



# Community-Based Strategies to Improve Screening, Diagnosis and Linkage to Care for Patients with Chronic Hepatitis B

Monica Robotin<sup>1,2</sup> · Jacob George<sup>3</sup>

Published online: 24 July 2019  
© Springer Science+Business Media, LLC, part of Springer Nature 2019

## Abstract

**Purpose of Review** Chronic hepatitis B (CHB) places 3.5% of the world population at risk of dying from liver failure or liver cancer. Effective antiviral therapies can change disease outcomes, provided that CHB screening and linkage to care can be delivered at population level, to reach the vast numbers of undiagnosed people. We therefore reviewed the experience of community-based CHB screening programs reported in the English literature since 2014.

**Recent Findings** Twenty papers met eligibility criteria and only one originated from a low-income country. The two randomised studies found that culturally tailored hepatitis education increased hepatitis testing. Successful linkage to care was facilitated by partnerships with community-based organisations and the use of bilingual patient navigators. Point of care testing and chain referral sampling were successfully tested in two programs.

**Summary** These studies demonstrated that community-based interventions can screen large numbers of people and could deliver the population-level outcomes required to meet the WHO targets of hepatitis B elimination.

**Keywords** Chronic hepatitis B · Immigrants · Screening · Liver cancer prevention · Antiviral treatment

## Introduction

In 2015, of the 257 million persons (or 3.5% of the world population) affected by chronic hepatitis B (CHB), 68% were living in the African and Western Pacific Regions [1]. As these regions represent significant sources of emigration for migrants and refugees settling in North America, Europe and Australia, migration patterns impact hepatitis B virus (HBV) prevalence in host countries. For example, during 2004–2008, it is estimated that the United States (US) received 54,000 people with hepatitis B infection [2]. Chronic viral hepatitis (mostly chronic hepatitis B and C) has a long asymptomatic period, but without diagnosis and treatment, as many as a

quarter of those infected succumb to cirrhosis and liver cancer [3], which caused 1.34 million deaths in 2015 [4]. This 22% increase in the number of deaths over 15 years shifted viral hepatitis from 10th to 7th place as a leading cause of death worldwide [5].

Therefore, changing migration patterns lead to rising prevalence of chronic hepatitis B and liver cancer in migrant-receiving countries and to significant health disparities [6] in migrants and other marginalised populations [2]. For example, there is a 100-fold discrepancy between the prevalence of HBV infection in white Americans (0.1%) and Asian Americans (up to 10%), a key driver for the rising liver cancer incidence in the US [7, 8]. In Australia, the likelihood of developing liver cancer is 6–12 times higher for people born in China or Vietnam than in Australian-born non-indigenous people [9] and higher hepatocellular cancer (HCC) incidence rates have been observed in migrants in the US [10], Canada [11], the United Kingdom [12] and the Netherlands [13]. To reverse this trend requires significant buy-in from at-risk populations to know their hepatitis B status and be willing and able to access appropriate care. This review focuses on the evidence around strategies to deliver community-based screening and testing for hepatitis B in high-risk populations.

---

This article is part of the Topical Collection on *Hepatitis B*

---

✉ Monica Robotin  
monica.robotin@nd.edu.au

<sup>1</sup> University of Notre Dame Australia, School of Medicine, Sydney, Australia

<sup>2</sup> University of Sydney, School of Public Health, Sydney, Australia

<sup>3</sup> Storr Liver Centre, Westmead Institute for Medical Research, Westmead Hospital, University of Sydney, Sydney, Australia

## Changing the Paradigm in Hepatitis B Control

Unlike in other major infectious diseases, mortality and DALYs due to viral hepatitis increased from 1990 to 2013, with morbidity evenly distributed among high-income and low-income settings [4]. However, until recently, the public health response to chronic viral hepatitis was well below that engendered by other infectious diseases with a comparable burden of disease, such as HIV or tuberculosis [1]. For example, from 2000 to 2015, scaled-up interventions led to a fall in HIV mortality (from 1.46 to 1.06 million deaths) and tuberculosis (from 1.67 to 1.37 million deaths), while mortality due to viral hepatitis continued to increase [1].

The availability of effective antiviral therapies with low rates of resistance has provided improved treatment options for people with CHB and has been shown to reduce or even reverse disease progression [14] and to reduce hepatitis-related mortality from decompensated liver disease and cancer [15, 16]. A simulation model of the global HBV epidemic found that scaling up hepatitis B vaccination can avert 1.1 million deaths by 2030, but that unless screening and treatment activities are scaled up, 17 million people will still die of CHB-related causes [17]. To reach the 2030 WHO target of 90% reduction in new chronic infections and 65% reductions in mortality requires scaling up of neonatal vaccination (to 90% of infants), birth dose vaccination (to 80% of infants), use of peripartum antivirals (to 80% of hepatitis B eAg-positive mothers) and effective population-wide testing and treatment (reaching 80% of eligible people) [17].

The success of any treatment program that seeks to achieve treatment goals relies on the target population being aware of their status and being willing and able to access regular monitoring and treatment [18]. This is not the case for the vast majority of people infected: it has been estimated that approximately two thirds of Americans [18] and 40% of Australians with CHB [19] are unaware they are infected, while in the European Union, as many as 90% of people are unaware of their status [20]. Further, over 1 million people with CHB remain undiagnosed or do not receive treatment in the US [21]. The reasons include personal barriers (i.e. no awareness and knowledge of hepatitis, low health literacy, limited language proficiency, cultural beliefs about not seeing a doctor if not feeling ill and fear of stigmatisation and discrimination) and environmental/access barriers (i.e. lack of access to health care due to non-insurance and difficulty navigating the US health care system) [22–25]. In low- and middle-income countries, these challenges are compounded by over-stretched health services, poorly equipped to deliver hepatitis testing and treatment [26]. Furthermore, many health care providers have limited knowledge about hepatitis and are not confident in ordering and interpreting the results of screening tests [27–29].

Globally, the large number of people infected means that an opportunistic approach to screening cannot deliver population-level coverage or outcomes. Therefore, simple, efficient and scalable screening models are required to address this challenge. To increase the number of people tested and accessing hepatitis care, low-cost interventions are needed to maximise the engagement and retention of infected people along the chronic viral hepatitis care continuum [26]. An added impetus for considering a population-level approach to viral hepatitis management has come from economic modelling studies, which found that screening and treating high-risk migrant populations is cost-effective in high-income countries with a circumscribed epidemic, such as the US [18], Australia [19] and the Netherlands [20]. Subsequently, it has been shown that antiviral treatment may also be cost-effective in middle-income countries such as Turkey [16]. A consensus statement on the cost-effectiveness of antiviral treatment in the Asian Pacific region also confirmed that entecavir and tenofovir treatment was cost-effective in higher-income countries in the region, but significant variations in cost-effectiveness of different treatment strategies remained in less affluent nations [21]. More recently, economic modelling showed that it is also feasible and likely cost-effective to screen and treat CHB in a high prevalence African country (the Gambia), using generic-priced tenofovir [22].

## The Role of Community-Based Screening

Community-based strategies can deliver screening and linkage to care in populations where limited English proficiency, lower socioeconomic and educational levels, lack of health insurance and disease stigma severely limit their ability to effectively navigate the health care system [30]. In 2014, we conducted a systematic literature review of community-based screening and treatment interventions for hepatitis B, covering the period from 1984 through to January 2014 [31]. Papers describing community screening programs in the English language were identified through a search in PubMed and EMBASE, using the terms “hepatitis B testing”, “hepatitis B screening”, combined with “community programs”, “migrant screening”, “CHB screening”, “high risk”, “population” and “population-based screening”. Abstracts were identified and relevant full articles were retrieved, with the list augmented with manual searches of reference lists. Where more than one publication described the same program, the paper providing the greatest level of detail was used as a key reference, with additional data from other publications included (and referenced), if they contributed salient information (i.e. updates on program outcomes). Publications not providing details about how screening was conducted were excluded.

Of the 27 discrete programs identified, 20 (74%) were based in the United States (US), 3 in the Netherlands, 2 in

New Zealand and 1 each in Taiwan and Australia. Some programs conducted exclusively outreach screening, while others used a combination of community-based and facility-based approaches. Using the Internet to enroll participants was trialed in the Netherlands, with screening conducted at pathology labs, community health centers [32], community meeting places or at Public Health Services [33]. The great majority of interventions (93%) were non-randomised studies; only one US [34] and one Dutch study were randomised controlled trials [32]. The remaining 25 (93%) studies described non-randomised screening interventions.

Outcomes reported were mostly number of people reached by the program (the highest was an estimate of 200,000 people reached by the San Francisco program [35]), number of screenings performed (ranging from 202 at a community health fair in the US [36] to 177,000 screened by the New Zealand program [37]) and the rate of HBsAg+ve participants (ranging from 1% in a program targeting Filipino immigrants in Hawaii [38] to 17.3% in the general population in Taiwan [39]).

While linkage to care was offered by 66% of non-US-based programs, only 30% of US-based ones achieved linkage as they grappled with care for uninsured participants. Two US programs used a patient navigator to assist patients in negotiating the health care system [40, 41]. The BFreeNYC program was the only US-based program able to provide ongoing free care during its 4 years of activity, achieving a 57% retention in care [42]. However, even in countries with socialised medicine, such as in the Netherlands, 30% of program participants did not get to see a specialist [43].

Estimates of the size of the target population and the proportion reached are critical to estimate progress in disease control; yet, this information was infrequently reported (by the HepBFree New Zealand program [37] and the B Positive disease registry in Australia [44]). Program costs and the impact of scaling up testing and treatment on the health workforce were also not documented.

The most successful programs achieved significant buy-in from target communities, delivered culturally appropriate educational initiatives and offered comprehensive care packages. We concluded that while community-based screening for hepatitis B was a promising way to shift the management paradigm from individual patient to population level, program coverage was too low to achieve the desired public health impact. For example, the 31 programs active across the US in 2008 had screened fewer than 25,000 people; even assuming a 10% sero-prevalence rate in their target populations (unlikely as this may be), this would only identify 2500 infections; so, reaching the estimated 1.2 million Americans unaware they were infected [18] remains a significant challenge. Reaching the WHO target of 90% reduction in new CHB cases by 2030 [45] is a daunting task, particularly as the vast majority are living in low-resource settings. However, some

recent developments could make a significant change to these dispiriting statistics.

## Has Community-Based Screening Come of Age?

In recognition of the challenges posed for identifying people with chronic viral hepatitis and linking them to care, in 2011, the US Department of Health and Human Services developed an action plan which funded nine sites to conduct demonstration projects of HBV testing and referral for evaluation through the Hepatitis Testing and Linkage to Care initiative (HepTLC) [46]. These projects were conducted from 2012 to 2014 and commenced reporting their results in 2014. Secondly, in 2016, the WHO Global Health Sector Strategy (GHSS) of comprehensive viral hepatitis control by 2030 emphasised increasing access to screening and treatment as core interventions in hepatitis elimination [45], giving new impetus to community-based screening as a means to link people to care.

We therefore sought to ascertain the status of community-based screening since 2014 and conducted a systematic review of the relevant literature published from January 2014 to January 2019, utilising the same search strategy and methodology as in our 2014 paper.

The new search identified 377 papers, and based upon the information provided in the abstracts, 330 papers were excluded, leaving 47 full-text papers to be assessed. Twenty-nine full-text papers were excluded (as they duplicated the findings of previous papers, did not provide details of the intervention or its outcomes or used a qualitative methodology). Two additional papers were identified through secondary searches, leaving a total of 20 papers in the final analysis. Eighteen (90%) were non-randomised studies and two US studies (10%) were cluster-randomised control trials.

Reported outcomes were: receipt of HBV screening only in three programs [47•, 48•, 49•], HBV screening and vaccination [50], combined HBV and HCV screening [51], HBV and screening for hypertension [52], or HBV, HCV and HIV screening [53]. Screening for HBV and linkage to care was reported in nine programs [54–62], all US-based, while screening, linkage to care and treatment were reported in studies originating in the Netherlands [63••, 64], the Gambia [65••] and Australia [66••].

The two randomised studies compared the self-reported receipt of HBV screening in people receiving culturally tailored hepatitis education, compared to general information about hepatitis or liver cancer only. In both studies, the testing rates in the intervention groups were significantly higher (OR = 5.13 and RR = 19.15, respectively) than in the controls [48, 49•].

Only one paper (5%) originated in a low-income country of high HBV prevalence: a population-based screen-and-treat intervention in the Gambia [65••]; the remainder originated from high-income countries. Sixteen papers originated from the US (75%), one from Italy, two from the Netherlands (both

reporting outcomes of scaling up earlier projects) and one from Australia (also updating results of an earlier project)—for details, see Table 1. The number of participants screened and number and proportion testing HBSAg+ve were reported by all programs, while some also reported the number/proportion of those immune and susceptible, disaggregated by ethnicity and gender [56, 58•, 63••, 64].

Four US papers reported results of the CDC-funded demonstration projects seeking to improve community-based programs conducting hepatitis B testing and immunisation in foreign-born populations [54, 56, 57••, 62]. These summarised the results of nine programs funded from 2012 to 2014 to conduct community-based hepatitis screening and referral services in seven US states. Programs targeted communities with HBV sero-prevalence exceeding 2% and reported on the number of people tested, the number and proportion of people testing HBsAg positive, those referred to care and those attending their first medical appointment. A total of 23,144 people were tested and 1317 (6%) were HBsAg positive. The great majority of positive people (90%) received their test results, received post-test counseling (85%) and were referred to specialist care (83%). Only about half (46%) had seen a specialist by the reporting date, but many participants had pending medical appointments at the time of reporting [57••].

Half of the programs offered both community-based and facility-based testing [47•, 53–58, 62, 63••, 65••]. Testing was conducted exclusively in community settings in seven programs [24, 48, 51, 52, 59–61], exclusively in health facilities in two [64, 66••] and not documented in one paper [49•]. The total number of screenings was higher in programs offering both community and facility-based screening (43,872 people screened) than in community-based screening (7928 people) or facility-based screening alone (2459 people).

Nine programs used a combination of HBsAg, anti-HBc and anti-HBs for screening [47•, 50, 53, 55, 56, 58•, 60, 61•, 66••]. Four programs used a combination of HBsAg and anti-HBc [52, 57••, 62, 64], one used a combination of HBsAg and HBsAb [51], while in other programs, a positive HBsAg prompted additional testing, such as a confirmatory hepatitis B DNA test [59], or referral to a clinic/specialist for further assessment and additional testing [63••, 65••].

Linkage to care ranged from 27.5 to 97% in community-based programs; it was more common in community-based programs, compared to facility-based testing (e.g. 77% vs 56% in a study in Chicago [55] and in the Gambia, where 81% people tested in the community were linked to care, compared to 42% of those tested at the blood bank [65••]. Programs using patient navigators achieved linkage to care in a large proportion of people tested, ranging from a low of 77% [55] to 97% [61•]. Linkage to care in the Dutch and Australian programs involved either primary care follow-up, or specialist referral, depending on patients' estimated level of HCC risk [63••, 64, 66••].

Some programs targeted people of a specific ethnicity: Vietnamese people were targeted in programs in Virginia [51], California [50] and three US Eastern seaboard states [49•]; Koreans were targeted in programs in California [60], New Jersey [58•] and New Jersey and New York [59]; Chinese-born migrants were targeted by a Dutch program [63••]. Other programs targeted migrants born in certain geographical regions—i.e. Asian-born migrants [48, 52, 55, 56, 66••] or African migrants [47•, 61•]. Others offered screening targeting population groups from regions of intermediate or high disease prevalence (the HEPTLC initiative in the US [62], or targeted migrants from Afghanistan, Iran, Iraq, the former Soviet Union and Vietnam in the Netherlands [64]), while some offered screening to all hard-to-reach migrants and refugees [53]. Additional to reporting aggregate rates, some programs also reported the number of participants infected, those immune and susceptible, by ethnicity and gender, to ascertain communities needing special targeting [48, 53, 56, 64].

Eleven programs provided some detail about their community engagement and education activities, which included community awareness raising through a wide range of media and in-language education [47•, 48•, 49•, 54–56, 58•, 59•, 60•, 63••, 64, 66••].

Patient navigators/trained bilingual community health workers were used by eight US programs to facilitate linkage to care [47•, 49•, 54, 55, 57••, 58••, 59••, 61•]; no information was provided about the training and support provided to patient navigators. While linkage to care was a significant challenge for all programs, partnerships with community-based organisations, community health workers and physicians brought about higher rates of linkage for some programs [55, 65••]. The CDC-funded programs found that linkage to care was easier in clinics than in community settings, where 97% of the people linked to care saw a primary care provider [62]. Participants tested in outreach settings were less likely to have health insurance [47•, 62].

Novel features described in these programs include the use of point of care hepatitis B testing in the Gambia [65••] and the use of chain referral sampling to enhance program reach in hard to reach populations in a Chicago-based program [47•]. In the latter, community health workers, peers and faith-based leaders engaged with marginalised African migrants and started “chain links” to overcome mistrust and language and literacy issues.

## What Have We Learnt?

Perhaps the greatest evolution in care paradigms over the last nearly four decades has been that more community-based hepatitis programs have covered a wider span of the hepatitis care cascade. Linkage to care is increasingly viewed as an essential component of the care package and we identified

**Table 1** Hepatitis B screening programs identified by the literature search and their key features, components and outcomes

Author (year)/country	Name/location/duration/study design	Agent delivering intervention/target population/setting	Services provided/outcome measures	Summary results	Comments and recommendations
Navarro (2014) [60] USA	California Nov 2009-Feb 2010 NRS	Loma Linda University in collaboration with Korean churches First generation Korean Americans Community (churches)	Awareness campaign, in-language counselling, reflex testing, referral to low-cost clinic Receipt of HBV screening and LTC	10 screening events at 9 churches; 973 1st generation Koreans screened 3% (29) infected, 20% susceptible 27.5% successful LTC	CHB prevalence varied by age cohort, region and education level Successfully engaged population with low level of health insurance Recommendation: institute age-based cohort screening for migrants
Juon (2014) [48] Earlier results reported by Juon et al. (2008) [67] USA	Asian American Liver Cancer Education Program Baltimore-Washington DC areas Nov 2009-June 2010 Cluster RCT	John Hopkins SPH in collaboration with 25 CBOs Targeting Chinese, Vietnamese and Korean migrants Community (churches, language schools, other venues)	Culturally driven recruitment sites; wide range of recruitment sites and strategies Receipt of HBV screening	877 participants randomised to in-language education program (441), or English-language educational brochure (436) Adjusted OR = 5.13 in intervention group if no HBV screening at baseline	Culturally and linguistically tailored interventions important for migrants with low SES and English proficiency
Beckett (2014) [54] USA	Part of Hep TLC initiative—reported results for 3 sites New York, Minneapolis, San Diego Oct 2012-March 2014 NRS	1. New York- African Services Committee (CBO)—community outreach with African, Latin American, Caribbean and Asian populations 2. Minneapolis-St Paul Refugee Health Program for Somali and Karen speakers 3. San Diego: UCSD and Asia Pacific Health Foundation (CBO)—people from 31 countries (outreach settings) and facility based (government clinics, primary care centres) Collaboration between local hospital staff and volunteers and municipal health service Targeted migrants from Afghanistan, Iraq, Iran, former Soviet Republics and Vietnam Facility-based (hospital clinics)	1. Education via ‘conference call radio’ shows, public service announcements; outreach testing, patient navigation and linkage to assistance programs 2. In-language education, counselling and navigation, clinic-based testing 3. Community education and testing at outreach events; patient navigation Receipt of HBV screening and LTC	Three sites tested 4,727 people; 6.6% (310) HBsAg+ve 94% participants informed of test results LTC for 86%; 66% attended 1st visit Follow up attendance highest in refugee program (91%); 33–56% for community-based testing	Outreach, counselling and patient navigation required intensive effort and resources; LTC from community-based testing challenging Success factors: CBO partnerships, scheduling testing during medical visits (for refugee program)
Richter (2014) [64] Early results reported by Richter (2012) [68] Netherlands	Arnhem region Conducted in 2011 NRS	Collaboration between local hospital staff and volunteers and municipal health service Targeted migrants from Afghanistan, Iraq, Iran, former Soviet Republics and Vietnam Facility-based (hospital clinics)	Information / education materials in 5 languages; Newspaper advertising, dedicated website Personal invitation letters to educational evenings with free onsite hep B and C testing F/U to clinics, contact tracing and vaccination by municipal health service Receipt of HBV and HCV screening, LTC, assessment and treatment initiation	Reached 3226 registered migrants; 959 (29.7%) tested; 2.2% (21) HBsAg+ve; 5 started treatment Vietnamese participants had highest HBV prevalence (9.5%)	Personal invitation more effective than extensive community-based approach Recommendation: combine hep B and C testing
Stornaiuolo (2014) [53] Italy	Rural area of Southern Italy 1999–2009	Collaboration between academics from Naples University and the Social	Cultural mediators used in interactions with participants Receipt of HBV, HCV and HIV screening	Recruited and tested 2681 migrants; 206 (7.6%) HBsAg+ve (8.1%	Low HBV vaccination rate needs addressing

**Table 1** (continued)

Author (year)/country	Name/location/duration/study design	Agent delivering intervention/target population/setting	Services provided/outcome measures	Summary results	Comments and recommendations
	NRS	Medical Voluntary Association Targeting hard-to-reach immigrants Community (mobile unit) and facility-based (outpatient clinic)		for migrants from sub-Saharan Africa), 45% susceptible 3.1% anti HCV + ve, 5% anti-HIV + ve Prevalence of HIV infection higher with active recruitment	Recommendation: active recruitment and education effective in hard-to-reach migrants
Strong (2015) [51] USA	Northern Virginia Aug 2011 NRS	John Hopkins School of Public Health, Vietnamese Medical Society Community (health fair)	Offered onsite testing for HBV and HCV Receipt of HBV, HCV screening	Tested 617 people for HBsAg, HBsAb and HCV Ab; 8.8% (54) HBsAg+ve; 21.6% (133) susceptible 4.7% (29) were HCV Ab +ve 758 screened in 13 settings; 7.3% (55) were HBsAg+ve; 5.8% (81) HCV Ab+ve; 45.8% HBV-infected sought medical care 60% had no health insurance Community settings LTC 77%; 56% in clinical settings	Recommendation: low HBV knowledge and misunderstandings about HBV transmission need addressing to reduce stigma  Culturally competent programs have higher rates of LTC Success factors: CBO linkages, patient navigators and culturally competent physician providers
Chandrasekar (2015) [55] USA	Part of the HEPP (Hepatitis Education and Prevention Program) Dec 2012-Dec 2013 NRS	Asian Health Coalition in collaboration with academic and community partners Targeting Asian and Pacific Islanders in metropolitan Chicago 10 community (health fairs, churches) and 3 facility-based (clinics)	Community health workers trained as patient navigators and culturally competent physicians In-language education sessions and free HBV testing offered at non-clinical settings; LTC facilitated by community health workers Receipt of HBV screening and LTC	1405 participants screened; 8.8% (124) HBsAg+ve; 48.3% had no health insurance 11.3% HBV infected participants received vaccination	Recommendations: screening for HBV infection prior to vaccination
Nguyen (2015) [50] USA	Community Transformation grant California Aug 2008-Aug 2010 NRS	Vietnamese American Cancer Foundation and University of California, Irvine Community (health fair)	Participants completed knowledge survey; no details provided about other activities/education Receipt of HBV screening and vaccination	2298 people offered screening for hep B and BP; 2232 were screened for hep B; 7.1% (159) HBsAg+ve; 28% susceptible 63.4% had abnormal BP readings 23,144 participants tested at 34 sites; 1317 (5.7%) HBsAg+ve; highest rates in people born in Africa (9.7%), Western Pacific (6.4%) and Eastern Mediterranean (5.2%) 1098 (83%) referred, 46% attended first medical appointment	Sustainability was problematic and additional services not taken up Success factors: collaboration with multiple partners to leverage resources and develop community-clinical linkages  LTC challenging: cost of clinical services, limited access, language barriers Success factors: CBO - primary care clinic e.g. services partnerships, patient navigators, strategic CBO-specialist services partnerships, offering patient and provider education To increase testing uptake: bilingual staff, incentives, media and cultural events, identifying culturally and linguistically appropriate providers
Barragan (2015) [52] USA	Los Angeles County Aug 2012-Jan 2013 NRS	LA Department of Public Health, Asian Pacific Liver Center, UCLA academics Community (26 health events)	Hep B and blood pressure screening; educational information Referral to local clinics for F/U Receipt of HBV and BP screening		
Harris (2016) [57] USA	Part of Hep TLC initiative—summary results for all 9 pilot programs (in 7 States) Oct 2012-Sept 2014 NRS	Outreach via CBOs; partnering with medical providers to conduct testing Targeting people born in African and Asian countries Community (outreach) and facility-based (clinics)	Hep B screening, post-test counselling and LTC Receipt of HBV screening, counselling and LTC		

**Table 1** (continued)

Author (year)/country	Name/location/duration/study design	Agent delivering intervention/target population/setting	Services provided/outcome measures	Summary results	Comments and recommendations
Dang (2016) [56] USA	Part of Hep TLC initiative—results for Sacramento, CA site Sept 2012–Sept 2013 NRS	UC Davis, student-run Asian clinics (Chinese and Vietnamese), community leaders and churches (Korean) and community partners Targeting Korean, Chinese, and Hmong communities Community (outreach, health fairs) and facility-based (student-led clinics)	Screening promoted through in-language, culturally appropriate resources developed by San Francisco Hep B Free program Promotion through flyers, ethnic newspaper ads, churches Transportation provided to screening place; in-language results, further testing and counselling provided Receipt of HBV screening and LTC	Screened 1,004 Asian Americans at 28 screening events; 76 (7.6%) HBsAg+ve; 51 (67%) had post-test counselling Highest infection rates among Hmong (14.3%) and Vietnamese (13.6%) men; those susceptible were offered free vaccination LTC could not be documented	Success factors: In-language resources, translating services, screening at familiar locations and facilitated transport Recommendation: Disaggregation of data by ethnicity and gender needed for targeted and tailored programs
Walters (2016) [62] USA	Part of Hep TLC initiative—Oregon site Oct 2012–June 2014 NRS	Multnomah County Health Department, Refugee Medical Assistance (RMA) program, local organisations Targeting refugees in Oregon Community (outreach at apartment complexes and immigrant organisations) and facility-based clinics	Outreach clinics and community-based referrals; refugee testing offered to all incoming refugees and voucher system from partner organisations Testing at onsite clinics; education provided for HBsAg+ve Receipt of HBV screening and LTC	2,087 screened; 77 (4%) HBsAg+ve; Highest rates in people from East Asia, the Pacific (6%) and sub-Saharan Africa (7%) 94% LTC; 94% attended first F/U visit	Success factors: culturally and linguistically competent strategies; LTC most successful through refugee screening (accessing Medicaid benefits) than outreach (low insurance levels) Recommendations: testing for anti-HBs reduces vaccination costs; educating primary health care providers
Shankar (2016) [61] Early results reported by Perumalswami (2013) [69] USA	Part of the Hepatitis Outreach Network (HONE) program in New York; Oct 2011–July 2013 NRS	Collaboration between Mt. Sinai medical center, African Services Committee) and community health centers Targeting African-born people Community (community centres, places of worship or employment)	Free screening events, public service announcements, flyers (in French and Arabic), radio, community and religious leaders announcements Multilingual patient navigator provided education, counselling and arranged F/U visits Incentives: fare card and \$20 incentive Receipt of HBV screening and LTC	955 people from 31 African countries screened (38% from Senegal); 88 (9.6%) HBsAg+ve; 97% attended first F/U appointment; median Fibroscore score 5.7 kPa; 3 (4%) had HCC diagnosed 239 (56.6%) eligible for vaccination 21.9% with health insurance; < 23.9% had primary care provider	Recommendations: comprehensive risk factor ascertainment needed to understand transmission patterns Community testing critical for LTC for uninsured populations Factor for success: culturally targeted patient navigators
Chandrasekar (2016) [47] USA	Chicago metropolitan area Dec 2012–Dec 2014 NRS	Asian Health Coalition, academics, community partners Targeting African immigrants and Community (health fairs) and facility-based (health centers, CBOs, medical practices, hospitals)	Trialled chain referral sampling using community health workers, peers and faith-based leaders In-language educational workshops, free testing and vaccination if susceptible Receipt of HBV screening	3000 people received education (~1000 from 33 African countries); 445 screened; 35 (8%) HBsAg+ve; 26% susceptible 54% of people tested in non-clinical settings were uninsured (vs. 13% in clinical settings)	Trusted community members promoted buy-in; chain referral sampling can overcome mistrust, language and literacy problems Recommendations: standardisation of recruitment processes at screening events; critical role of community health

New Jersey

LTC a significant challenge

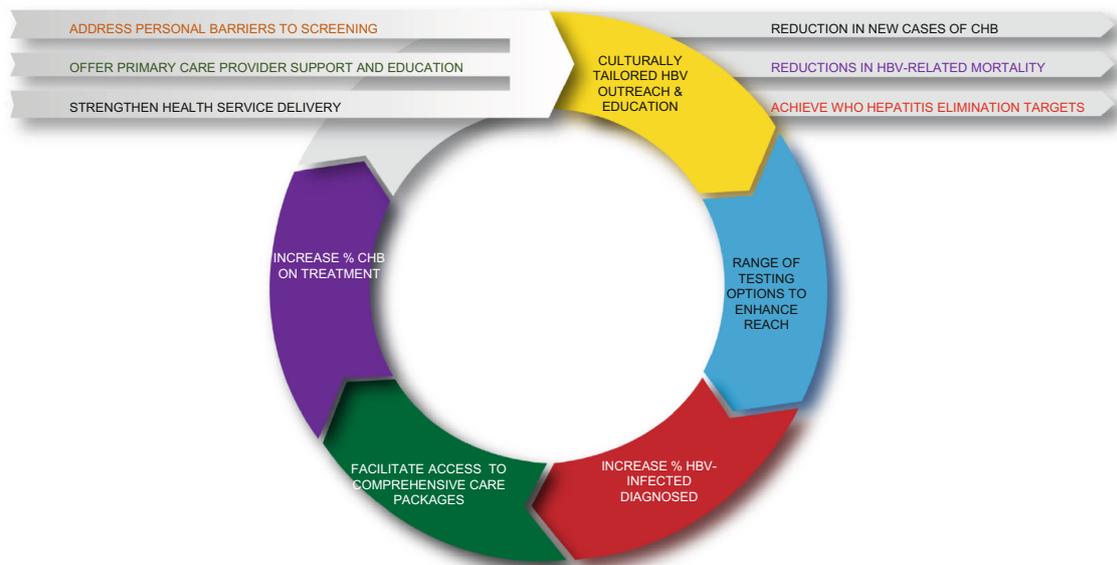
**Table 1** (continued)

Author (year)/country	Name/location/duration/study design	Agent delivering intervention/target population/setting	Services provided/outcome measures	Summary results	Comments and recommendations
Hyun (2016a) [58] USA	Dec 2009–June 2015 NRS	Center for Viral Hepatitis, Asian Liver Center, community volunteers, nurses and community physicians and local hospitals Targeting Korean Americans Community (churches, health fairs) and facility-based (community centers)	Screening and awareness campaign using community physicians, nurses and community volunteers Linkages with local hospitals, CBOs and physicians to enhance LTC Receipt of HBV screening and LTC	128 community outreach screening events testing 7199 people (98 churches, 18 health fairs, 12 community centers) Hepatitis awareness seminars and Q&A sessions in some HBSAg+ve; 94% referred, 76% had 1st consultation 75% of HBSAg+ve but not in care; 2736 (38.2%) not immune	LTC needs patient education and counselling, patient navigation, physician education, strategic partnerships with key CBOs to sustain engagement
Hyun (2016b) [59] USA	New Jersey and New York Jan–Dec 2014 NRS	Center for Viral Hepatitis, Korean Community Services and community service organisations Targeting Korean American adults Community (outreach screening events)	Hep B awareness events; LTC: patient navigators providing advocacy, support and education to patients and family and coordinating appointments Receipt of HBV screening and LTC	45 HBSAg+ve people – 84% previously diagnosed with HBV Successful LTC in 93%	Recommendations: language, finance and cultural factors are key barriers to health access Patient navigators increase initial LTC, but sustainability of LTC unproven
Coenen (2016) [63] Early results reported by Veldhuijzen (2012) [70] Netherlands	5 main Dutch regions Active from 2009 to 2013 NRS	Academic centres and Municipal Health Services in Holland, hospitals Targeting first generation Chinese migrants Community (outreach events) and facility-based (Municipal Public Health Service clinics)	Combined disease awareness activities (newspapers, website) with free HBV testing at outreach locations; offered counselling and established direct referral pathways to specialists Receipt of HBV screening, LTC, treatment	15% of target population (4423 people) screened; 6.0% (264) HBSAg+ve 129 (49%) saw specialists: 25% needed treatment, 50% HCC surveillance	First large-scale community-based screening project for HBV in Europe High LTC: the outreach design and establishment of direct referral pathways to hospital clinicians ensured high referral rates
Lemoine (2016) [65] The Gambia	PROLIFICA Dec 2011–Jan 2014 NRS	Academics and fieldworkers from the Gambia Medical Research Council Screening offered to potential blood donors in Gambia's capital and to randomly selected communities in Western Gambia Community (field testing) and facility-based (blood bank)	HBV point-of-care testing; LTC for all HBSAg+ve individuals (liver assessment and treatment) Receipt of HBV screening, LTC, treatment	5980 participants from 27 rural and 27 urban communities (HBSAg+ve prevalence 8.8%) and 5559 blood donors (HBSAg+ve prevalence 13.0%) were screened LTC higher in community (81.3%) than blood bank (41.6%) Treatment adherence 81% at 1 year and 91.5% had virological response	First screening screen-and-treat program for HBV in the general population in Africa - demonstrated feasibility (and cost-effectiveness) of a large-scale screen-and-treat program in a low-resource setting in Africa Trained fieldworkers led to high screening coverage and LTC
Ma (2017) [49] USA	in Pennsylvania, New Jersey and NYC 2009–2014 Cluster RCT	Academic centers, Center for Asian Health, Temple Uni, CBOs, community leaders Targeted Vietnamese CBOs	Cluster RCT: 18 CBOs randomised to a multilevel HBV screening intervention (interactive in-language group education, navigation services, community leadership and health care provider	88.1% of 1131 intervention participants and 4.6% of 1206 control participants underwent HBV screening (RR = 19.12)	First randomised community-based intervention to address individual and health care system barriers to screening in Vietnamese-Americans

**Table 1** (continued)

Author (year)/ country	Name/location/ duration/study design	Agent delivering intervention/ target population/setting	Services provided/outcome measures	Summary results	Comments and recommendations
		Not documented	engagement); 18 CBOs assigned to general cancer education program; HBV screening rates measured at 6 months Receipt of HBV screening		Community-based participatory research approach may increase intervention effects and enhance sustainability of intervention Recommendation: navigation to low cost screening program critical for low resource communities
Robotin (2018) [66] Early results reported by Robotin (2014) [71] Australia	Sydney Active 2007–2016 NRS	Cancer Council NSW, local Division of General Practice, specialists, community leaders and CBOs Targeting Chinese and Vietnamese-born Australians Facility-based (GP surgeries, pathology services)	CHB screening and follow up by General Practitioners; community awareness and education by bilingual program staff; multilingual patient resources; using ethnic media and community events; GP education and support (colour-coded CHB risk stratification and referral protocol), follow-up through CHB disease Registry Receipt of HBV screening, LTC, treatment	> 1500 HBsAg+ve people enrolled in Registry (25% of target population) by 70 GPs 79% of CHB patients could remain under GP care 18% of this cohort commenced antiviral therapy	Established a CHB Registry enrolling patients diagnosed in primary care LTC based upon disease severity and HCC risk, reducing unnecessary referrals Achieved optimal antiviral treatment uptake level predicted by economic level Collected data on population-level CHB disease stage

AAs Asian Americans, BP blood pressure, CBO community-based organisation, CDC Centers for Disease Control, F/U follow-up, HBsAg+ve hepatitis B serum antigen positive, LTC linkage to care, NRS non-randomised study, RCT randomised controlled trial



**Fig. 1** Proposed virtuous cycle of hepatitis B care requires community engagement, health practitioners education and support, flexible screening options and support for navigating the health system.

Affordable access to care and treatment and strengthening the health service delivery need to be part of the treatment package to make WHO elimination goals a reality

nine such programs, including four that also documented antiviral treatment uptake.

Partnerships between community-based organisations and medical providers, and in particular having bilingual workers from the target population acting as translators, navigators and educators were key factors for success. The cost of clinical services, lack of resources to guide participants through the continuum of care, the cost of clinical services and a belief among people with CHB that no effective treatment existed were commonly identified barriers. The adoption of a standardised reporting dataset by the HepTLC-funded programs for the first time enabled meaningful inter-program comparisons and enabled a better definition of program barriers and facilitators.

There was significant variability in approaches to testing, ranging from one assay screening, to comprehensive testing including anti-HBc and anti-HBs. While a one-assay testing strategy can answer the most pertinent question (i.e. if HBsAg is detectable in the blood, this confirms that there is current hepatitis B infection), a more comprehensive initial testing can help guide subsequent management (including whether immunisation is required or not). WHO recommends standardised testing strategies that maximise the accuracy of hepatitis B testing, while minimising cost and increasing simplicity, but its commissioned review found no studies directly comparing the diagnostic accuracy, cost and/or cost-effectiveness of one- vs. two-assay HBsAg testing strategies [72].

The successes reported by these programs can provide a way forward, by which hepatitis testing and treatment can be scaled up and delivered in both well-resourced and resource-

limited settings. While economic modelling has been used to determine the cost-effectiveness of screening and treatment programs, informed program design in US-based programs [73], as well as programs in the Netherlands [74], Australia [75] and the Gambia [76], the costing of discrete program components needs to be further examined.

A significant shift from earlier programs has been the wide adoption of patient navigators to improve linkage to care, with eight US programs adopting it since 2014. This supports the findings of a meta-analysis by Zhou et al. [77] of RCTs targeting Asian migrants in the USA or Canada that found that an educational intervention delivered by bicultural and bilingual lay health workers improved HBV knowledge and HBV testing, compared to no intervention, or general education (relative risk = 2.68, 95% CI 1.82–3.93).

Using community health workers (CHWs) and patient navigators can ensure that more people are engaged in care, making a significant contribution towards scaling up programs, provided that downstream services are available to absorb them. Their contribution is even more critical in low-resource settings, where the high numbers of people infected and low level of available facilities present added challenges. In Africa, task shifting is already a reality, with trained community health workers engaged in delivering HIV testing and linkage to care, although the full benefit of this is yet to be realised [78]. Using CHWs to also deliver hepatitis testing services and trialing novel initiatives, such as point-of-care testing, as demonstrated in the Gambia, may be a vehicle to achieve the ambitious WHO targets of hepatitis elimination [45].

**Table 2** Using the RE-AIM checklist for planning, delivering and evaluating community-based hepatitis B screening and treatment programs

Dimension or issue	Definition	Key questions
Reach	Number and proportion of people screened in the target population	Who is the target population? Are participants representative of the intended audience? Do recruitment methods address health inequities? How can they be reached?
Effectiveness	Impact of the intervention on important outcomes	Are the key outcomes being met? Does screening and linkage to care improve the quality of life for people with CHB? Possible negative effects of screening (i.e. hepatitis testing without access to care) Are resources available to deliver the program?
Adoption	Number and proportion of settings and partners adopting community-based screening	What are the program settings (i.e. clinics, community organisations, churches, health fairs)? How many suitable settings are likely to adopt the program or participate in it?
Implementation	Extent to which the program is being delivered as envisaged	How will the program be delivered? To what extent will key program components can be delivered and/or will adjustments/adaptations be required? What are the costs and resources (time and staff) needed to deliver the programs?
Maintenance/Sustainability	Extent to which program delivery is sustained	Can the program continue to deliver its objectives in the long term? What key elements are required to ensure ongoing delivery? Trained staff/ access to low cost clinics and cheap/ subsidised treatment? Is the initiative likely to produce lasting effects for people with CHB?

Tips provided by the RE-AIM collaboration <http://www.re-aim.org/resources-and-tools/self-rating-quiz/>

Adapted from the UPSTREAM program funded by the Colorado Health Foundation; the Evaluation Hub of the University of Colorado Department of Family Medicine; the “RE-AIM: Rate Your Plan Exercise” and the “RE-AIM: Extended Consort Diagram”; and elements from PRISM; with contributions from Samantha Harden, PhD of the Department of Human Nutrition, Foods, and Exercise at Virginia Tech and members of the RE-AIM workgroup

However, some caveats exist and strategies to move treatment into the community need to accompany community-based testing. While using CHWs for increasing antiretroviral treatment uptake confirmed their critical role in extending health services and providing comprehensive primary health care, lessons learnt through them suggest that the scale-up of these programs requires also broader health systems strengthening [79]. This ensures that the momentum achieved through community-based testing is maintained at clinic level, rather than shifting the bottleneck downstream. While CHW can improve program delivery, the impact of adding further deliverables needs to be carefully managed [80]. For example, CHWs involved in the Zimbabwe study for Enhancing Testing and Improving Treatment of HIV in Children (ZENITH) randomised controlled trial, expressed concerns about poor remuneration and lack of program sustainability. The CHWs were also reluctant to cease visiting the families they cared for during the period of the trials and raised concerns about the long-term sustainability of ‘task-shifting’ strategies [81].

The success of the screening and treatment program in The Gambia is a reason for cautious optimism: adult community-based screening and treatment are not only likely to be cost-effective [82], but have been shown to be feasible and

acceptable to the target population [65••]. However, translating the results of this successful pilot into practice needs to negotiate many barriers [76], with the prohibitive costs of antiviral therapy and monitoring, limited health infrastructure and the lack of trained health professionals compounding the challenges of setting up sustainable programs [83]. However, cost shifting using community educators, reductions in the cost of antiviral medications and tests and the integration of HBV screening with other public health interventions may make these a reality [17, 77].

The intervention in sub-Saharan Africa included many novel features. It was the only intervention deployed in a low-resource setting, used validated measures to ensure it was genuinely community-based, offered screening to all household participants in enumeration areas and used finger-prick whole blood tests. Two point-of-care tests were employed—one validated for fieldwork with a sensitivity of 88.5% and specificity of 100% (used for the rural arm of the study) and another with a 96% sensitivity and 100% specificity (used for the blood bank-based testing). Linkage to care was comprehensive, helped by up to three reminders for attendance to the liver clinic, while participant assessment included abdominal ultrasound examination, measurement of liver stiffness and a full

complement of blood tests for HBV (including genotyping), HCV and HIV. All patients requiring treatment accepted it, and adherence scores at 1 year were impressive (81% had high and 15% had medium adherence scores). This population-based study demonstrated that screening and treatment are feasible and acceptable to the target population in a limited resource setting [65••] and that the screening strategy is cost-effective [82].

### The Future: Towards a Public Health Evaluation of Hepatitis Elimination Programs

While progress has been achieved in reaching the WHO goals for hepatitis B elimination, at least in well-resourced settings, a good understanding of how far we have traveled on the path of fulfilling the potential of community-based testing remains elusive. We found that information enabling the evaluation of the programs was limited. For example, with few exceptions (Dutch, New Zealand and Australian programs) [37, 63••, 66••], the size of the programs' target population and the proportion of those reached by the program was not reported, nor could we infer information on programs' effectiveness and adoption.

Achieving the WHO elimination targets requires scaling up hepatitis testing and treatment. Community engagement in facilitating outreach and education is critical, as is the upskilling of health care providers. As both community- and facility-based testing appear attractive to different demographic groups, the capacity to deliver services in a range of settings, at flexible hours, offering point-of-care testing and using trained fieldworkers or patient navigators can ensure a broader reach.

Offering point-of-care testing is a useful addition to the WHO care package, but so far, the evidence for its effectiveness in large-scale programs remains limited. The program in Gambia used two different point-of-care tests: while both had 100% specificity, the field-ready one (Determine) had a relatively low sensitivity (88.5%), compared to the Onsite Combo Rapid Test used in the blood bank (sensitivity of 96%). Rapid diagnostic testing (RDT) would be very attractive for hepatitis B surface antigen detection, particularly in low-resource areas, provided that with its effectiveness and cost-effectiveness match that of *in vitro* diagnostics. A review of the diagnostic accuracy of RDTs to detect HbsAg was conducted for WHO by the London School of Hygiene and Tropical Medicine. In the 30 studies meeting selection criteria, the pooled clinical sensitivity was 90.0% (95% CI: 89.1, 90.8) and the specificity was 99.5% (95% CI: 99.4, 99.5), compared to laboratory-based immunoassay reference standards, with a low to moderate quality of evidence [72].

Linkage to care remains a significant challenge, particularly in settings without socialised medicine (such as the US) and in limited resource settings, where these challenges are

compounded by stretched, poorly resourced health services. Some of these components are captured in Fig. 1, depicting a proposed virtuous cycle of hepatitis B care.

The RE-AIM (Reach Effectiveness Adoption Implementation Maintenance) framework (Table 2) has been used to plan and evaluate a broad range of health promotion and disease management interventions, including cancer screening, weight loss, smoking cessation, chronic disease self-management, physical activity, obesity and disease management [84–87].

Applying the framework to address health disparities in viral hepatitis could make a significant contribution towards real improvements in health outcomes for people with CHB and has the ability to collate the evidence required for guideline development and for scaling up programs. RE-AIM provides a framework to systematically explore program reach, efficacy or effectiveness, adoption, implementation and maintenance. The framework also enables the identification of programs that work best in real-world environments and enables decision-makers to make informed decisions about adopting or discontinuing programs. This can be further augmented using mixed methods to better understand barriers to screening and how they can be addressed, to help understand variations in reach across settings and to evaluate factors that contribute to program effectiveness [88].

Reaching consensus on metrics and deliverables can provide a way to fit more pieces into the puzzle which is chronic hepatitis control.

## Conclusion

This review corroborates the findings of other studies which have emphasised the importance of integrated approaches to hepatitis care [77]. Future research is required to address optimal funding mechanisms, program sustainability, the best way of ensuring linkage to care and how to develop, select and implement the most effective strategies for screening, disease surveillance and community engagement and education. Given the large burden disease in low-resource settings, evidence from implementation research conducted in low-resourced settings is acutely needed.

## Compliance with Ethical Standards

**Conflict of Interest** Monica Robotin and Jacob George each declare no conflicts of interest.

**Human and Animal Rights and Informed Consent** This article does not contain any studies with human or animal subjects performed by any of the authors.

## References

Papers of particular interest, published recently, have been highlighted as:

- Of importance
- Of major importance

1. World Health Organization, *Global Hepatitis Report 2017*. <https://www.who.int/hepatitis/publications/global-hepatitis-report2017/en/>, W.H. Organization, Editor. 2017, World Health Organization: Geneva. Accessed 15 May 2019.
2. Gellert L, Jalaludin B, Levy M. Hepatocellular carcinoma in Sydney south west: late symptomatic presentation and poor outcome for most. *Intern Med J*. 2007;37(8):516–22.
3. Lok AS, McMahon BJ. Chronic hepatitis B: update 2009. *Hepatology*. 2009;50(3):661–2.
4. World Health Organization, *Global Health Estimates 2015: deaths by cause, age, sex, by country and by region, 2000–2015*. Geneva: *World Health Organization*; 2016. [https://www.who.int/healthinfo/global\\_burden\\_disease/estimates/en/index1.html](https://www.who.int/healthinfo/global_burden_disease/estimates/en/index1.html), W.H. Organization, Editor. 2016, World Health Organization: Geneva. Accessed 15 May 2019.
5. Stanaway JD, Flaxman AD, Naghavi M, Fitzmaurice C, Vos T, Abubakar I, et al. The global burden of viral hepatitis from 1990 to 2013: findings from the global burden of disease study 2013. *Lancet*. 2016;388(10049):1081–8.
6. Juon HS, Strong C, Kim F, Park E, Lee S. Lay health worker intervention improved compliance with hepatitis B vaccination in Asian Americans: randomized controlled trial. *PLoS One*. 2016;11(9):e0162683.
7. Kwong SL, Stewart SL, Aoki CA, Chen MS. Disparities in hepatocellular carcinoma survival among Californians of Asian ancestry, 1988 to 2007. *Cancer Epidemiol Biomark Prev*. 2010;19(11):2747–57.
8. Trinh-Shevrin C, Pollack HJ, Tsang T, Park J, Ramos MR, Islam N, et al. The Asian American hepatitis B program: building a coalition to address hepatitis B health disparities. *Prog Community Health Partnersh*. 2011;5(3):261–71.
9. Supramaniam R, et al. Cancer incidence in New South Wales migrants 1991 to 2001. Sydney: The Cancer Council NSW; 2006.
10. Altekruse S, McGlynn K, Reichman ME. Hepatocellular carcinoma incidence, mortality, and survival trends in the United States from 1975 to 2005. *J Clin Oncol*. 2009;27(9):1485–91.
11. McDermott S, DesMeules M, Lewis R, Gold J, Payne J, Lafrance B, et al. Cancer incidence among Canadian immigrants, 1980–1998: results from a national cohort study. *J Immigr Minor Health*. 2011;13(1):15–26.
12. Haworth EA, Soni Raleigh V, Balarajan R. Cirrhosis and primary liver cancer amongst first generation migrants in England and Wales. *Ethn Health*. 1999;4(1–2):93–9.
13. Visser O, van Leeuwen FE. Cancer risk in first generation migrants in North-Holland/Flevoland, the Netherlands, 1995–2004. *Eur J Cancer*. 2007;43(5):901–8.
14. Chang TT, Liaw YF, Wu SS, Schiff E, Han KH, Lai CL, et al. Long-term entecavir therapy results in the reversal of fibrosis/cirrhosis and continued histological improvement in patients with chronic hepatitis B. *Hepatology*. 2010;52(3):886–93.
15. Papatheodoridis GV, Manolakopoulos S, Touloumi G, Nikolopoulou G, Raptopoulou-Gigi M, Gogos C, et al. Hepatocellular carcinoma risk in HBeAg-negative chronic hepatitis B patients with or without cirrhosis treated with entecavir: HepNet.Greece cohort. *J Viral Hepat*. 2015;22(2):120–7.
16. Toy M, Veldhuijzen IK, de Man RA, Richardus JH, Schalm SW. Potential impact of long-term nucleoside therapy on the mortality and morbidity of active chronic hepatitis B. *Hepatology*. 2009;50(3):743–51.
17. Nayagam S, Thursz M, Sicuri E, Conteh L, Wiktor S, Low-Beer D, et al. Requirements for global elimination of hepatitis B: a modelling study. *Lancet Infect Dis*. 2016;16(12):1399–408.
18. IOM (Institute of Medicine), *Hepatitis and liver cancer: a national strategy for prevention and control of hepatitis B and C*, IOM, Editor. 2010, Institute of Medicine: Washington DC.
19. Cowie, B. and H.Kelly, *Outcomes of a complex dynamic mathematical model of hepatitis B virus in Australia*. (PP-027), in *20th Conference of the Asian Pacific Association for the Study of the Liver (APASL)*; . 2010, Hepatology International Beijing, China p. 27.
20. Hatzakis A, Wait S, Bruix J, Buti M, Carballo M, Cavaleri M, et al. The state of hepatitis B and C in Europe: report from the hepatitis B and C summit conference. *J Viral Hepat*. 2011;18(Suppl 1):1–16.
21. Cohen C, Holmberg SD, McMahon BJ, Block JM, Brosgart CL, Gish RG, et al. Is chronic hepatitis B being undertreated in the United States? *J Viral Hepat*. 2011;18(6):377–83.
22. Hu KQ, Pan CQ, Goodwin D. Barriers to screening for hepatitis B virus infection in Asian Americans. *Dig Dis Sci*. 2011;56(11):3163–71.
23. Ma GX, Fang CY, Shive SE, Toubbeh J, Tan Y, Sui P. Risk perceptions and barriers to hepatitis B screening and vaccination among Vietnamese immigrants. *J Immigr Minor Health*. 2007;9(3):213–20.
24. Nguyen CT, Lin SY. Hepatitis B screening in Asian and Pacific islanders: new guidelines, old barriers. *J Immigr Minor Health*. 2015;17(5):1585–7.
25. Xu K, Watanabe-Galloway S, Rochling FA, Zhang J, Farazi PA, Peng H, et al. Practice, knowledge, and barriers for screening of hepatocellular carcinoma among high-risk Chinese patients. *Annals of Global Health*. 2017;83(2):281–92.
26. Zhou K, Fitzpatrick T, Walsh N, Kim JY, Chou R, Lackey M, et al. Interventions to optimise the care continuum for chronic viral hepatitis: a systematic review and meta-analyses. *Lancet Infect Dis*. 2016;16:1409–22.
27. Ferrante JM, Winston DG, Chen PH, de la Torre AN. Family physicians' knowledge and screening of chronic hepatitis and liver cancer. *Fam Med*. 2008;40(5):345–51.
28. Lai CJ, Nguyen TT, Hwang J, Stewart SL, Kwan A, McPhee SJ. Provider knowledge and practice regarding hepatitis B screening in Chinese-speaking patients. *J Cancer Educ*. 2007;22(1):37–41.
29. Robotin M, Patton Y, George J. Getting it right: the impact of a continuing medical education program on hepatitis B knowledge of Australian primary care providers. *Int J Gen Med*. 2013;6:115–22.
30. *Status of Vietnamese Health: Santa Clara County, California, 2011*, C.o.S.C.P.H. Department, Editor. 2011, Public Health Department Santa Clara.
31. Robotin MC, George J. Community-based hepatitis B screening: what works? *Hepatol Int*. 2014;8(4):478–92.
32. van der Veen YJ, et al. Cultural tailoring to promote hepatitis B screening in Turkish Dutch: a randomized control study. *Health Promot Int*. 2013;29(4):692–704.
33. Zuure FR, Bouman J, Martens M, Vanhommerig JW, Urbanus AT, Davidovich U, et al. Screening for hepatitis B and C in first-generation Egyptian migrants living in the Netherlands. *Liver Int*. 2013;33(5):727–38.
34. Ma GX, Gao W, Tan Y, Chae WG, Rhee J. A community-based participatory approach to a hepatitis B intervention for Korean Americans. *Prog Community Health Partnersh*. 2012;6(1):7–16.
35. Bailey MB, et al. San Francisco Hep B free: a grassroots community coalition to prevent hepatitis B and liver Cancer. *J Community Health*. 2010;36(4):538–51.
36. Hwang JP, Mohseni M, Gor BJ, Wen S, Guerrero H, Vierling JM. Hepatitis B and hepatitis C prevalence and treatment referral among

- Asian Americans undergoing community-based hepatitis screening. *Am J Public Health*. 2010;100(Suppl 1):S118–24.
37. Robinson T, Bullen C, Humphries W, Hornell J, Moyes C. The New Zealand hepatitis B screening Programme: screening coverage and prevalence of chronic hepatitis B infection. *N Z Med J*. 2005;118(1211):U1345.
  38. Marineau M, Tice AD, Taylor-Garcia D, Akinaka KT, Lusk H, Ona F. Culturally sensitive strategies designed to target the silent epidemic of hepatitis B in a Filipino community. *Hawaii Med J*. 2007;66(6):154–6.
  39. Chen CH, Yang PM, Huang GT, Lee HS, Sung JL, Sheu JC. Estimation of seroprevalence of hepatitis B virus and hepatitis C virus in Taiwan from a large-scale survey of free hepatitis screening participants. *J Formos Med Assoc*. 2007;106(2):148–55.
  40. Lee J, Lok AS, Chen J. Hepatitis B prevalence among Asian Americans in Michigan: an assessment to guide future education and intervention strategies. *J Community Health*. 2010;35(5):534–42.
  41. Lin SY, Chang ET, So SK. Why we should routinely screen Asian American adults for hepatitis B: a cross-sectional study of Asians in California. *Hepatology*. 2007;46(4):1034–40.
  42. Buster EH, et al. Sustained HBeAg and HBsAg loss after long-term follow-up of HBeAg-positive patients treated with peginterferon alpha-2b. *Gastroenterology*. 2008;135(2):459–67.
  43. Mostert MC, Richardus JH, de Man RA. Referral of chronic hepatitis B patients from primary to specialist care: making a simple guideline work. *J Hepatol*. 2004;41(6):1026–30.
  44. Robotin MC, Kansil MQ, Porwal M, Penman AG, George J. Community-based prevention of hepatitis-B-related liver cancer: Australian insights. *Bull World Health Organ*. 2014;92(5):374–9.
  45. World Health Organization, Global health sector strategy on viral hepatitis, 2016–2021., in <http://apps.who.int/iris/bitstream/10665/246177/1/WHO-HIV-2016.06-eng.pdf?ua=1>, W.H. Organization, Editor. 2016, World Health Organization: Geneva. Accessed 12 Apr 2019.
  46. Ward JW. Strategies for expanding access to HBV and HCV testing and Care in the United States: the CDC hepatitis testing and linkage to care initiative, 2012–2014. *Public Health Rep*. 2016;131(Suppl 2):1–4.
  47. Chandrasekar E, et al. A Novel Strategy to Increase Identification of African-Born People With Chronic Hepatitis B Virus Infection in the Chicago Metropolitan Area, 2012–2014. *Prev Chronic Dis*. 2016;13:E118 **Trialled chain referral sampling to encourage testing and engagement in care of uninsured and marginalised African-born people; used patient navigators.**
  48. Juon HS, Lee S, Strong C, Rimal R, Kirk GD, Bowie J. Effect of a liver cancer education program on hepatitis B screening among Asian Americans in the Baltimore-Washington metropolitan area, 2009–2010. *Prev Chronic Dis*. 2014;11:130258.
  49. Ma GX, et al. A Community-Based Randomized Trial of Hepatitis B Screening Among High-Risk Vietnamese Americans. *Am J Public Health*. 2017;107(3):433–40 **Cluster RCT of multilevel intervention offering interactive in-language education and patient navigators vs. general information; outcomes: screening rates. Used a participatory approach to enhance intervention effects and enhance its sustainability.**
  50. Nguyen K, van Nguyen T, Shen D, Xia V, Tran D, Banh K, et al. Prevalence and presentation of hepatitis B and C virus (HBV and HCV) infection in Vietnamese Americans via serial community serologic testing. *J Immigr Minor Health*. 2015;17(1):13–20.
  51. Strong C, Hur K, Kim F, Pan J, Tran S, Juon HS. Sociodemographic characteristics, knowledge and prevalence of viral hepatitis infection among Vietnamese Americans at community screenings. *J Immigr Minor Health*. 2015;17(1):298–301.
  52. Barragan NC, et al. A case study of a hepatitis B screening and blood pressure assessment program in Los Angeles County, 2012–2013. *Prev Chronic Dis*. 2015;12:E19.
  53. Stomaiuolo G, Cuniato V, Cuomo G, Nocera E, Brancaccio G, de Rosa M, et al. Active recruitment strategy in disadvantaged immigrant populations improves the identification of human immunodeficiency but not of hepatitis B or C virus infections. *Dig Liver Dis*. 2014;46(1):62–6.
  54. Beckett GA, et al. Early identification and linkage to care of persons with chronic hepatitis B virus infection—three U.S. sites, 2012–2014. *MMWR Morb Mortal Wkly Rep*. 2014;63(18):399–401.
  55. Chandrasekar E, Kaur R, Song S, Kim KE. A comparison of effectiveness of hepatitis B screening and linkage to care among foreign-born populations in clinical and nonclinical settings. *J Multidiscip Healthc*. 2015;8:1–9.
  56. Dang JH, Chen MS Jr. Increasing hepatitis B testing and linkage to Care of Foreign-Born Asians, Sacramento, California, 2012–2013. *Public Health Rep*. 2016;131(Suppl 2):119–24.
  57. Harris AM, et al. Testing and Linking Foreign-Born People with Chronic Hepatitis B Virus Infection to Care at Nine U.S. Programs, 2012–2014. *Public Health Rep*. 2016;131(Suppl 2):20–8 **Summary results from a prospective cohort drawn from population groups with a HBV prevalence >2%, based on their country of birth. Nine pilot sites conducted targeted screening of 23, 144 participants; linkage to primary care providers was achieved in 83% of HBsAg+ve people. Data collected using a common dataset. Authors provide insights into success factors and recommendations for how to increase testing uptake.**
  58. Hyun CS, et al. Chronic hepatitis B in Korean Americans: decreased prevalence and poor linkage to care. *BMC Infect Dis*. 2016;16(1):415 **Summarises findings of a large-scale screening and awareness campaign targeting Korean Americans. Through 128 separate community events, tested 7,199 people, with HBV prevalence of 2.4%. Identified role of education and navigation in facilitating linkage to care.**
  59. Hyun CS, Ventura WR, Kim SS, Yoon S, Lee S. A community-based hepatitis B linkage-to-care program: a case study on Asian Americans chronically infected with hepatitis B virus. *Hepatol Med Policy*. 2016;1:6.
  60. Navarro N, Lim N, Kim J, Joo E, Che K, Runyon BA, et al. *Lower than expected hepatitis B virus infection prevalence among first generation Koreans in the U.S.: results of HBV screening in the Southern California Inland Empire*. *BMC Infect Dis*. 2014;14:269.
  61. Shankar H, et al. A Novel Collaborative Community-Based Hepatitis B Screening and Linkage to Care Program for African Immigrants. *Clin Infect Dis*. 2016;62(Suppl 4):S289–97 **Novel partnership involving a community-based organisation, an academic medical center and community health centers to provide comprehensive screening and linkage to care of underserved / uninsured people from African countries. Used culturally targeted patient navigators.**
  62. Walters J, Sullivan A. Early identification and linkage to Care of Foreign-Born People with chronic hepatitis B virus infection, Multnomah County, Oregon, 2012–2014. *Public Health Rep*. 2016;131(Suppl 2):105–11.
  63. Coenen S, et al. Clinical impact of five large-scale screening projects for chronic hepatitis B in Chinese migrants in the Netherlands. *Liver Int*. 2016;36(10):1425–32 **First large-scale community based screening and treatment intervention in high risk Chinese residents in a European country. Combination of outreach with direct clinic referral ensured high referral and treatment rates.**
  64. Richter C, et al. Screening for chronic hepatitis B and C in migrants from Afghanistan, Iran, Iraq, the former soviet republics, and Vietnam in the Arnhem region. *Netherlands Epidemiol Infect*. 2014;142(10):2140–6.

65. Lemoine M, et al. Acceptability and feasibility of a screen-and-treat programme for hepatitis B virus infection in The Gambia: the Prevention of Liver Fibrosis and Cancer in Africa (PROLIFICA) study. *Lancet Glob Health*. 2016;4(8):e559–67 **First large-scale screen-and-treat program in the general population in a low-resource country in Africa. Used point-of-care testing and trained fieldworkers and achieved high screening coverage and linkage to care.**
66. Robotin MC, et al. Using a chronic hepatitis B Registry to support population-level liver cancer prevention in Sydney, Australia. *Clin Epidemiol*. 2018;10:41–9 **Established a disease Registry enrolling patients with CHB diagnosed in primary care. Specialist referral based upon risks stratification by primary care providers, which reduced unnecessary specialist referrals. Validated assumptions of the economic level, including antiviral treatment in 18% of those enrolled.**
67. Juon HS, Strong C, Oh TH, Castillo T, Tsai G, Oh LDH. Public health model for prevention of liver cancer among Asian Americans. *J Community Health*. 2008;33(4):199–205.
68. Richter C, et al. Hepatitis B prevalence in the Turkish population of Arnhem: implications for national screening policy? *Epidemiol Infect*. 2012;140(4):724–30.
69. Perumalswami PV, Factor SH, Kapelusznik L, Friedman SL, Pan CQ, Chang C, et al. Hepatitis outreach network: a practical strategy for hepatitis screening with linkage to care in foreign-born communities. *J Hepatol*. 2013;58(5):890–7.
70. Veldhuijzen IK, Wolter R, Rijckborst V, Mostert M, Voeten HA, Cheung Y, et al. Identification and treatment of chronic hepatitis B in Chinese migrants: results of a project offering on-site testing in Rotterdam The Netherlands. *J Hepatol*. 2012;57(6):1171–6.
71. Robotin M, et al. *Characteristics of chronic hepatitis B infection in SW Sydney: clinical correlates and policy implications*. In: in *9th Australasian Viral Hepatitis Conference*. Australia: Alice Springs; 2014.
72. World Health Organization, *Guidelines on hepatitis B and C testing*. 2017, World Health Organization Geneva.
73. Hutton DW, Tan D, So SK, Brandeau ML. Cost-effectiveness of screening and vaccinating Asian and Pacific islander adults for hepatitis B. *Ann Intern Med*. 2007;147(7):460–9.
74. Veldhuijzen IK, Toy M, Hahné SJM, de Wit GA, Schalm SW, de Man RA, et al. Screening and early treatment of migrants for chronic hepatitis B virus infection is cost-effective. *Gastroenterology*. 2010;138(2):522–30.
75. Robotin MC, Kansil M, Howard K, George J, Tipper S, Dore GJ, et al. Antiviral therapy for hepatitis B-related liver cancer prevention is more cost-effective than cancer screening. *J Hepatol*. 2009;50(5):990–8.
76. Lemoine M, Nayagam S, Thursz M. Viral hepatitis in resource-limited countries and access to antiviral therapies: current and future challenges. *Futur Virol*. 2013;8(4):371–80.
77. Zhou K, Fitzpatrick T, Walsh N, Kim JY, Chou R, Lackey M, et al. Interventions to optimise the care continuum for chronic viral hepatitis: a systematic review and meta-analyses. *Lancet Infect Dis*. 2016;16(12):1409–22.
78. Shapiro AE, et al. Completion of the tuberculosis care cascade in a community-based HIV linkage-to-care study in South Africa and Uganda. *J Int AIDS Soc*. 2018;21(1):e25065.
79. Hermann K, van Damme W, Pariyo GW, Schouten E, Assefa Y, Cirera A, et al. Community health workers for ART in sub-Saharan Africa: learning from experience—capitalizing on new opportunities. *Hum Resour Health*. 2009;7:31.
80. Dunbar EL, Wroe EB, Nhlema B, Kachimanga C, Gupta R, Taylor C, et al. Evaluating the impact of a community health worker programme on non-communicable disease, malnutrition, tuberculosis, family planning and antenatal care in Neno, Malawi: protocol for a stepped-wedge, cluster randomised controlled trial. *BMJ Open*. 2018;8(7):e019473.
81. Busza J, Dauya E, Bandason T, Simms V, Chikwari CD, Makamba M, et al. The role of community health workers in improving HIV treatment outcomes in children: lessons learned from the ZENITH trial in Zimbabwe. *Health Policy Plan*. 2018;33(3):328–34.
82. Nayagam S, Conteh L, Sicuri E, Shimakawa Y, Suso P, Tamba S, et al. Cost-effectiveness of community-based screening and treatment for chronic hepatitis B in the Gambia: an economic modelling analysis. *Lancet Glob Health*. 2016;4(8):e568–78.
83. Allain JP. Screen-and-treat for chronic hepatitis B: an overdue issue for sub-Saharan Africa. *Lancet Glob Health*. 2016;4(8):e507–8.
84. Glasgow RE, Askew S, Purcell P, Levine E, Warner ET, Stange KC, et al. Use of RE-AIM to address health inequities: application in a low-income community health center based weight loss and hypertension self-management program. *Transl Behav Med*. 2013;3(2):200–10.
85. Glasgow RE, Estabrooks PE. Pragmatic applications of RE-AIM for health care initiatives in community and clinical settings. *Prev Chronic Dis*. 2018;15:E02.
86. Glasgow RE, Klesges LM, Dziewaltowski DA, Estabrooks PA, Vogt TM. Evaluating the impact of health promotion programs: using the RE-AIM framework to form summary measures for decision making involving complex issues. *Health Educ Res*. 2006;21(5):688–94.
87. Glasgow RE, Vogt TM, Boles SM. Evaluating the public health impact of health promotion interventions: the RE-AIM framework. *Am J Public Health*. 1999;89(9):1322–7.
88. Forman J, Heisler M, Damschroder LJ, Kaselitz E, Kerr EA. Development and application of the RE-AIM QuEST mixed methods framework for program evaluation. *Prev Med Rep*. 2017;6:322–8.

**Publisher's Note** Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.