Funding: NA	Outcomes: HIV testing rates and positivity before and after the alert. Findings: Among previously unscreened patients the proportion tested for HIV increased from 15.3% (pre EMR alert) to 30.7% after the EMR alert (RR 2.02, CI 1.95–2.09, $p < 0.0001$). HIV testing rates increased the most (from 9.7% to 27.2%) for patients aged 45–65 years. Patients of white ethnicity with English as the primary language and a higher median household income were less likely to be screened both before and after the EMR alert. HIV positivity increased from 0.3% pre-intervention to 0.7% post alert ($p = 0.0001$).

Author, year, country, disease, *Question*	Design	Setting (target patient population)	Type of change initiative and description	Study outcomes and main findings
Khan[51] **2021** US (HCV) *Question 1 and 2*	Pre-post intervention Quantitative	NorthShore University Health System—no further details provided (Target—birth cohort 1945–65) (Target—primary care physicians)	**EMR Modifications (EMR alert)** Aim: To evaluate the impact of a best practice alert on HCV birth-cohort screening rates. Elements: An EMR-based BPA to prompt HCV birth-cohort screening. The alert was linked to an order for the HCV antibody test, allowing the HCP to place the order with a single keystroke, or to forgo testing. Opt-out without response was possible. Types of general practices: Unclear, involved 155 primary care physicians. Funding: Gilead Biosciences.	Outcomes: Change in HCV screening rates. Findings: The HCV screening rate per clinician increased from 3.3% to 13.2% (P < 0.0001). After the introduction of BPA the gap between low- and high-performing testers narrowed. Modest increases in testing by a large number of low-performing PCPs could have the potential to drive substantial improvement in the program's implementation.
Layman[46] **2020** US (HCV) *Question 1*	Pre-post intervention Quantitative	Federally Qualified Heath Centres (n=6) in Baltimore and county areas of Maryland Family practice, internal	**Quality improvement and streamlining clinic processes** (Target—providers and medical assistants) Aim: To reduce barriers to HCV risk assessment and testing and to improve assessment and testing rates by 30%.	Outcomes: HCV testing rates. Findings: A total of 2973 risk assessments and 1831 HCV tests were completed pre-intervention compared with 3708 risk assessments and 3790 tests post-intervention, demonstrating a 35% and 125% improvement respectively.

Author, year, country, disease, *Question*	Design	Setting (target patient population)	Type of change initiative and description	Study outcomes and main findings
		medicine and paediatrics	Elements: Staff education, streamlined risk screening assessment, automated electronic health record alerts, monthly feedback reports and standing orders were integrated into current screening and testing practices. Funding: NA	
Leber[47] **2020** UK (HIV) *Question 1*	Interrupted time series Quantitative	General practice (n=42)	**Financial incentives, EMR modifications, models of care** (Target—nurses) Aim: To promote HIV screening in general practice. Elements: Real-world post-trial implementation of Rapid HIV Assessment (RHIVA) involving a routine HIV test offer of rapid/serology testing by nurses. This study followed a cluster RCT of RHIVA showing nurse-led screening (with an education and support package, quality assurance, computer prompts and incentives (£10 for clinic per rapid test performed / recorded) resulted in	Outcomes: Comparison of HIV testing and diagnosis rates and CD4 at diagnosis between three periods (pre-trial 2009–10, trial 2010–12, real-world implementation 2012–14). Findings: The HIV testing rate in real-world implementation practices increased by 85% from 1.798 (95%CI 1.657,1.938) per 1000 people at baseline to 3.081 (95%CI 2.865,3.306) per 1000 people p = 0.0000). Real-world implementation and trial practices achieved similar testing rates (3.764 vs. 3.081; 6% difference (95% CI -5%,18%) p = 0.358) and similar diagnosis

Author, year, country, disease, *Question*	Design	Setting (target patient population)	Type of change initiative and description	Study outcomes and main findings
			increased and earlier HIV diagnosis and was cost effective. Types of general practices: n=42 inner London general practices with high HIV prevalence. Funding: Not reported.	rates. Mean CD4 count at diagnosis increased in real-world clinics by 55% from 273 to 425 (p=0.433).
Lopez[36] **2022** US (STIs) *Question 1*	Cross-sectional Quantitative	Federally Qualified Health Centre (FQHC) (Target—heterosexual people with HIV)	**Streamlining clinic processes, innovative testing methods and increasing patient engagement** (Target—clinical staff) Aim: To assess implementation of comprehensive STI screening in clients with HIV. Elements: Audio computer assisted self-interview (ACASI) to gain sexual history, patient self-collection of chlamydia and gonorrhoea extra-genital swabs, sexual and gender minority welcoming space and provider training.	Outcomes: Uptake of comprehensive chlamydia and gonorrhoea screening. Findings: Among 230 consented patients over a 16-month period ACASI identified the need for pharyngeal (26%), rectal (16%), urogenital (27%) and syphilis testing (41%). Of 1063 samples collected, 80% were urine, 13% pharyngeal and 6.4% rectal. Almost all (99%) eligible participants were tested for syphilis one or more times. For NAAT specimens, 52% preferred provider-collected, 24% preferred self-collected. For extra-genital specimens, most preferred provider collected (pharyngeal =77%, rectal =57%). Extra-

Author, year, country, disease, *Question*	Design	Setting (target patient population)	Type of change initiative and description	Study outcomes and main findings
			Type of general practice: One FQHC with 80% Black/African American patients, 48% Medicaid and 11% Medicare recipients. Funding: US department of Health.	genital infections were identified that may not have been otherwise.
MacLean[55] **2018** US (HCV) *Question 1 and 2*	Retrospec-tive cohort Quantitative	Academic medical centre with nine primary care practices (25,000 birth cohort patients) (Target—birth cohort 1946–65)	**EMR modifications (EMR alert)** (Target—primary care clinicians) Aim: To increase HCV screening of baby boomers (born 1946–65). To measure HCV screening rates after CDC birth cohort screening guidelines and after institutionalising an EMR alert. Elements: EMR prompt for HCV testing for people born 1946–65 integrated into the health maintenance section of the Epic based EMR software. Health maintenance section also includes reminders for vaccines, cancer and mental health screening.	Outcomes: Comparison of HCV testing rates and positivity during three periods: i) pre 2012 when case finding was used for HCV case detection ii) 2012–2014 after CDC recommended birth cohort HCV testing iii) 2014–2016 after an EMR prompt for HCV testing was implemented. Findings: The cumulative proportion tested for HCV increased from 12% (case finding period) to 15% (CDC recommendation period) to 37% after the EMR prompt was implemented. Over the three time periods HCV positivity declined from 6.4% to 4.4% to 1.6% (after the EMT prompt).

Author, year, country, disease, *Question*	Design	Setting (target patient population)	Type of change initiative and description	Study outcomes and main findings
			Types of general practices: Five family medicine and four primary care internal medicine practices at University of Vermont Medical Center. Funding: None reported.	
Mehta[35] **2021** US (HCV) *Question 1*	Randomised controlled trial Quantitative	Primary care practices (n=43) (Target—birth cohort 1945–65)	**Streamlining clinic processes and increasing patient engagement** Aim: To increase HCV screening uptake among baby boomers (born 1945–65). Elements: Sub study A: Eligible patients of 17 clinicians were randomised to receive a mailed letter about HCV screening vs. a mailed letter about HCV screening with a pathology request. Sub study B: Eligible patients of 417 clinicians were randomised to receive i) a mailed letter about HCV screening or ii) an electronic patient portal message with similar content to the letter (further randomised to receive	Outcomes: Proportion of patients who completed HCV testing in four months and HCV antibody testing in 12 months. Findings: Sub study A: Of patients receiving a letter suggesting they contact their primary care for testing 19.2% (95%CI 16.5–21.9) completed screening compared with 43.1% (95%CI 39.7–46.4) who received a letter and pathology form (P<0.001). Sub study B: Among patient portal users HCV screening rates were higher for patients receiving mailed letters (17.8%) vs. 13.8% for patients receiving a portal message (P<0.001). Message content

Author, year, country, disease, *Question*	Design	Setting (target patient population)	Type of change initiative and description	Study outcomes and main findings
			standard content about testing vs. content based on social norming principles). Type of general practice: In a University of Pennsylvania affiliated health system. Funding: University of Pennsylvania.	enhanced with principles of behavioural science did not increase screening rates.
Nelson[37] **2022** US STIs and HIV *Question 1*	Quantitative Cross-sectional	HIV primary care settings (n=9) (Target—all patients, with a focus on priority populations)	**Streamlining clinic processes, innovative testing methods and increasing patient engagement** (Target—clinic staff) Aim: To routinise STI screening, testing and treatment in HIV primary care settings Elements: Audio computer-assisted self-interview (ACASI) for sexual history taking, self-collection of CT/NG NAAT specimens, sexual and gender minority (LGBTIQ+) welcoming clinical space indicators (WCSI) and three-monthly virtual provider training.	Outcomes: Patient satisfaction, provider acceptability, ACASI-use, STI test results, WCSI uptake and costs. Findings: A total of 1348 patients self-completed the ACASI and 2862 CT NAATs (3.04% positive), 2816 GC NAATs (3.13% positive), and 2146 syphilis tests were completed. For urogenital specimens 62% preferred urine self-collection, 19% preferred self-swabbing and 19% preferred provider-swabbing. For rectal specimens, 57% preferred self-collected and 43% preferred provider-collected swabs. For pharyngeal specimens, 33.1% preferred self-collected and 66.9% preferred

Author, year, country, disease, *Question*	Design	Setting (target patient population)	Type of change initiative and description	Study outcomes and main findings
			Type of general practices: Health Resources and Services Administration and Ryan White HIV/AIDS Program clinics in regions with high STI and HIV incidence (Florida, Louisiana, Washington DC).	provider- swabbing. Most clinics implemented welcoming clinical space indicators. Impact of provider training not reported.
Nitsche[58] **2018** US (HCV) *Question 1 and 2*	Non-randomised trial Quantitative	Primary care (n=7) (Target—birth cohort 1945–65)	**Quality improvement and EMR modifications (EMR alert)** (Target—clinicians) Aim: To improve clinician knowledge and competence for HCV testing. Elements: **Intervention** (three clinics) comprising continuous audit and feedback on HCV testing, continuing medical education publication, HCV focused grand rounds, EMR prompt for birth cohort-based HCV testing. **Control** (four clinics): HCV focused grand rounds meeting, EMR prompt for birth cohort-based HCV testing.	Outcomes: Change in HCV testing rates. HCV testing knowledge. Findings: Baseline HCV testing rates in control clinics ranged from 4%–6% between clinics and after six months increased to 9%–12%. Baseline HCV testing rates in intervention clinics ranged from 5.0%–7.6% and increased to 13.6%–20.2%. Differences were statistically significant.

Author, year, country, disease, *Question*	Design	Setting (target patient population)	Type of change initiative and description	Study outcomes and main findings
			Types of general practices: Seven primary care sites in the Virginia Mason healthcare system. Funding: NA	
Ong[18] **2022** Australia (STIs and HIV) *Question 1*	Pre-post intervention Mixed-methods	General practice (n=3 suburban practices in Victoria, Australia)	**Provider education, streamlining clinic processes, increasing patient engagement, models of care and service-level funding** (Target—general practice staff) Aim: To evaluate a hub-and-spoke model for improving access and increasing HIV/STI testing. Elements: Training and education to GPs, nurses and reception staff, confidential booking appointments, nurse-initiated model of care where the nurse completes the initial risk assessment, bulk billing, posters and flyers, access to a sexual health specialist and direct referral pathway for complex clients. Funding: Victorian Department of Health.	Outcomes: HIV and STI (chlamydia, gonorrhoea, syphilis) testing rates. Findings: A statistically significant rise in testing for HIV and STIs that was sustained for at least one year in all general practices. An increase of an average of 11.2 chlamydia tests per month (p = 0.026), 10.5 gonorrhoea tests per month (p = 0.001), 4.3 syphilis tests per month (p = 0.010), and 5.6 HIV tests per month (p = 0.010). General practice clinical staff reported increased knowledge and confidence in offering STI testing and providing sexual healthcare.

Author, year, country, disease, *Question*	Design	Setting (target patient population)	Type of change initiative and description	Study outcomes and main findings
Pant Pai[81] **2018** Canada HIV *Question 1*	Quantitative Cross-sectional feasibility study	Private sexual health clinic specialising in HIV / STI testing and treatment (Target—MSM)	**Innovative testing methods and models of care** (Target—nurses and patients) Aim: To assess the feasibility of an app-optimised oral HIV self-testing strategy for MSM presenting for testing at a large sexual health clinic. Elements: Offer of a HIV self-test (OraQuick In-Home HIV Test) and accompanying app (HIVSmart!) for test information, data storage, referral to post-test counselling and follow-up care for positive results. Self-tests were unsupervised to mimic a home environment. Type of general practice: Private sexual health clinic in urban Montreal. Funding: Federally funded.	Outcomes: Feasibility of the HIVSmart self-testing strategy. Findings: Among 451 MSM study participants, >=97% used and indicated HIVSmart! was acceptable and a preferred option for HIV testing. Among the 451 self-testers all were linked to counselling and for the three participants with HIV detected, all were linked to care within one working day. Most participants (98.8%) viewed the app- approach to HIV self-testing as useful and 94.3% wanted to recommend it to friends.

Author, year, country, disease, *Question*	Design	Setting (target patient population)	Type of change initiative and description	Study outcomes and main findings
Richmond[13] **2018** Australia (HBV) *Question 1*	Quantitative Obser-vational	General practice in high-prevalence area (n=11 GPs)	**Provider education, quality improvement and streamlining clinic processes** (Target—GPs) Aim: Increase testing via a multi-component GP intervention Elements: Four elements: 1) externally delivered case-based education, 2) audit and feedback cycle, 3) EMR review, 4) patient-held reminder card to give to GP during consultation. Type of general practice: Primary care clinic in high-prevalence area, inner Melbourne. Funding: Not reported.	Outcomes: Number untested patients (% from priority populations), number of corrected ordered tests Findings: Over 2 years increased number of patients tested (15 to 24 per month) and correctly ordered tests (17-61%). A patient held reminder card was associated with the greatest increases (n=54 tests in 1 month). No proportional increase in testing for African/Asian-born patients.
Scott[16] **2021** US (HCV) *Question 1 and 2*	Interrupted time series without a parallel control group Quantitative	Federally qualified primary health centres (n=54) King County, Washington state	**Provider education, EMR modifications (EMR alert), increasing patient engagement** (Target—clinicians) Aim: To increase testing, linkage to care, treatment and cure of HCV. Elements: Modification to EMR to flag patients, posters, mailed reminders, reminder	Outcomes: Changes in screening and treatment. Findings: Screening of baby boomers increased significantly (18%–54%) over four years. A combination of EHR-based active linkage to care, and clinician training contributed to a threefold increase in the number of patients screened and a >10-

Author, year, country, disease, ***Question***	Design	Setting (target patient population)	Type of change initiative and description	Study outcomes and main findings
	Obser-vational study	(Target—birth cohort 1945–65)	cards at check-in, training (online tutorial, didactics, speciality clinic shadowing, case-based telemedicine), patient advocacy group. Type of general practices: Three community health centres, three large multiclinic healthcare systems (private, public, capitated). Funding: Not reported.	fold increase of those treated over four years. The increase was most closely related temporally to the institution of EMR-based prompts, although relaxation of Medicaid restrictions also occurred halfway through the project, and this likely also factored.
Tapp (56) 2020 US (HCV and HIV) Question 2 Pre-post study	Quantitative	Primary care clinics (n=12) (Target—birth cohort 1945–65, Medicaid and uninsured patients) EMR modification (EMR alert)	Aim: To assess the impact of the HCV and HIV EMR alerts on screening rates and linkage to care. Elements: To satisfy the HCV alert (birth cohort) and/or HIV alert (unscreened aged 18–64) a test must be ordered. If the patient refuses testing, the alert remains active. Provided a streamlined referral process to specialty care. Types of general practices: Atrium Health, non-profit, vertically integrated healthcare system. Practices were chosen based on high numbers of patients born 1945–65.	Outcomes: The number of patients screened for HCV and/or HIV after the introduction of the EMR alert. Findings: HCV screening increased from 3.2%–22.7% and HIV screening increased from 6.2%–11.3% after the EMR alert was introduced. Screening all patients decreases testing stigma. In one practice, HCV alerts were activated alongside a Plan-Do-Study-Act (PDSA) cycle including clinician education, public education posters and reminder flyers in patient

Author, year, country, disease, *Question*	Design	Setting (target patient population)	Type of change initiative and description	Study outcomes and main findings
			Funding: Not reported.	charts—therefore results may not be from the alert alone.
Tomcho[27] **2021** US (CT, NG) *Question 1*	Quantitative Quasi-experimental, controlled pre-post test	Federally qualified health centres (n=30 paediatric/family medicine providers) Target—14–18 year-olds (n=>20,000 visits)	**Quality improvement, streamlining clinic processes, increasing patient engagement and models of care** (Target—primary care clinicians) Aim: To evaluate whether a universal testing program for chlamydia and gonorrhoea improved testing rates for adolescents. Elements: Adolescent separated from caregiver during check-in for confidential testing. Testing and counselling by medical assistant. Team champion for local site implementation and problem solving with use of plan-do-study-act cycles.	Outcomes: % of patients with testing completed and prevalence of CT and NG. Findings: Increased screening rates: 25.2% (P < .01) in paediatrics and 11.8% (P < .01) in family medicine. Paediatric providers see a greater volume of adolescent patients with fewer competing priorities. Shifting STI testing to medical assistant and a standard billing algorithm were important. The intervention was well received and cost-neutral to the clinic.
Tomcho[82] **2022** US	Quantitative Quasi-experimental design,	Federally qualified health centres (n=28)	**Streamlining clinic processes, EMR modifications (EMR alert)** (Target—primary care clinicians)	Outcomes: Number of CT and NG tests completed and cases detected. Findings:

Author, year, country, disease, ***Question***	Design	Setting (target patient population)	Type of change initiative and description	Study outcomes and main findings
(CT, NG) *Question 1 and 2*	interrupted time series analysis	(Target—14–24 year-olds)	Aim: To examine the effectiveness of an opt-out testing program to improve testing rates. Elements: Opt-out testing implemented in primary care. Patients provided education sheet at check-in. EMR alert to prompt testing. Type of general practices: Federally qualified health centres in Denver, US. Funding: Federally funded.	Significant (14.2%) improvement in testing rates. Number of cases detected increased during intervention (CT: 20.7/1000 patients to 31.1/1000, NG: 4.4/1000 to 9.6/1000). Significant reductions in testing inequities, difference in male/female testing rates decreased from 37.5% to 22.7% (P < .001) and English/non-English speakers (difference decreased from 16.8% to 4.7% (P < .001).
Walter[40] **2023** UK (CT, NG) *Question 1*	Quasi-experimental controlled interrupted time series Quantitative	Integrated sexual health services (n=2) (Target—patient records)	**Innovative testing methods** Aim: Evaluate the impact of in-clinic rapid STI testing intervention on diagnosis, treatment, and costs. Elements: Rapid on-site testing and new treatment pathway. Postal tests were returned to the clinic for rapid testing. Type of general practice: Intervention site is a sexual health service in Bristol, UK. Control site is a similar sexual health service in South London. Funding: Research.	Outcomes: Rate of NG swabs per consult, time to notification, rate of examinations for symptomatic attendance, rate of follow-up, staff capacity (rate of patients seen per four- hour clinic). Findings: Substantial increase in number of asymptomatic negative episodes managed via postal test kits. Decrease in NG swabs sent to lab (due to rapid testing in clinic), with shorter time to notification (8–9 days pre-intervention, one day one-year post-intervention). Mean cost per episode

Author, year, country, disease, *Question*	Design	Setting (target patient population)	Type of change initiative and description	Study outcomes and main findings
				decreased by 7.5% (95% CI 5.7% to 9.3%).
Ward[28] **2019** Australia (STIs) *Question 1*	RCT Quantitative	Primary healthcare centres servicing remote Aboriginal communities (n=68) (Target—people aged 16–34 years)	**Quality improvement, financial incentives and innovative testing methods** Aim: To assess the effect of a continuous quality improvement program on testing coverage for CT, NG and Trichomonas vaginalis. Elements: Continuous quality improvement program, including annual review of key indicators and creation of action plans. Education and financial incentives were also provided. Type of general practice: Remote primary healthcare centres serving communities with predominantly Aboriginal people and no other service providers. Funding: Not reported.	Outcomes: Testing coverage for CT, NG and T vaginalis among 16–34 year-olds. Findings: No reduction in STI prevalence, despite significant increase in testing (overall 38%). Resources were useful to clinicians, who often integrated them into their routine clinical practice. Small financial incentives added little value.

Author, year, country, disease, *Question*	Design	Setting (target patient population)	Type of change initiative and description	Study outcomes and main findings
Weir[14] **2018** US (HBV) *Question 1*	Cross-sectional Quantitative	Primary care clinics (Target—18–70 year-olds from high-prevalence HBV countries)	**Provider education, quality improvement, EMR modifications** Aim: To determine the effectiveness of an EHR intervention to improve HBV screening and vaccination rates. Elements: Training on screening and treatment guidelines provided to staff, data on patient HBV status from the EHR was provided to staff each day via daily huddle sheet, provider dashboard report provided to clinicians detailing number of patient unscreened. Types of general practices: Clinics were from international community health services and historically Asian-American and Pacific Islander communities in Washington. Funding: National Institutes of Health grant.	Outcomes: HBV testing and vaccination rates for unscreened patients. Findings: Patients who visited the clinic after implementing the intervention were more likely to be screened (OR = 1.8, p<.001) and vaccinated (OR = 2.8, p<.001) for hepatitis B.

Author, year, country, disease, *Question*	Design	Setting (target patient population)	Type of change initiative and description	Study outcomes and main findings
Wood[20] **2021** Australia (ACCEPt study) (Chlamydia) *Question 1*	RCT Quantitative	Rural general practices (Target—young people aged 16–29 years)	**Provider education and models of care** Aim: To investigate the impact of chlamydia education and training on testing rates and acceptability of the program. Elements: Chlamydia education and training, discussion and role-play in a two-hour interactive session endorsed by the Australian Primary Health Care Nurses Association. Type of general practices: Rural towns with a minimum of 500 men and women aged 16–29 years in the 2006 census and no more than six primary care clinics. A total of 44 GPs at baseline and 24 at midpoint were interviewed. Funding: Research funding at federal and state levels.	Outcomes: Chlamydia testing rates and program acceptability. Findings: Testing rates increased in all practices over time with no significant difference by intervention arm. Training was associated with a significantly greater absolute increase in chlamydia testing rates of 4.9% in year two (treatment effect: 4.9% (1.1–8.7), but this difference was not maintained in year three; further training is required to sustain improvements.
Yeboah-Korang[57] 2018 US	Pre and post intervention without a parallel	Primary care clinics within the NorthShore University Health System	**EMR modification (EMR alert)** Aim: To identify whether an electronic medical record (EMR)-driven Best Practice Alert (BPA) would improve birth cohort testing rates.	Outcomes: Change in testing rates after introduction of the EMR alert. Findings: HCV testing rates increased from 0.68%–10.76% (15.9-fold increase) during

Author, year, country, disease, *Question*	Design	Setting (target patient population)	Type of change initiative and description	Study outcomes and main findings
(HCV) Question 2	control group.	(Target—birth cohort 1945–65)	Elements: An EMR alert identified unscreened, age-cohort patients. Types of general practices: Primary care clinics within the NorthShore University Health System. Funding: Gilead Sciences.	the four months after the alert was instituted.
Yeung[70] **2018** Australia (ACCEPt study) (Chlamydia) *Question 1*	Qualitative	Rural general practices (Target—young people aged 16–29 years)	**Quality improvement, financial incentives and EMR modifications** Aim: To explore factors influencing the offer of a chlamydia test, assess the feasibility of the intervention and modify trial components. Elements: Computer alerts, education resources, financial incentives, recall system support, visual media (posters and reminder cards), and quarterly feedback to increase testing rates. Type of general practices: Rural towns with a minimum of 500 men and women aged 16–29 years (2006 census) and <=6 primary care clinics. A total of 44 GPs at baseline and 24 at midpoint were interviewed.	Outcomes: GP acceptability and feasibility of offering a chlamydia test to patients. Findings: GPs considered quarterly feedback reports the most useful for encouraging opportunistic testing. Use of computer alerts, financial incentives, visual media and nurses also contributed to increased testing. Busy workload was a barrier to prioritising testing.

Author, year, country, disease, *Question*	Design	Setting (target patient population)	Type of change initiative and description	Study outcomes and main findings
			Funding: Federal/state research funding.	
Zijlstra[52] **2022** US (HCV) *Question 1 and 2*	Interrupted time series Quantitative	Primary care (n=190 primary care physicians) (Target—birth cohort 1945–65)	**EMR modifications (EMR alert)** (Target—primary care physicians) Aim: To evaluate the effectiveness of an EMR-facilitated HCV birth cohort screening program. Elements: At point of care, Best Practice Alerts and Health Maintenance Alerts were activated for the target population. Customised HCV dashboard to track orders. Types of general practices: NorthShore University Health System (serves 4.2 million in 9 hospitals, >300 practices). Funding: Private donor support for the HCV birth cohort program. Investigator-initiated grant from Gilead Biosciences.	Outcomes: Number of eligible patients screened for HCV after introduction of the EMR alert. Findings: In response to the alert, 64.3% of 96,001 patients completed the HCV antibody test (0.26% positive, 34.2% confirmed viraemic). Progressive increase in screening rates (2017–2020) and a 50% reduction in unscreened eligible patients.
Diabetes, HPV and mental health				

Author, year, country, disease, *Question*	Design	Setting (target patient population)	Type of change initiative and description	Study outcomes and main findings
Acharya[32] **2019** Australia (Diabetes *Question 1*	Quantitative Quasi-experimental pre-post	General practice in regional area (n=20 initially, scaled to 80)	**Quality improvement and models of care** (Target—GPs) Aim: To deliver standardised evidence-based practice, integrated care, and reduce demands on tertiary services. Elements: Case conferencing between primary care and specialist services; education sessions, clinical practice audit (PENCAT tool) with performance feedback. Types of general practices: Regional NSW practices. Funding: Cost-sharing between health district and PHN. Bulk-billing for patient case-conferencing.	Outcomes: Improvement in patient HbA1c levels and clinical processes. Findings: Authors did not report impact on testing rates but HbA1c levels improved. Significant variation in clinical processes and outcome measures across 80 practices, including incomplete recording of clinical parameters in electronic data fields.
Aubrey-Bassler[22] **2019** Canada (Diabetes and HPV)	Quantitative Obser-vational pre-post	Clinics serving rural, remote or underserved populations (n=3)	**Provider education, quality improvement, streamlining clinic processes and models of care** Aim: Implementation of the successful chronic disease prevention and screening (CDPS) intervention from the BETTER trial. Elements: Clinician/ nurse/ dietician trained in behavioural change conducts consult with	Outcomes: Proportion of completed actions from a composite index of 27 chronic disease prevention and screening actions at six months. Findings: 6/8 participants eligible to improve cervical cancer screening and 20/45 eligible to improve fasting blood

Author, year, country, disease, *Question*	Design	Setting (target patient population)	Type of change initiative and description	Study outcomes and main findings
Question 1			patient about chronic disease prevention and screening. Together, the nurse and patient develop three goals to address prevention and screening. Types of general practices: 1) a primary care clinic in a remote town serving a large indigenous population; 2) a rural shared-care family physician and nurse practitioner practice; 3) urban academic family practice serving migrants and refugees. Funding: NA	glucose or HbA1c were screened. An improvement in screening tests was observed.
Akhbari[33] **2020** UK (HPV) *Question 1*	Mixed methods	General practice (n=1)	**Quality improvement, streamlining clinic processes and patient engagement** Aim: To exceed national screening targets of 80%. Elements: **Patient level:** Audit of reasons for patient non-compliance with screening, text message reminder to clients, alert reminder for patient on check-in screen, posters, practice website reminders, group educational sessions for	Outcomes: Percentage change in cervical smear test uptake. Findings: Over the five-month course of the project, the cervical smear test uptake in the eligible female cohort aged 25–64 years rose by 8.09%. There was limited information available to interpret these findings.

Author, year, country, disease, *Question*	Design	Setting (target patient population)	Type of change initiative and description	Study outcomes and main findings
			patients about screening program, e-learning module for patients. **Practice level:** Extra clinic dates and extended hours for screening program. Type of general practice: NA Funding: NA	
Diaz[34] **2019** Australia (HPV) *Question 1*	Quantitative Cross-sectional	Aboriginal Primary Health Care Centres (n=135) (Target—Aboriginal people)	**Quality improvement** (Target—GP level) Aim: Examine whether participation in a continuous quality improvement program is associated with variation in cervical screening coverage in Aboriginal PHC centres. Elements: Participating centres received automated reporting, training and site support for conducting audits according to standard protocols. Types of general practices: Aboriginal PHC centres participating in the Audit for Best Practice in Chronic Disease (ABCD) continuous quality improvement (CQI).	Outcomes: HPV screening rates. Findings: Centres that had completed two or more audit cycles had a higher screening coverage than centres that had completed a baseline audit only. Over 10 years, there was no significant change in the median proportion of women screened and the wide variation in screening coverage remained.

Author, year, country, disease, *Question*	Design	Setting (target patient population)	Type of change initiative and description	Study outcomes and main findings
			Funding: Research funding, Cancer Council, Lowitja Institute, government.	
Gidding[66] **2018** Netherlands (Mental health) *Question 2*	RCT	Primary care (n=10) (Target—mental health problems, in people aged ≥18 years)	**Clinical decision support** Aim: To determine the effects of PsyScan, a patient e-tool that provides therapeutic advice between GP consultations; tool provides diagnostic advice to GPs. Elements: Intervention patients used PsyScan mental health screening tools and received individualised information about symptoms and treatment. Study authors developed an algorithm to translate PsyScan screening scores into diagnostic and therapeutic advice, which was automatically transferred to the EMR. Types of general practices: 10 multidisciplinary care centres with 44 GPs. Funding: Eindhoven Corporation of Primary Health Care Centres (SGE).	Outcomes: Treatment outcomes, quality of life, cost-effectiveness. Findings: A significant difference in successful treatment outcomes (60% vs. 32%) and quality of life in intervention compared with control group. Agreement in International Classification of Primary Care (ICPC) coding between GPs' actions and PsyScan advice (ICPC coding) occurred in 45% (n= 68) of cases, medication in 93% (n= 141), and treatment/referral in 97% (n= 147). The mean one-year costs were similar across groups.

Author, year, country, disease, *Question*	Design	Setting (target patient population)	Type of change initiative and description	Study outcomes and main findings
MacDonald[42] **2021** New Zealand (HPV) *Question 1*	Quantitative RCT	Primary care clinics (n=6) (Target—Māori women)	**Testing methods and models of care** (Target—GPs) Aim: To increase cervical screening for under-screened/never-screened Māori women. Elements: Offer of HPV self-collection for under/never-screened Māori women (vs. usual care in control clinics). Clinics used usual methods to invite women for cervical screening (e.g. text, email, letter, phone). Used outreach services including non-clinical, Māori community health workers. Types of general practices: Primary care clinics located in the Northland region of NZ, where 48% of population identify as Māori. Funding: Self-collected tests are federally funded.	Outcomes: Cervical screening uptake. Findings: Māori women in the intervention arm with self-collection were 2.8 times more likely to be screened than women in the control arm (95% CI: 2.4–3.1, P-value <0.0001).
Møen[23]	Quantitative	General practice (n=71)	**Provider education**	Outcomes: Screening status of immigrant women.

Author, year, country, disease, *Question*	Design	Setting (target patient population)	Type of change initiative and description	Study outcomes and main findings
2020 Norway (HPV) *Question 1*	RCT	(Target—Immigrants)	(Target—GPs) Aim: To evaluate the effect of an educational intervention targeting general practices on increased screening rates by immigrants. Elements: 15-minute educational session for GPs, advice for invitations, a mouse pad as a reminder, waiting room poster. Types of general practices: urban, primary care, general practices in 20 subdistricts of Bergen, Norway. Funding: Norwegian Cancer Society.	Findings: The proportion of immigrant women screened increased by 2.6% in the intervention group and 0.6% in the control group (OR, 1.24 [95% CI, 1.11–1.38]). The absolute effect size of 2% was small.
Ridgway[68] **2021** US (Mental health in HIV patients) *Question 2*	Retrospective cohort study	Primary care (Target—HIV patients)	**Natural language processing** Aim: To use natural language processing of clinical notes to detect mental illness and substance use among people living with HIV. Elements: Structured EMR data (diagnosis codes, social history, problem list) and unstructured text of clinical HIV care notes were analysed by NLP. Types of general practices: University of Chicago Medicine, Illinois. Funding: National Institutes of Health (NIH).	Outcomes: To compare the number of patients with documented mental illness/substance use in structured EMR fields with those identified by natural language processing algorithms. Findings: Of 13,905 clinical notes, the algorithm for detecting mental illness had a positive predictive value of 98% for detecting mental illness and 92% for substance use. The algorithm identified

Author, year, country, disease, *Question*	Design	Setting (target patient population)	Type of change initiative and description	Study outcomes and main findings
				high rates of mental illness and substance use that were often not documented in structured EMR fields.
Ronda[64] **2018** Netherlands (Diabetes) *Question 2*	RCT	Primary care (n=47) (Target—those with a diabetes diagnosis)	**Clinical decision support** Aim: To support diabetes care providers in allocating patients to the preferred treatment setting (hospital outpatient clinic or primary care practice) by using EMR. Elements: An algorithm was developed based on management guidelines. If a patient in the intervention group was not treated correctly according to the algorithm, the clinician was alerted via the EMR email box and a pop-up to change the setting. Types of general practices: 47 primary care practices. Funding: Diamuraal and Julius Center for Health Sciences and Primary Care Research.	Outcomes: Proportion of patients that changed to the correct treatment setting after one year. Findings: After one year, 45% patients in the intervention group and 46% in the control group remained in the incorrect setting. No intervention effect from using the EMR to send consultation-linked advice to shift the treatment setting. Reasons for not adhering to EMR advice included the physician considering other treatment options and patient preferences.

Author, year, country, disease, *Question*	Design	Setting (target patient population)	Type of change initiative and description	Study outcomes and main findings
Sabik[45] **2020** US (HPV) *Question 1*	Quantitative Cross-sectional	Primary care (n=countrywide) (Target—non-elderly, non-disabled women who are Medicaid enrollees)	**Financial incentives** Aim: Evaluate the relationship between Medicaid physician reimbursement rates and cervical cancer screening in Medicaid enrollees. Elements: No intervention. Population data. Type of general practice: Primary care. Funding: Affordable Care Act (federal).	Outcomes: HPV screening rates under different reimbursement rates. Findings: Higher physician fees are associated with greater screening (8%–16%) for enrollees in primary care case management (comprehensive managed care); for enrollees in fee-for-service (FFS) Medicaid, the findings are mixed.
Sperl-Hillen[65] **2019** US (Diabetes and mental health) *Question 2*	Review	Primary care (Target—chronic care patients)	**EMR modification (clinical decision support)** Aim: To develop an electronic clinician-designed EHR-linked web-based CDS system that would be scalable to many care delivery systems. Elements: The CDSS system extracts data from EMR, processes the data using web-based clinical support algorithms, and displays the output on the EMR screen for physicians. The CDSS addresses more than	Outcomes: Clinical outcomes, usage rates. Findings: RCTs show that this CDS system significantly improved glucose and blood pressure control in diabetes patients and reduced 10-year CV risk in high-CV risk adults without diabetes. Perceived as useful by providers and used at 71%–77% of targeted visits. Usage rates are similar whether or not financial incentives are provided to clinicians or rooming staff to encourage use.

Author, year, country, disease, *Question*	Design	Setting (target patient population)	Type of change initiative and description	Study outcomes and main findings
			20 clinical domains (including diabetes and mental health). Types of general practices: Health Care Systems Research Network (HCSRN) institutions. Funding: NIH.	
Willis[62] **2020** UK (Diabetes) *Question 2*	Pragmatic cluster randomised controlled, intervention trial	Primary care (n=22) (Target—aged 17–76, with type 2 diabetes and microalbumin-uria (T2DM))	**EMR modification (EMR alert)** Aim: To test the effects of using an electronic prompt with a treatment algorithm to support a treat-to-target approach for T2DM. Elements: Integration of a software prompt and care template that appeared at the time of the consultation for patients with risk factors above target range. Healthcare provider training and education, audit and feedback also provided. Types of general practices: 22 general practices in Leicestershire, UK. Funding: NIHR grant.	Outcomes: Proportion of individuals achieving risk factor targets at 24 months. Findings: Improvements in risk factor control compared with standard care were not achieved. However, there was a significant difference in the proportion of individuals achieving the prespecified total cholesterol outcome compared to control.
Zammit[43]	Qualitative Interviews	Stakeholder perspectives on	**Innovative testing methods**	Outcomes: Barriers and facilitators to implementation of self-collection.

Author, year, country, disease, ***Question***	Design	Setting (target patient population)	Type of change initiative and description	Study outcomes and main findings
2022 Australia (HPV) *Question 1*		HPV screening program (n=49)	Aim: To investigate the experiences of stakeholders after implementation of a restricted self-collection pathway. Elements: HPV self-collection among priority populations. Types of general practices: Stakeholders working in primary care. Funding: Federally funded screening program.	Findings: Perceived as exciting alternative. Barriers included: Lack of clear communication to providers about processes; only one testing laboratory available, which limited perceived viability of the new pathway.

Appendix 5—Summary of change initiatives and their effectiveness and sustainability

Question 1

Change initiative	Effectiveness and sustainability
STIs, HIV, HBV and HCV	
Provider education and training (n=10) (12, 15, 17, 19) (18, 21) (13, 14, 16, 20)	Overall, nine studies showed an increase in testing. Hepatitis B: Three studies showed an increase.[12] [13] [14] Hepatitis C: Three studies showed an increase.[15], [12], [16] HIV: Two studies showed an increase[17] [18], one study showed an increase in both intervention and control groups[19] and one study showed a reduction in a pre-existing testing decline.[21] STIs: Two studies showed an increase.[20], [18] Sustainability One study found the increase in STI testing was not maintained at year three, recommending the need for further training.[20]
Quality improvement (n=15) (21, 24-26, 29-31, 46, 58, 69), (13, 14, 27, 28, 70)	Overall, 10 studies showed an increase in testing. Hepatitis B: Two studies showed an increase.[, (13, (14))] Hepatitis C: Two studies showed an increase.[28, 43] HIV: Two studies showed an increase[24, 29], one study showed a reduced pre-existing decline[21] and one study showed a stabilisation from a pre-existing decline[30] STIs: Six studies showed an increase[7, 24-28], one showed only a modest increase and only in the earlier CQI cycles[69], one study showed a larger decrease in testing when audit/feedback was removed compared with when it was retained[31], one

Change initiative	Effectiveness and sustainability
	study showed no change in chlamydia and gonorrhoea testing rates for men but a slight increase for women[30] and an updated study from the same authors showed an increase in chlamydia testing (6%) and slight decrease in gonorrhoea testing (2%).[29] Sustainability: One study[26] showed a decline in testing by the final year and a later study[31] showed audit/feedback was more effective at sustaining GP practices over time compared with financial incentives.
Financial incentives (n=7) (12, 25, 26, 28, 31, 47) (70)	Overall, six studies showed an increase in testing. Hepatitis B: One study showed an increase.[12]2 Hepatitis C: One study showed an increase.[12] HIV: One study showed an increase.[47] STIs: Four studies showed an increase in testing[7, 25, 26, 28, 70] and one study showed a slightly larger reduction in testing when financial incentives were removed compared with when they were retained.[31] Sustainability: NA
Streamlining clinic processes (n=11) (13, 18, 27, 39, 46, 48) (25, 35, 81), (36, 37)	Overall, nine studies showed an increase in testing (HBV=1, HCV=2, STIs=6). Initiatives included patient-held reminder cards for clinicians for HBV testing[13], standing orders for HCV testing[46], opt-out testing (chlamydia, gonorrhoea[25] [25, 27, 81], posted pathology forms with an invitation letter for HCV testing[35], computer assisted self-interviews for HIV testing[36, 37], confidential booking appointments for HIV and STI testing[18] and express asymptomatic STI testing without clinical examination.[39] Hepatitis B: Patient-held reminder cards for the clinician were used within a multifaceted intervention and associated with the greatest increase in testing.[13]

Change initiative	Effectiveness and sustainability
	Hepatitis C: Two studies showed an increase.[35, 46] An invitation letter with a pathology form showed a greater increase in HCV screening compared with letter only.[35] HIV: NA STIs: Six studies showed an increase.[18, 25, 27, 39, 48, 81] two studies showed CASI was useful for identifying eligible patients for STI and HIV testing but did not comment on a change in testing.[36, 37] Sustainability: Universal opt-out urine collection showed a slight reduction in the increase in chlamydia screening at 18 months compared with 12 months.[25]
EMR modifications	Studies found in the Question 1 search pertaining to EMR modifications are reported in the findings for Question 2.
Risk stratified test invitation sent by public health service (n=1), (38)	Hepatitis B and C: One study showed an average (50.9%) test uptake with no active HCV infections diagnosed. The authors do not recommend this strategy for countries with low HCV prevalence.[38] HIV: NA STIs: NA Sustainability: NA
Innovative testing methods (n=6) (36, 39, 82) (37, 41) (40)	Overall, two studies showed an increase in testing. Testing methods included self-collection[36, 39, 82], point-of-care testing[37, 39, 41] and postal and rapid tests.[40] Hepatitis B: NA Hepatitis C: NA

Change initiative	Effectiveness and sustainability
	HIV: One study showed app-optimised self-testing was acceptable to patients and had good linkage to care though did not comment on testing rate impact.[82] STIs: One study showed an increase in testing for self-sampling[39], one study showed an increase in asymptomatic negative samples via postal testing kits[40] and one study showed a slight (3%) decrease in the number of people retested within three weeks to three months of a positive test among the intervention group compared with control, though retesting rates were too low to draw conclusions on the intervention effect.[41] Two studies did not comment on an impact on testing rates but commented that patient specimen self-collection aided in identifying extra-genital infections that may not have been found otherwise[36] and showed good patient acceptability for urine and rectal patient specimen self-collection.[37] Sustainability: NA
Increasing patient engagement (n=8) (16, 18, 24, 27, 35-37, 44)	Overall, five studies showed an increase in testing. Initiatives included testing campaigns[44] and creating welcoming clinical environments for priority populations.[36, 37] Hepatitis B: NA Hepatitis C: two studies showed an increase[16, 35]: mailed patient invitation letters with pathology forms were better than letter without pathology forms and mailed letters were better than electronic patient portal letters at increasing screening rates.[35] One study did not comment on the impact on testing rates but showed high RNA positivity (26%) among those tested and higher retention in care for regular clients.[44] HIV: One study showed an increase.[24] STIs: Three studies showed an increase.[18, 24, 27] Two studies did not comment on an impact on testing rates but noted that patient specimen self-collection aided in identifying extra-genital infections that may not have been found otherwise[36] and showed good patient acceptability for urine and rectal patient specimen self-collection.[37]

Change initiative	Effectiveness and sustainability
	Sustainability: NA
Models of care (n=6) (18, 20, 27, 47, 80, 82)	Overall, four studies showed an increase in testing (HIV n=1, STIs n=3). Hepatitis B: NA Hepatitis C: One study of a **nurse-led model** for HCV testing in Canadian primary care[80] did not comment on its effectiveness in raising testing rates but found good uptake of the model by nurse practitioners. HIV: Of two studies, one reported on oral HIV self-testing for MSM in a Canadian sexual health clinic with post-test counselling by a **research nurse.**[82] Effectiveness and sustainability were not reported, but there was good acceptability for patients and the study demonstrated good same-day linkage to care. Another reported on a **nurse-led** HIV screening model[47] in 42 UK general practices in high HIV prevalence areas and showed a substantial increase in HIV testing over a two-year period. STIs: Of three studies, one reported on a **nurse-education package** within a large multifaceted intervention focusing on chlamydia testing for young people in regional Australian general practices.[20] Testing rates increased by 4.9% but were not maintained after three years, with further training recommended. Another reported on **medical assistant-led** universal chlamydia and gonorrhoea testing in US paediatric and family medicine clinics.[27] Testing increased by 12%–25% over one year. Another study reported on a **hub-and-spoke model** involving clinician training in sexual health in three Australian (Victorian) general practices (spokes) with Melbourne Sexual Health Centre serving as the specialist hub.[18] Testing for chlamydia, gonorrhoea, syphilis and HIV increased significantly over one year.
Service-level funding (n=2) (18, 48)	Overall, two studies showed an increase in testing (STIs n=2). One study[18] reported on the Victorian Department of Health's **hub-and-spoke model** in which funding supported general practices (the spokes) to provide sexual healthcare with specialist support from Melbourne Sexual Health Centre (the hub). Testing increased for at least one year. The other study showed higher uptake of **Medicare Benefits Scheme (MBS)**

Change initiative	Effectiveness and sustainability
	rebatable telehealth consultations by patients for STI-related consultations compared with face-to-face only and both telehealth and face-to-face.[48]
HPV, diabetes	
Provider education (n=2) (22) (23)	One study showed an improvement in HPV and HbA1c screening tests.[22] One study showed only a very modest increase in HPV screening.[23] Sustainability: NA
Quality improvement (n=4) (22) (32-34)	One study showed an improvement in HPV and HbA1c screening tests.[22] One study showed an increase in HPV screening over five months[33] and another showed in an increase in HPV screening after two or more audit cycles.[34] In one study the authors did not report an impact on testing rates but HbA1c levels improved.[32] Sustainability: There was no change in the number of people screened for HPV after 10 years.[34]
Financial incentives (n=1), (45)	Higher physician fees increased HPV screening among patients receiving comprehensive managed care. There were mixed findings for patients within the fee-for-service Medicaid mode.[45] Sustainability: NA
Streamlining clinic processes	One study showed an improvement in HPV and HbA1c screening tests with the use of a screening tool.[22] One study showed an increase in HPV screening over five months when using extended dates and opening hours.[33]

Change initiative	Effectiveness and sustainability
(n=2) (22, 33)	Sustainability: NA
Innovative testing methods (n=2) (42, 43)	In one study, women were 2.8 times more likely to receive HPV screening with self-collection compared with speculum exam.[42] One study provided no information about impact on HPV screening. Providers and stakeholders were very receptive to self-collection but raised a number of barriers to implementation.[43] Sustainability: NA
Increasing patient engagement (n=1), (33)	One study showed an increase in HPV screening over five months.[33] Sustainability: NA
Models of care (n=3) (22, 32, 42)	Two studies showed an increase in screening (HbA1c among people with diabetes n=1; HPV n=1). Diabetes: One study[32] of **case-conferencing** with specialists did not report on testing rates but HbA1c levels improved. There was significant variation in clinical processes and recording of clinical parameters indicating challenges with uptake. Another study of a chronic disease and prevention screening tool (focusing on 27 conditions) **led by prevention practitioners** (no further detail provided) in Canadian primary care showed an improvement in **HbA1c and HPV** screening.[22]

Change initiative	Effectiveness and sustainability
	HPV: A study involving non-clinical Māori community health outreach workers to support cervical screening engagement in New Zealand primary care clinics found Māori women were 2.8 times more likely to receive HPV screening with self-collection compared with speculum examination.[42] Sustainability: NA

** Systematic review with multiple interventions

*** Intervention categories are non-exclusive as many studies employed multiple interventions

Question 2

Modification	No of studies	Effectiveness
STIs, HIV, HBV and HCV		
EMR alert or prompt	(n=19) (39, 49, 50, 59, 60, 63) (26, 51, 53, 54, 61) (16, 52, 55-58, 81) (12)	Nineteen studies reported on alerts / prompts triggered from practice management software to increase screening (two for HIV, four for STIs, 11 for hepatitis C, three for hepatitis B) and one study on linkage to HCV care. In some studies EMR alerts were used in combination with other initiatives (e.g. quality improvement, provider education) so the impact of the EMR alert alone is not clear. Hepatitis C: 10 US studies focused on birth cohort screening and eight reported increased HCV screening and coverage among eligible patients after 1–4 years of EMR alerts (baseline range 1.9%–18%, after alert range 13.2%–54%).[16, 49, 51–57] [58] One showed a modest increase from a low baseline testing rate[51] and one found variation between clinicians (35% of clinicians conducted 80% of tests).[49] A systematic review found EMR referral alerts increased linkage to care.[53] Two showed about half[50] and two-thirds[52] of eligible people were tested without commenting on an increase or decrease.

Modification	No of studies	Effectiveness
		Hepatitis B: Two US studies[59, 60] used EMR alerts to identify patients from priority populations (Asian and Pacific Islanders, born in a high-prevalence country) for HBV screening. HBV testing rates were higher for patients in the alert group (range 8.0%–15.7%) vs. no alert (range 3.2%–12.6%) though one study did not confirm with a statistical analysis; clinician response to the alert was low and decreased over time.[60] A UK study[12] reported higher rates of HBV and HCV screening for migrant patients when EMR alerts were used alongside provider education and financial incentives compared with non-intervention clinics. HIV: Two US studies[56, 61] used EMR alerts to identify patients for aged-based (13–64 years) one-time HIV screening. HIV screening increased over one year from pre-alert (range 3.2%–15.3%) to after-alert (range 22.7%–30.7%). One study used EMR alerts in combination with a quality improvement initiative so the impact of the EMR-alert alone is not clear. STIs: One Australian and one US study used EMR alerts within multifaceted interventions to increase annual chlamydia or gonorrhoea testing among young people.[26, 81] Testing increased from 8.2%–20.1% in one study and from 66.8%–81.0% in the other and reductions in testing inequities by gender and English/non-English speakers were reported. Two further studies[39, 63] included STI testing alerts within a CDSS (described under CDSS below).
CDSS	(n=4) (39, 50, 60, 63)	Four studies reported on clinical decision support for screening that was integrated with the practice management software (HCV=1, HBV=1, STIs=2). Hepatitis C: The HCV CDSS integrated links to testing protocols and patient resources about HCV testing and gave prompts for birth cohort screening (for untested patients). The prompt was accessed for 28% of eligible patients; 95% were actioned (e.g. resources given and/or HCV test), with 11.5% of eligible patients tested; 87% of HCV-positive patients were linked to care but the role of the CDSS is not provided. STIs: A CDSS in general practice in an Australian study comprised prompts for STI testing and recording sexuality and facilitated routine audit / feedback reports. It was associated with increased sexuality recording

Modification	No of studies	Effectiveness
		(19%); comprehensive STI testing (89%); and chlamydia and gonorrhoea detection. A systematic review of STI screening approaches reported that one study found adolescent girls were >2-fold more likely to be screened with a CDSS.
NLP	(n=1) (67)	HIV: A feasibility study that examined whether natural language processing (NLP) could improve predictive models of HIV diagnosis found that algorithms based on structured data in the electronic health record and keywords (e.g. MSM, unprotected, HIV) improved HIV risk assessment compared with algorithms based on structured data alone. This has implications for CDSS development.
HPV, diabetes and mental health		
EMR alert or prompt	(n=1) (62)	A UK cluster RCT of an EMR prompt and integrated treatment algorithm to support control of cardiovascular risk factors and diabetes control in people with type 2 diabetes for multiethnic patients. The intervention did not achieve improvements in risk factor management.
CDSS	(n=3) (64-66)	Three studies of a CDSS to support diabetes and mental healthcare. An RCT provided decision support for allocating diabetic patients to the correct setting but did not find evidence that the EMR advice led to patients shifting treatment setting. Patient preference was a factor in patients not shifting settings. A US study reported on findings from multiple studies of a CDSS to support chronic care outcomes (including for diabetes) in a primary care network. While positive impacts were reported, minimal study data was provided. One RCT provided decision support for GPs on treatment advice for patients with mental health problems. Quality of life was higher in the CDSS group at 12 months compared with the control group. Costs were similar between intervention and control groups.

Modification	No of studies	Effectiveness
NLP	(n=1) (68)	Retrospective cohort study using NLP to detect mental illness and substance use among people living with HIV. NLP algorithms using key words in the clinical notes (e.g. depression, bipolar, anxious) were developed and validated against diagnosis codes and compared with structured EMR data. The NLP algorithm for detecting mental illness had high positive and negative predictive value (98%) and identified mental illness that was not documented in structured fields.