Welcome to the webinar!

Epidemiological Tools and Analytics to Support the Global Elimination of Hepatitis B

January 23, 2019

About Us

Hep B United is a national coalition that was established by the Hepatitis B Foundation and the Association of Asian Pacific Community Health Organizations to address the public health challenge of hepatitis B.

The coalition is dedicated to reducing the health disparities associated with hepatitis B by increasing awareness, screening, vaccination, and linkage to care for high-risk communities across the United States.

Speaker

Devin Razavi-Shearer
HBV/HDV Project Lead
Center for Disease Analysis Foundation

Epidemiological Tools and Analytics to Support the Global Elimination of Hepatitis B

D. Razavi-Shearer

January 23rd, 2019

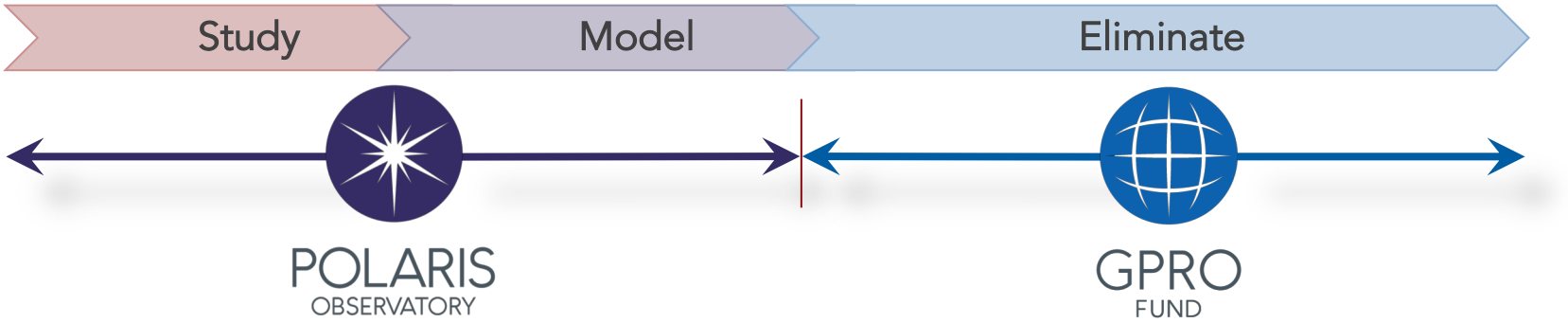
@CDAFound

Topics

- CDAF Background
- Delphi Process
- Global Work
- State Work
- PRoGReSs Model
  - » Overview
  - » Model Validation
  - » Economic Impact
  - » Immigration
- Model

CDA Foundation (CDAF) is a non-profit organization with the goal of assisting countries in achieving the 2030 hepatitis elimination targets

We work to ***study, model & eliminate*** hepatitis. We accomplish this through our two major initiatives:



Provide collaborators with epidemiological data, modeling tools and decision analytics to support eliminating Hepatitis B and C globally by 2030.

Improve access to medicines and diagnostics, and develop scalable, sustainable funding mechanisms for low and middle-income (LMIC) countries. Provide optimized hepatitis elimination programs.

CDAF provides technical assistance to aid in the decision making process

POLARIS OBSERVATORY

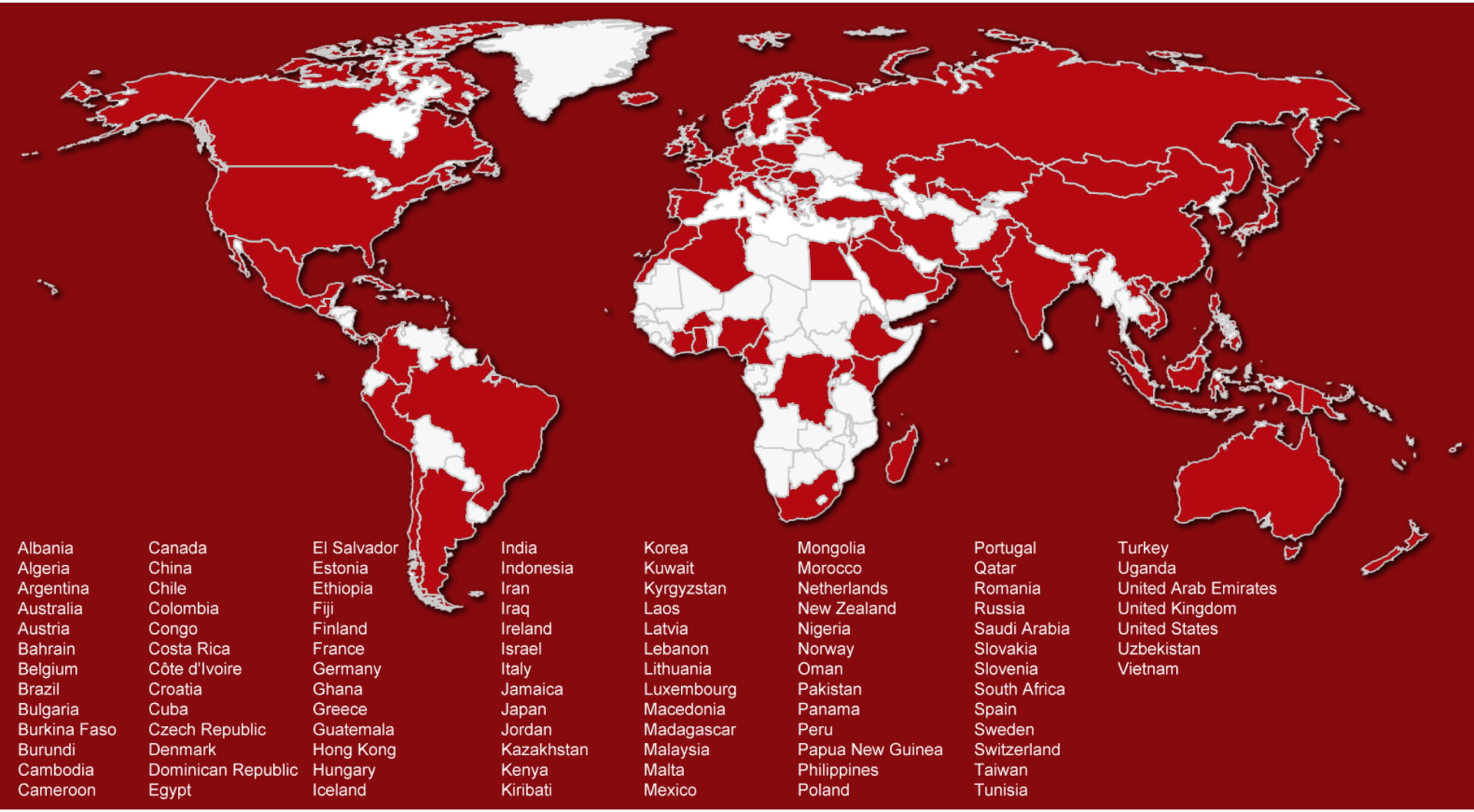
Services

- HCV & HBV disease burden modeling
- HCV & HBV economic impact modeling
- HBV vertical and horizontal transmission modeling
- Cohort analysis
- Training on how to use models
- Hepatitis elimination strategies
- Cost-effectiveness and ROI analyses
- Data and metrics to track progress to elimination

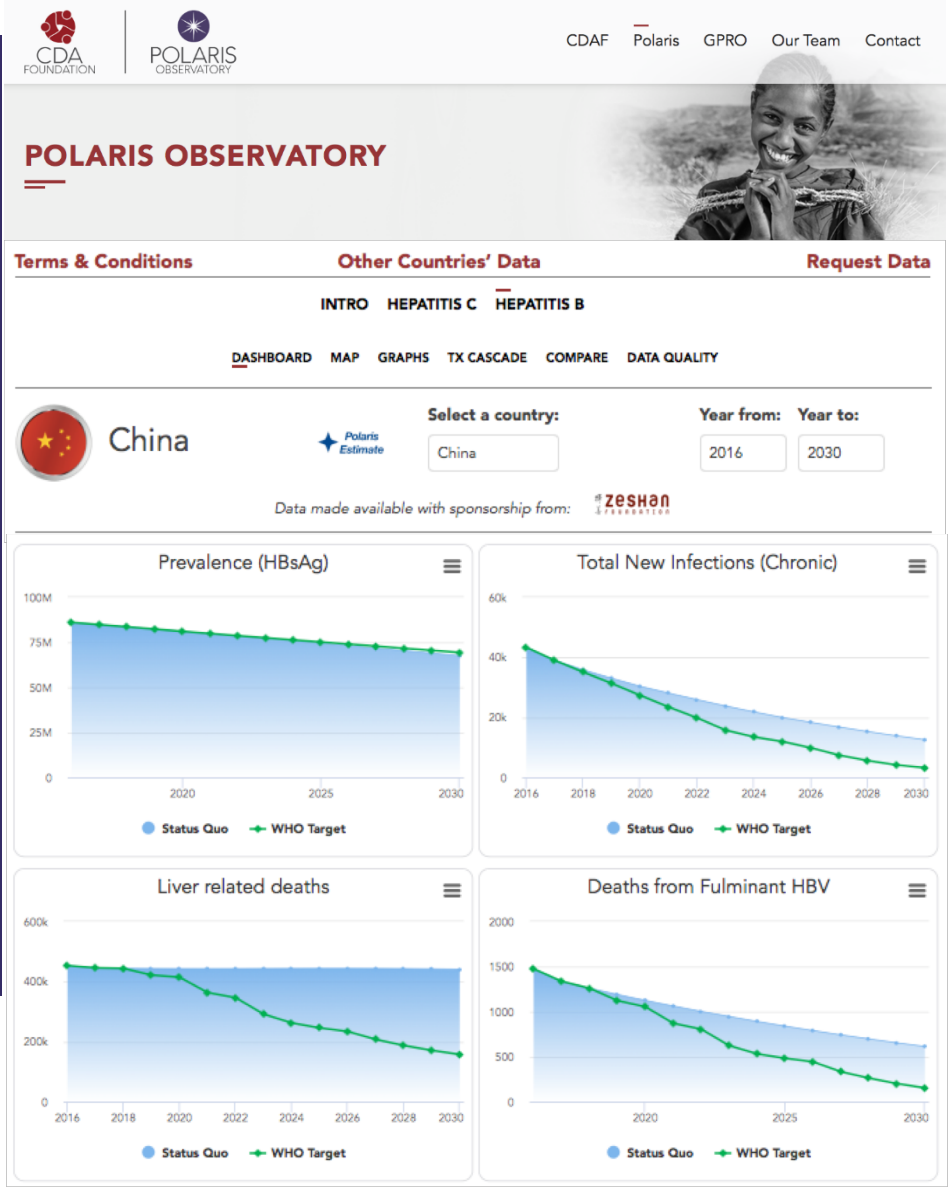
Guiding Principles

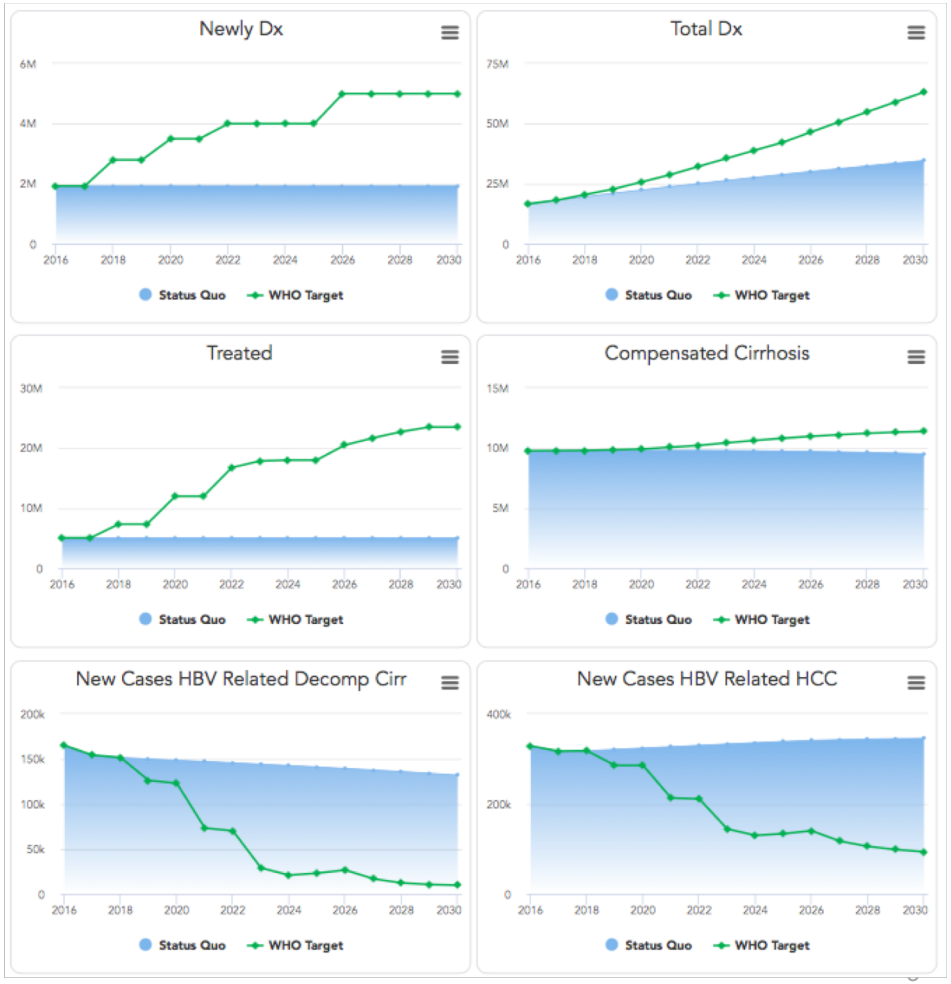
- Validate all data/analyses with local experts
- Complement country interviews with literature searches to minimize the burden on country experts
- Facilitate objective, data-driven decisions and policy-making with consideration of each country's unique needs
- Publish key findings with local collaborators
- Function as a platform to provide data, tools and analyses with a user-friendly Microsoft Excel® interface

We have modeled hepatitis disease burden for over 100 countries/regions in collaboration with more than 750 country experts



The Polaris Observatory keeps track of how countries are progressing & provides guidance on how they can achieve the elimination targets





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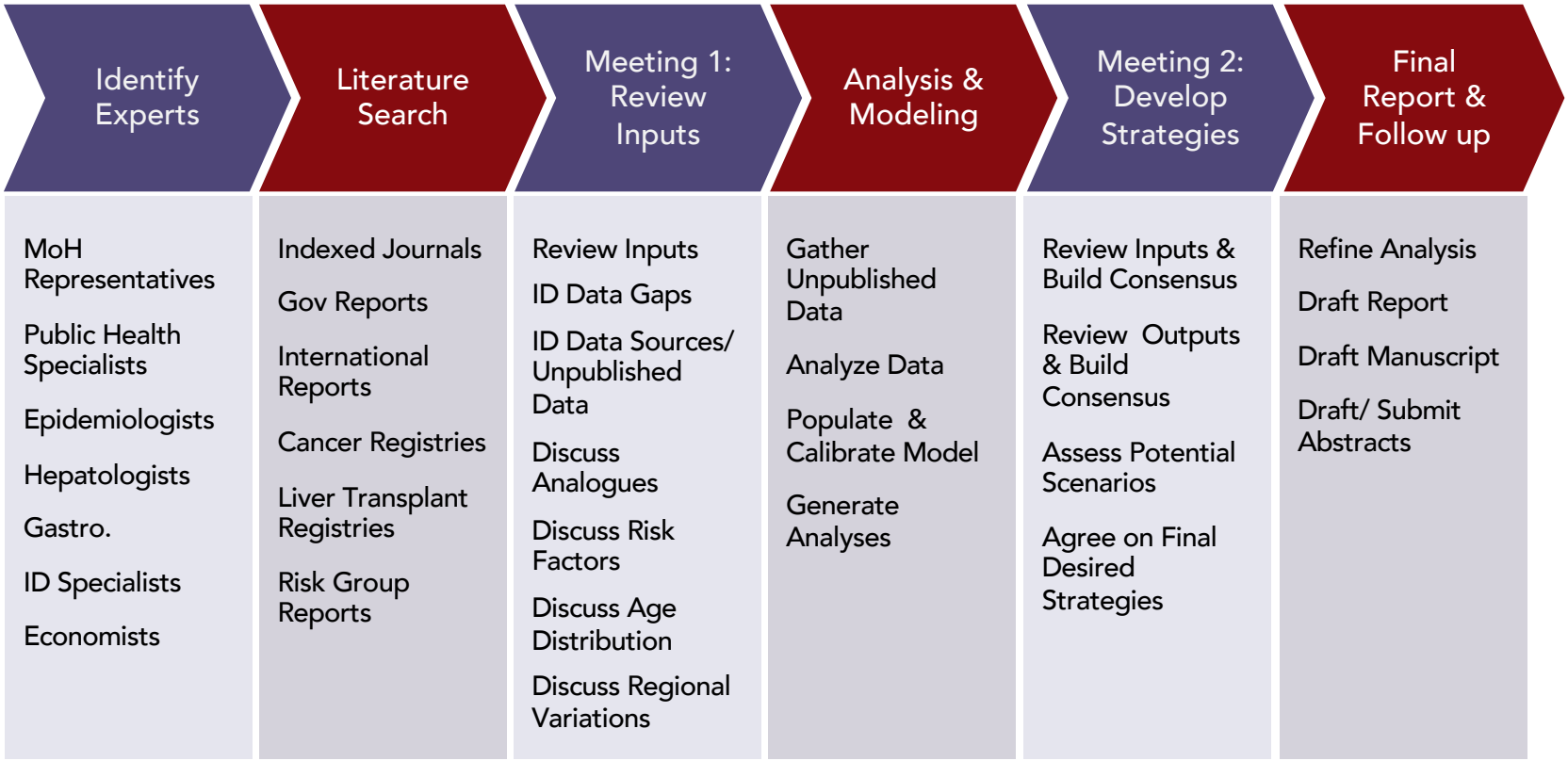
A modified Delphi process is used to develop consensus estimates for all inputs



A systematic process is used to develop consensus estimates of HBV disease burden in each country

- Pre-Meeting 1
  - Conduct an exhaustive literature search for English and non-English published studies finding key inputs — HBsAg prevalence, age distribution, HBeAg prevalence among women of childbearing age, diagnosed, treated, incidence
  - Pre-populate the disease burden model and send out a slide deck summarizing findings
- Meeting 1 with local experts (2 hours)
  - Provide a brief overview of the methodology and model
  - Review assumptions and identify data gaps
  - Make modifications to key inputs based on expert input and unpublished data
  - Identify action items with key responsibilities
- Between Meetings 1 & 2
  - Work with stakeholders to gather additional data and re-calibrate the model
- Meeting 2 teleconference with local experts (1.5 hours) if necessary
  - Review updated inputs and gain consensus
  - Review the scenarios and discuss any additional analysis
- Post-Meeting 2
  - Develop manuscripts to be submitted to peer-reviewed journals
  - Submit abstracts to conferences to present findings

Publications & Citations

- CDAF partners with our collaborators to publish data, analyses and related findings.
- Since 2011, together we have published **65 papers** in prominent, peer reviewed journals.
- Polaris and its collaborators have over **4,500 citations**, and growing.

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As part of the Polaris Observatory, the following HBV projects are underway:

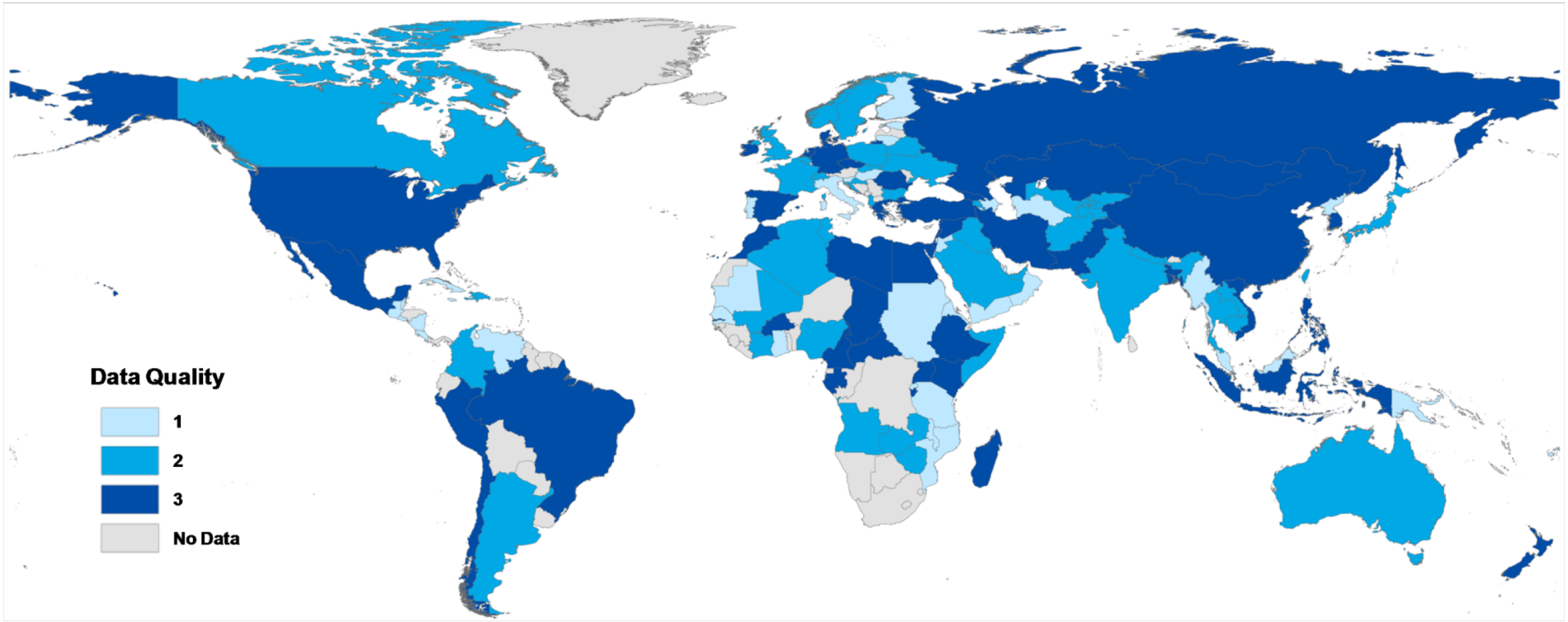
- HBV epidemiology
  - HBsAg prevalence
  - HBeAg prevalence
  - HDV prevalence
- PRoGReSs Model
  - HBV perinatal and horizontal transmission model with disease burden
  - Economic Impact Module
  - Immigration Module

A data quality scoring system was developed to select the most representative studies – only studies with a score of ≥3 are used

Geographic Scope	**Scale, 0–10**				
National	0	3	4 Meta-analysis - 4	6	10† 9 Model - 6 Meta-Analysis - 5
Large Region **Multi-Region** **Multi-City** **Large City**	0	1	2-3‡	4-5‡	6-8‡
Small Region/Town **Village** **Tribe** **Hospital**	0	0	1	1	2
Population →	***High risk, any sampling method*** - ***IVDUs*** - ***HIV*** - ***Surgical patients***	***Healthy adults, self-selected*** - ***Blood donors***	***Healthy adults, self-selected*** - ***Health check-up patients*** - ***Screening***	***Healthy adults, randomly selected*** - ***Health care workers*** - ***Pregnant women*** - ***Soldiers***	***General population, randomly selected***

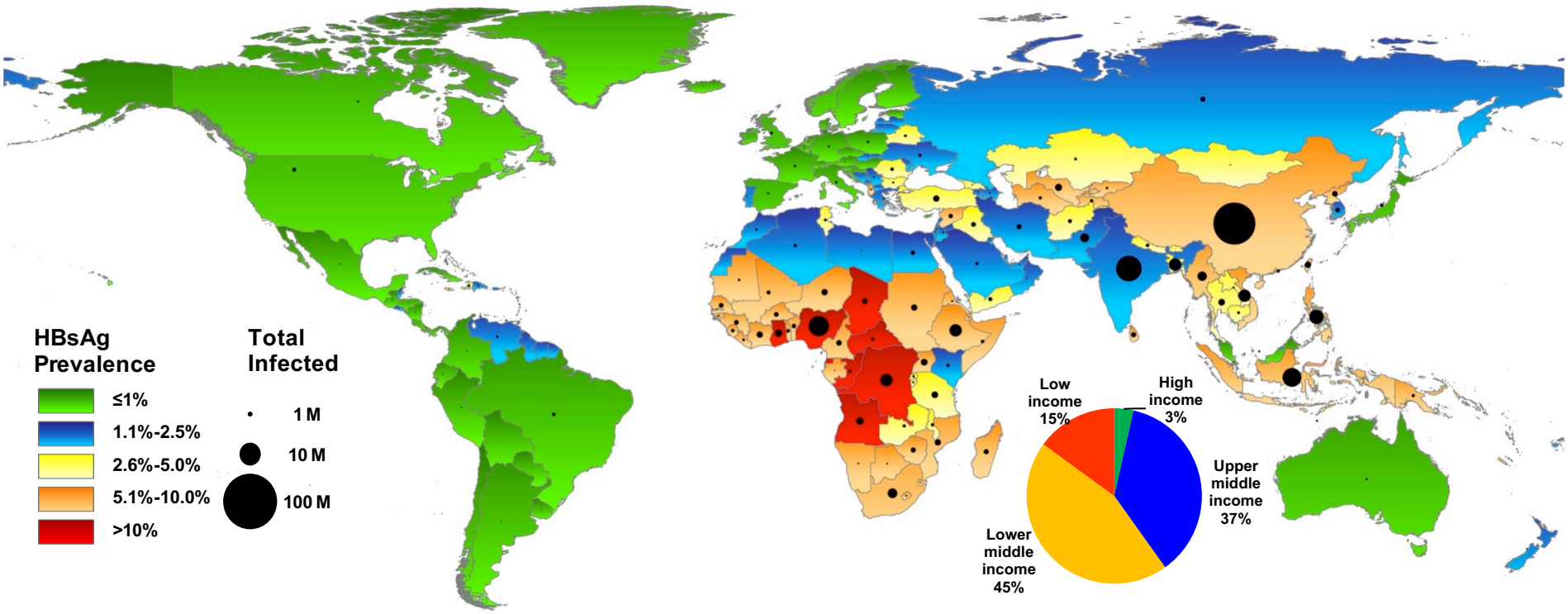
†10 reserved for a nationally representative sample with a stratified, multistage and random sampling design, which documents the study design and demographics of subjects thoroughly (e.g. NHANES).
‡Variability subject to authors discretion based on quality of study design, as well as the geographic scope of the respective country.

Data was available for 93% of the global population and 90% of all estimated HBsAg+ infections



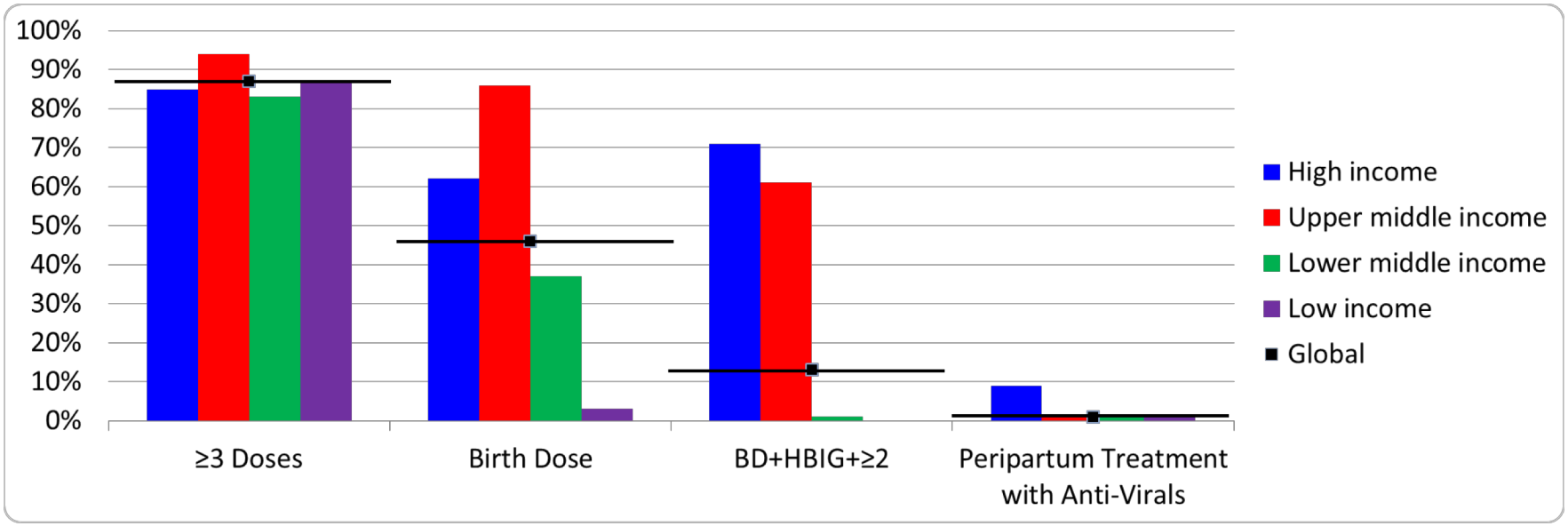
*Razavi-Shearer D, Gamkrelidze I, Nguyen MH, et al. Global prevalence, treatment, and prevention of hepatitis B virus infection in 2016: a modelling study. Lancet Gastroenterol Hepatol 2018; **3**(6): 383-403.*

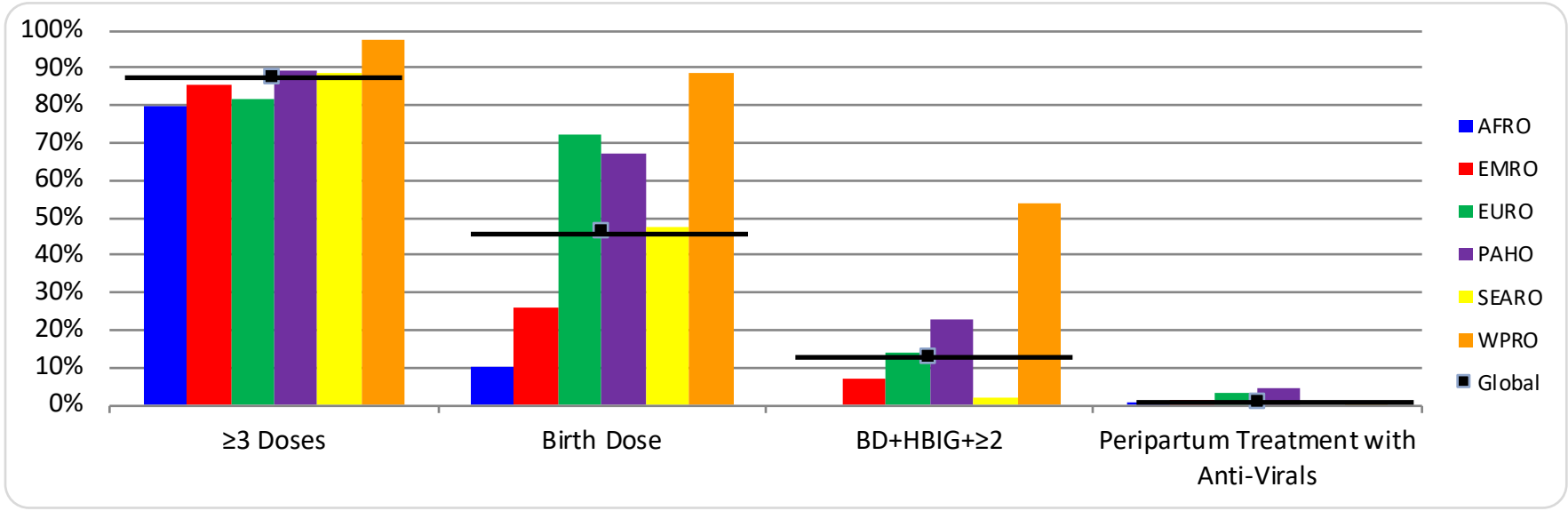
Global HBsAg prevalence was 3.9% (3.4-4.6%) corresponding to 292 million (252-341) infections in 2016



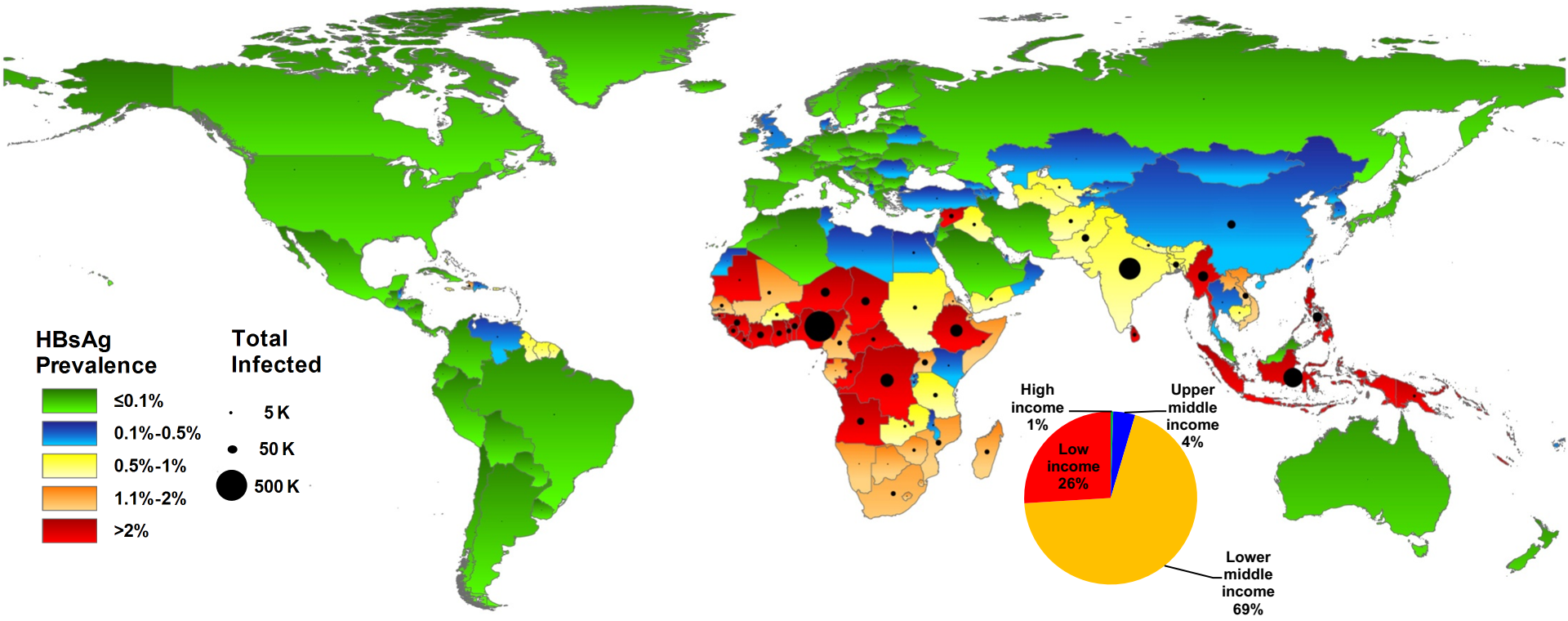
*Razavi-Shearer D, Gamkrelidze I, Nguyen MH, et al. Global prevalence, treatment, and prevention of hepatitis B virus infection in 2016: a modelling study. Lancet Gastroenterol Hepatol 2018; **3**(6): 383-403.*

A large disparity in access to tools to reduce mother-to-child-transmission exists across countries



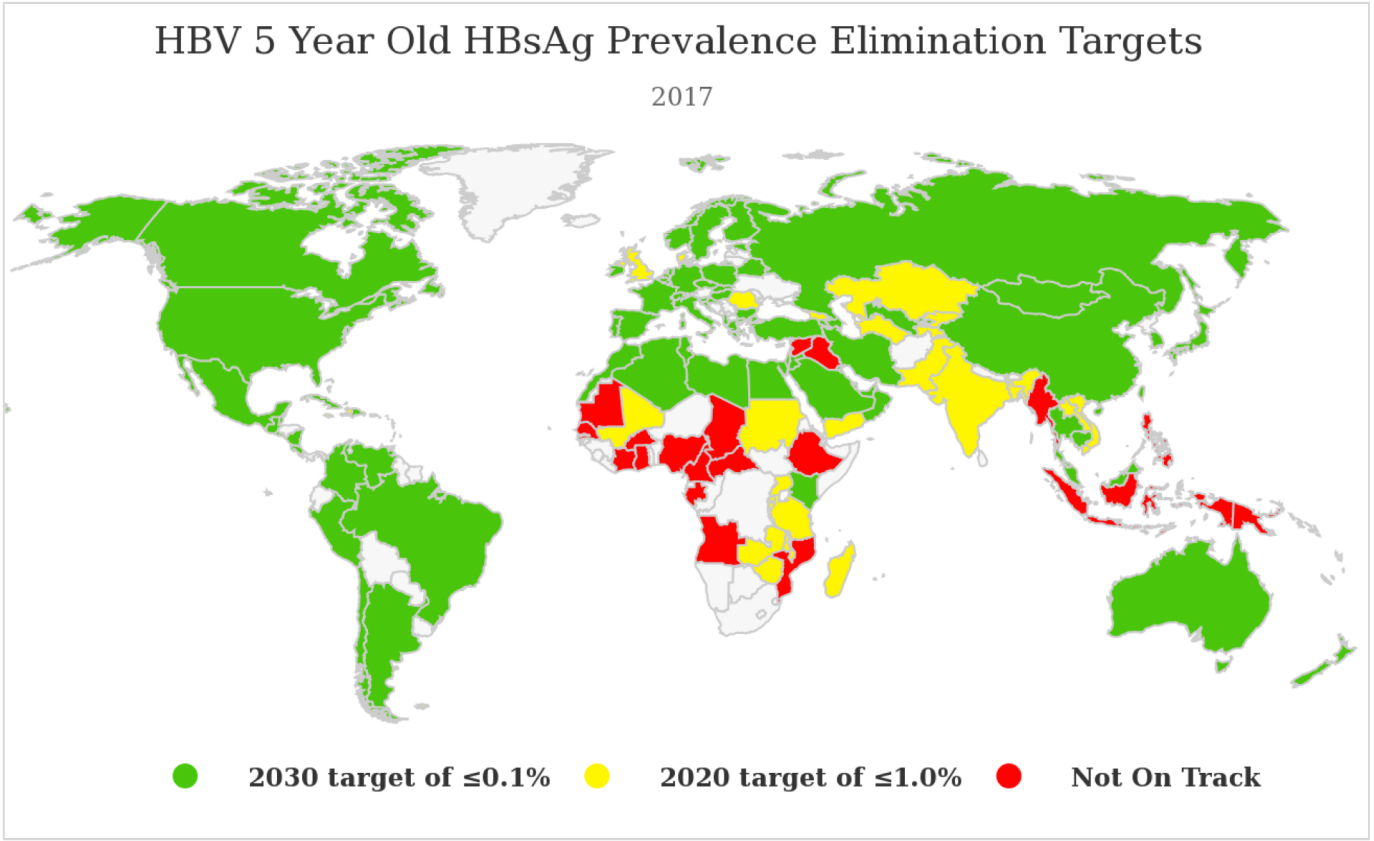


The global HBsAg prevalence among 5-year olds was estimated to be 1.4% (1.2-1.6%) representing 1.8 million (1.6-2.2) infections in 2016



*Razavi-Shearer D, Gamkrelidze I, Nguyen MH, et al. Global prevalence, treatment, and prevention of hepatitis B virus infection in 2016: a modelling study. Lancet Gastroenterol Hepatol 2018; **3**(6): 383-403.*

20 countries will not reduce their HBsAg prevalence to less than 1.0% by 2020 and 0.1% by 2030 among 5-year-olds



Angola
Burkina Faso
Cameroon
Central African Republic
Chad
Côte d'Ivoire
Ethiopia
Gabon
Ghana
Indonesia
Iraq
Kiribati
Mauritania
Mozambique
Myanmar
Nigeria
Papua New Guinea
Philippines
Senegal
Syrian Arab Republic

Polaris Observatory (http://cdafound.org/polaris/ accessed June 14, 2018)

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Past State Work- HCV

- Quantify HCV epidemiology at the state level
  - » Prevalence by age, diagnosed, treated, incidence
- Model HCV disease burden at the state level
  - » Fibrosis, compensated cirrhosis, decompensated cirrhosis, hepatocellular carcinoma, liver transplants
- Model future HCV disease burden under the current standard of care
- Model the requirement to achieve HCV elimination by 2030

The HCV epidemiology, disease burden and elimination has been assessed in 14 states and the District of Columbia

- Independent analysis of HCV disease burden and elimination targets in the United States[1,2]
- States modeled in collaboration with local health departments
  - » Colorado, District of Columbia, Kentucky, Rhode Island[3]
- States modeled in collaboration with the CDC Foundation and local health departments
  - » California, Louisiana, New York*, Ohio, Washington
- States modeled in collaboration with ASTHO and local health departments
  - » Georgia, Iowa, Maryland, New Mexico, Pennsylvania, Tennessee

1. *National Academies of Sciences, Engineering, and Medicine. 2017. A National Strategy for the Elimination of Hepatitis B and C: Phase Two Report. Washington, DC: The National Academies Press. doi: 10.17226/24731.*
2. *Razavi H, Elkhoury AC, Elbasha E, Estes C, Pasini K, Poynard T, et al. Chronic hepatitis C virus (HCV) disease burden and cost in the United States. Hepatology. 2013;57(6):2164-70.*
3. *Soipe AI, Razavi H, Razavi-Shearer D, Galarraga O, Taylor LE, Marshall BD. Chronic hepatitis C virus (HCV) burden in Rhode Island: modelling treatment scale-up and elimination. Epidemiol Infect. 2016:1-11.*

** Meetings in progress, or being planned, with experts*

Future ASTHO Project – Planning for State Viral Hepatitis Elimination Programs

- Unfortunately, the due date for applications was January 22nd
- This project will support approximately 30 states or territorial health departments with the following activities available:
  - Local hepatitis B and C burden estimates (collaboration with CDAF)
    - Gain consensus on prevalence estimates
    - Model the disease burden
    - Work with states to develop elimination targets
  - Hepatitis B and C elimination planning (collaboration with CDAF)
  - Demonstration projects for viral hepatitis elimination plans that have been or are being implemented
- In addition, CDAF is planning a conference to provide elimination strategy guidance, share best practices and lessons learned
  - More details will be available in a month

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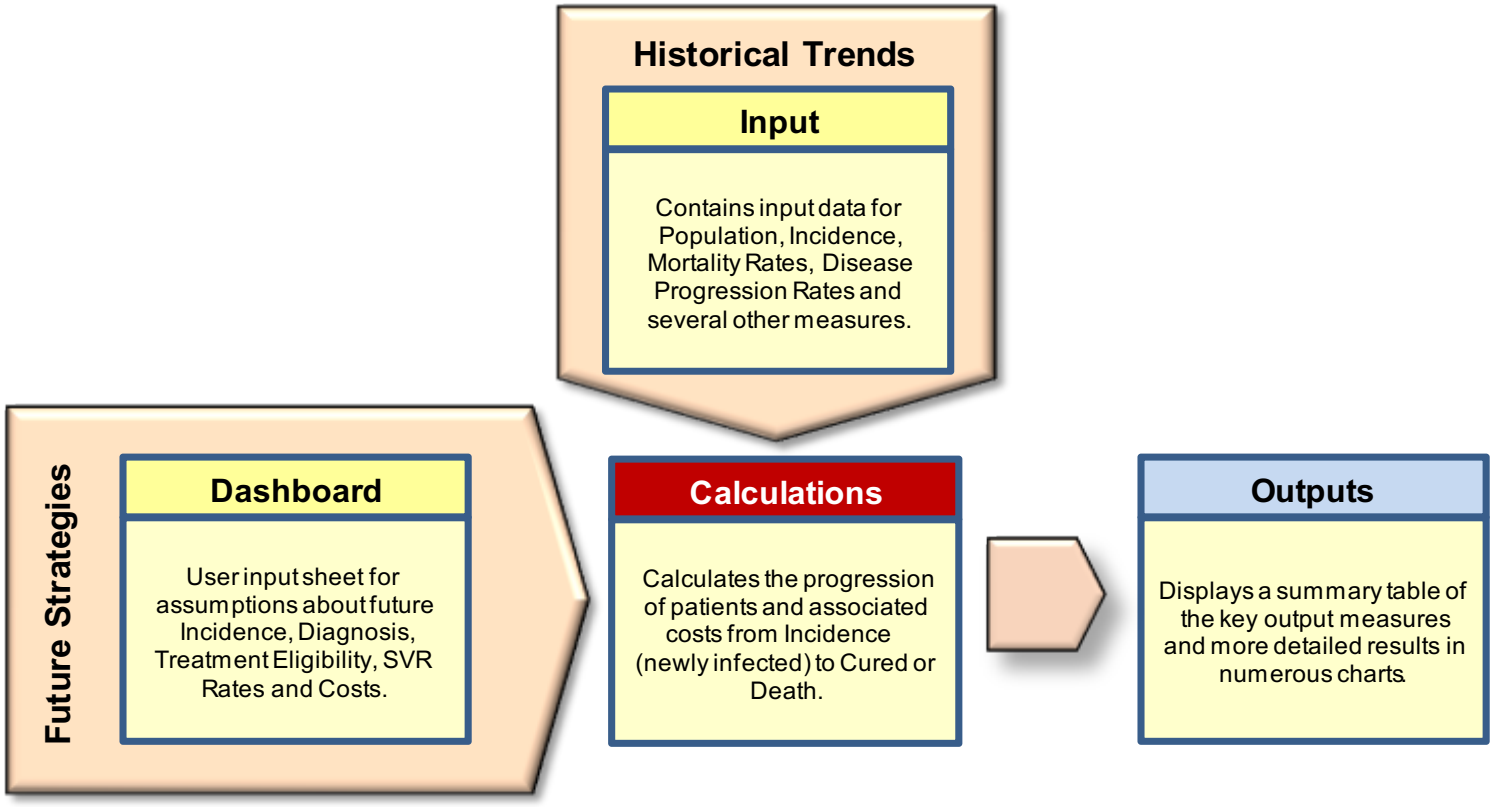
CDA models characteristics

- **Easy to use platform** – Excel-based model
- **Transparent** – All formulas are unprotected and visible
- **Ties to historical data** – Published data is used to calibrate the model
- **Measures the impact of future decisions** – Interface to input potential strategies



PRoGReSs Model — Inputs, non-perinatal

- Demographic
  - Population by year, sex, and age
  - Background mortality by year, sex, and age group
- Epidemiological
  - Newly diagnosed patients by year
  - Antiviral treatments
    - Total patients (stock) receiving treatment by year
    - Mean duration of treatment
  - Liver transplants
    - Total transplantations by year
    - Proportion of transplantations attributed to HBV

PRoGReSs Model — Inputs, perinatal

- Demographic
  - » Male-to-female sex ratios at birth, quinquennial
  - » Births by mother's age group, by year
- Epidemiological
  - » HBeAg prevalence among HBsAg+ women of childbearing age
  - » Prophylaxes coverage
    - **Women of childbearing age**: peripartum antiviral treatment
    - **Infants**
      - Timely birth dose of HBV vaccine
      - Complete HBV vaccine series
      - HBIG, of those receiving timely birth dose
    - **Non-infants**: complete HBV vaccine series

PRoGReSs Model — Collecting input data

- Prevalence
  - » PubMed and Embase were utilized to search:
    - "[Country Name] AND ('prevalence'/exp OR prevalence) AND ('hepatitis b'/exp OR 'hepatitis b' OR 'hbv'/exp OR 'hbv')"
    - All countries with a population over 1 million as well as Belize, Fiji, and Kiribati
  - » 42 691 studies identified with estimates for 128 countries
  - » 121 country level models were built
- Prophylaxes Coverage
  - » WHO/UNICEF coverage rates were supplemented by:
    - PAHO Report
    - 2013 WHO Global Policy Report on Prevention and Control of Viral Hepatitis
    - National Guidelines
    - Country Interviews

HBV Perinatal Transmission

- Developed a perinatal transmission algorithm to estimate the full impact of vaccination, HBIG, and treatment of pregnant women on HBsAg prevalence
- The model uses:
  - » Age-specific HBsAg prevalence among women of childbearing age (WoCBA)
  - » Overall HBeAg prevalence among WoCBA
  - » Portions of HBeAg+ and HBeAg- populations with high viral load (HVL) and low viral load (LVL)
- Births by age group of mother are utilized
- All infected female infants are tracked to estimate HBV prevalence when they become WoCBA
- After perinatal transmission of HBV, risk for developing a chronic HBV infection is 0.885 (Edmunds 1993)

*Razavi-Shearer D, Gamkrelidze I, et al. Global prevalence, treatment, and prevention of hepatitis B virus infection in 2016: a modelling study. Lancet Gastroenterol Hepatol 2018; **3**(6): 383–403.*

*Edmunds W, Medley G, Nokes D, Hall A, & Whittle H. The Influence of Age on the Development of the Hepatitis B Carrier State. Proceedings: Biological Sciences. 1993; **253**(1337):197–201.*

HBV Horizontal Transmission

- Horizontal transmission covers all transmission occurring non-perinatally
- Horizontal incidence of acute HBV is assumed to be a linear function *I* of prevalence of HBsAg with high viral load *p* for a population of susceptible individuals *S* at time *t*, of sex *s*, and age *a*. For those younger than 15, incidence is based on the prevalence of those aged 1–35 to simulate household infection from siblings, peers, parents, and other adults. For those 15 or older, incidence is based on the prevalence among peers of the same age:

$$I_{t,s,a} = \begin{cases} S_{t-1,s,a-1} \times \left(1 - d_{t-1,s,a-1}\right) \times p_{t-1,0\text{–}35} \times (k_a \times C_s) & \text{if } 0 \leq a < 15 \\ S_{t-1,s,a-1} \times \left(1 - d_{t-1,s,a-1}\right) \times p_{t-1,a} \times (k_a \times C_s) & \text{if } a \geq 15 \end{cases}$$

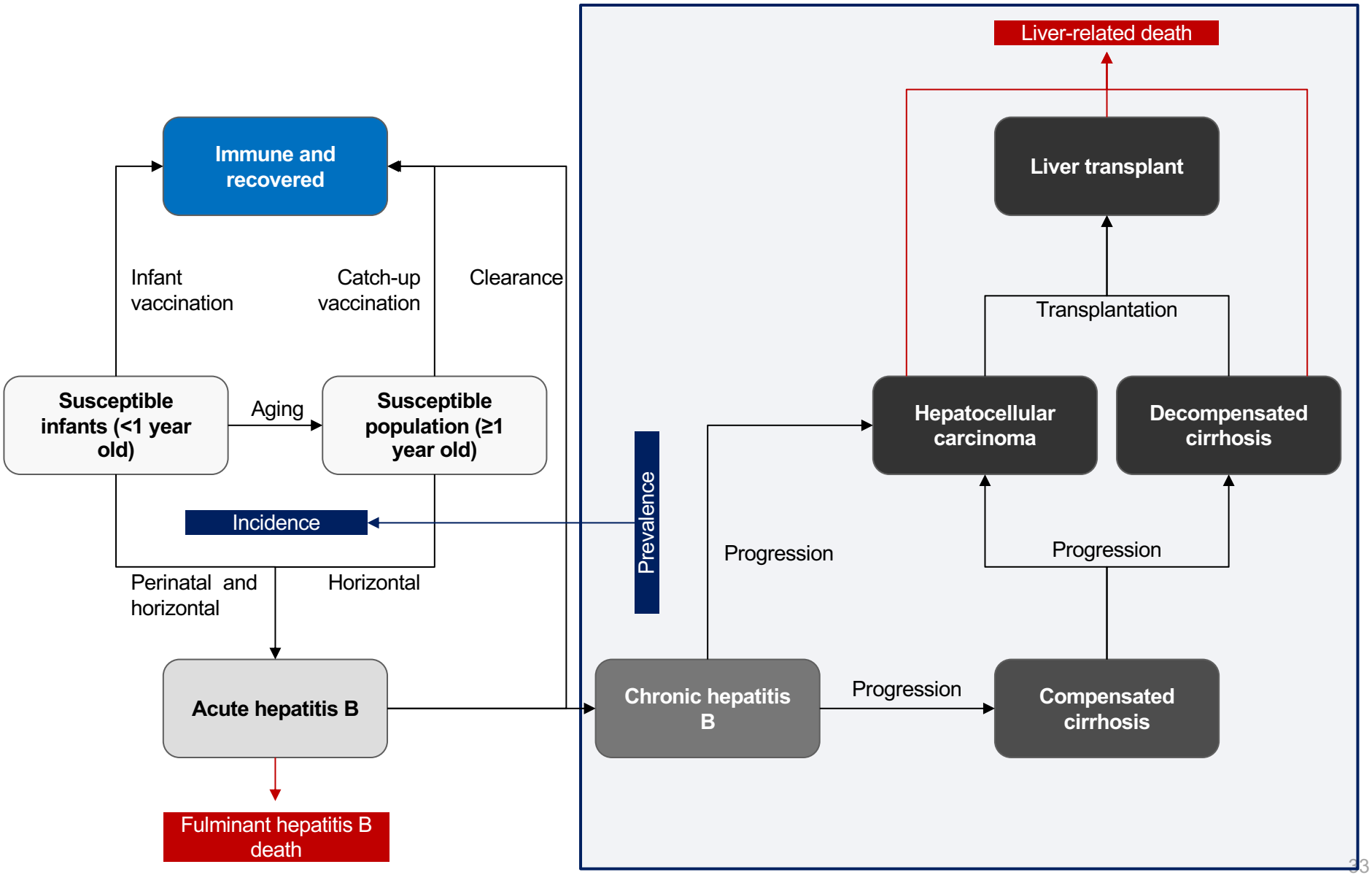
where *d* is background mortality rate, *k* is the shape parameter, and *C* is the scale parameter

- Individuals acquiring acute HBV infection are removed from the susceptible population
- After horizontal transmission of HBV, risk *c* for developing a chronic HBV infection at age *a* is calculated using:

$$c_a = \begin{cases} c_1 & \text{if } a = 0 \\ 1 - 0.7145a^{0.0814} & \text{if } 1 \leq a < 35 \\ c_{34} & \text{if } a \geq 35 \end{cases}$$

*Razavi-Shearer D, Gamkrelidze I, et al. Global prevalence, treatment, and prevention of hepatitis B virus infection in 2016: a modelling study. Lancet Gastroenterol Hepatol 2018; **3**(6): 383–403.*

HBV Disease Progression



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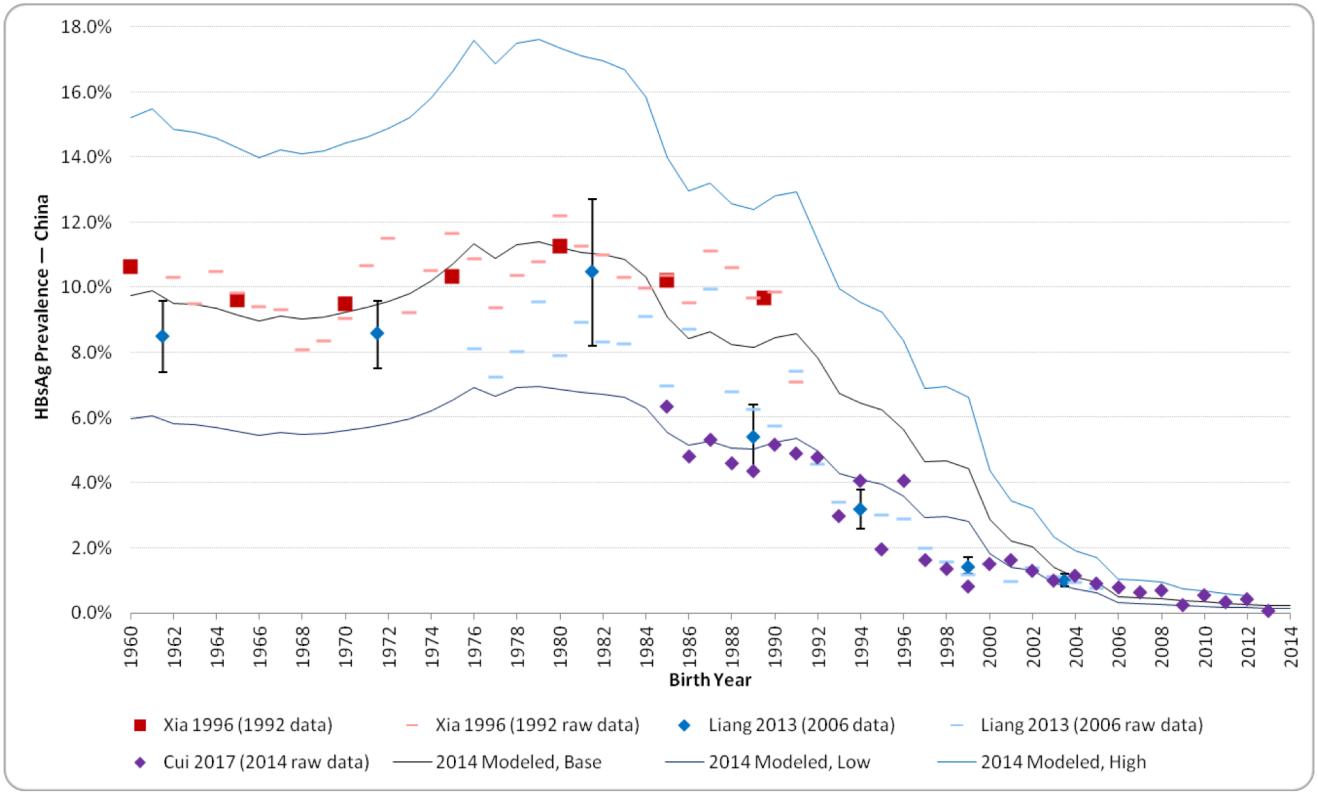
Model validation

- Objective of validation: accurately predict age-specific prevalence of HBsAg
- Prevalence studies with at least two time points were chosen
  - China
  - Iran
  - United States
- Chosen countries vary by
  - Region
  - HBsAg prevalence
  - HBeAg prevalence
  - Genotype
- Reported prevalence of HBsAg was compared to modeled prevalence

Razavi-Shearer D, Gamkrelidze I, et al. Global prevalence, treatment, and prevention of hepatitis B virus infection in 2016: a modelling study. Lancet Gastroenterol Hepatol 2018; 3(6): 383–403.

Model validation — China

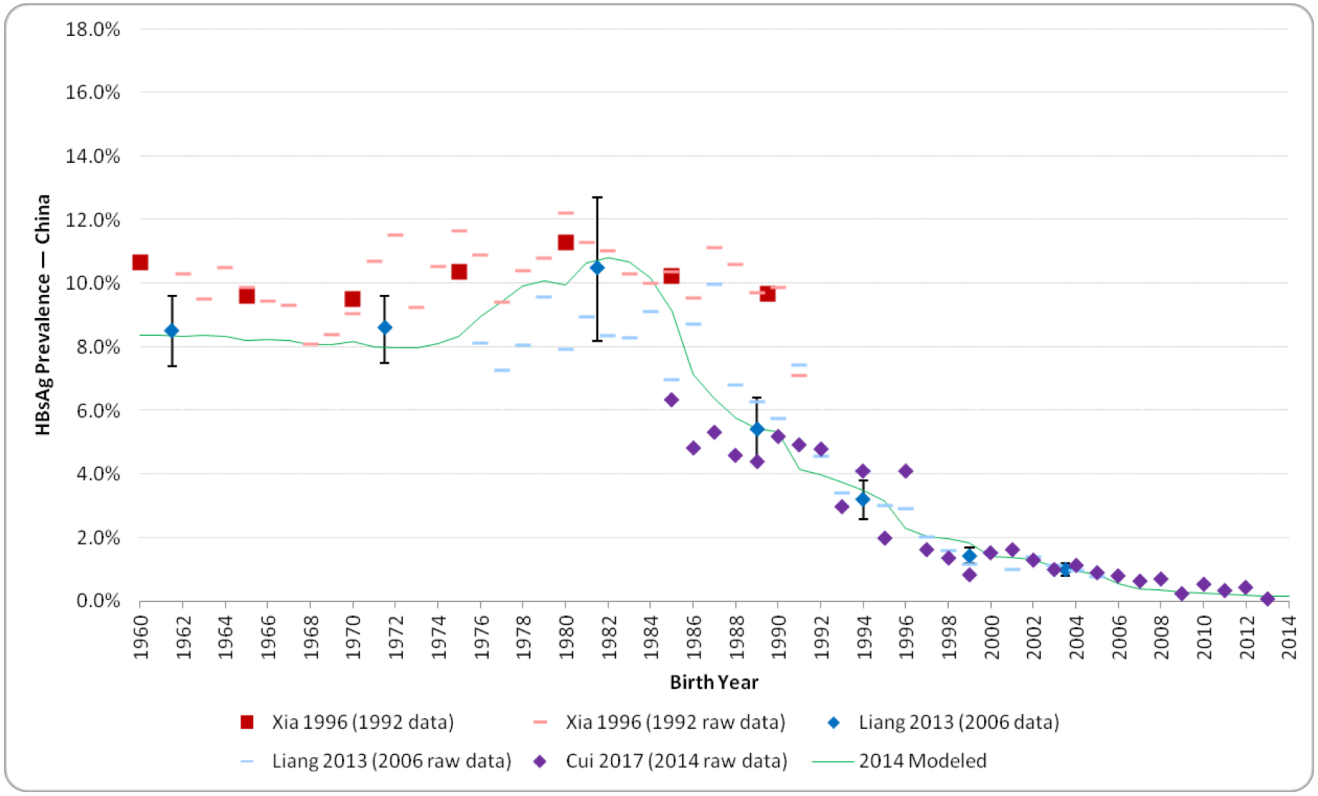
- Calibrate model to reported HBsAg prevalence in 1992 (Xia 1996)
  - » Compare modeled prevalence in 2014 by birth year to reported 2006 (Liang 2013) and 2014 (Cui 2017) data
    - Base modeled prevalence was a good match to reported data for birth years until 1988; low modeled prevalence was a good match for birth years after 1988



- *Xia GL, Liu CB, Cao HL, et al. Prevalence of hepatitis B and C virus infections in the general Chinese population. Results from a nationwide cross-sectional seroepidemiologic study of hepatitis A, B, C, D, and E virus infections in China, 1992. International Hepatology Communications 1996; **5**(1): 62–73.*
- *Liang X, Bi S, Yang W, et al. Reprint of: Epidemiological serosurvey of Hepatitis B in China—declining HBV prevalence due to Hepatitis B vaccination. Vaccine 2013; **31 Suppl 9**: J21–8.*
- *Cui F, Shen L, Li L, et al. Prevention of Chronic Hepatitis B after 3 Decades of Escalating Vaccination Policy, China. Emerging Infectious Disease journal 2017; **23**(5): 765–72.*

Model validation — China

- Calibrate model to reported HBsAg prevalence in 2006
  - » Compare modeled prevalence by birth year to reported 1992 and 2014 data
    - Modeled prevalence was a good match to reported data in all years, particularly among those born after 2006



- *Xia GL, Liu CB, Cao HL, et al. Prevalence of hepatitis B and C virus infections in the general Chinese population. Results from a nationwide cross-sectional seroepidemiologic study of hepatitis A, B, C, D, and E virus infections in China, 1992. International Hepatology Communications 1996; **5**(1): 62–73.*
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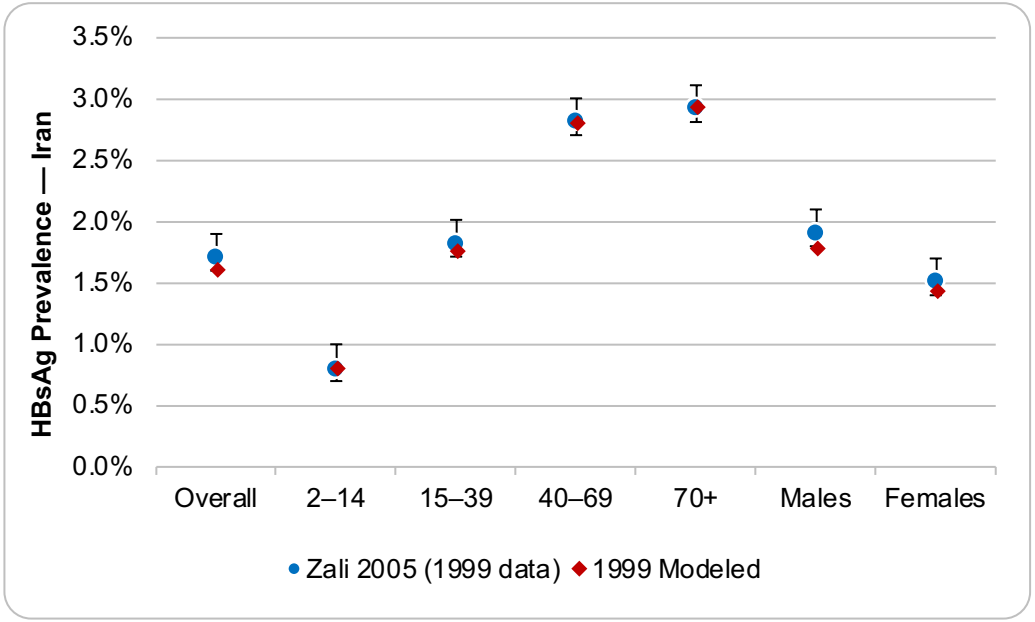
- *Cui F, Shen L, Li L, et al. Prevention of Chronic Hepatitis B after 3 Decades of Escalating Vaccination Policy, China. Emerging Infectious Disease journal 2017; **23**(5): 765–72.*

Model validation — Iran

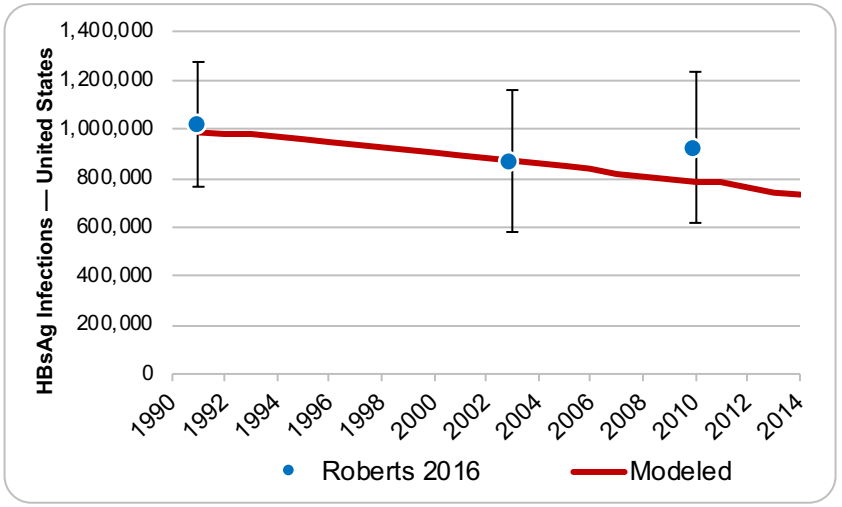
- Calibrate model to reported pre-vaccination HBsAg prevalence in 1990 (Zali 2005)
- Compare modeled HBsAg prevalence to reported 1999 data (Zali 2005)
  - » Modeled overall, age- and sex-specific HBsAg prevalence was a good match to reported data

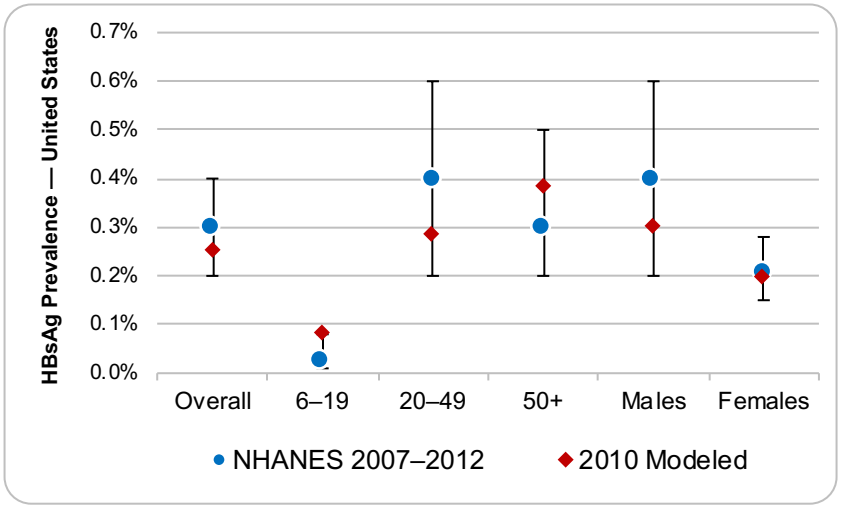


Zali MR, Mohammad K, Noorbala AA, Noorimayer B, Shahraz S. Rate of hepatitis B seropositivity following mass vaccination in the Islamic Republic of Iran. East MediterrHealth J 2005; ***11****(1–2): 62–7.*

Model validation — United States

- Calibrate model to reported HBsAg prevalence in NHANES 1988–1994 (Roberts 2016)
- Compare modeled number of HBsAg infections in 2003 and 2010 to reported NHANES 1999–2006 (Roberts 2016) and NHANES 2007–2012 (Roberts 2016) data, respectively
  - » Model predicts well within the CIs, with less HBsAg infections than those reported in NHANES 2007–2012
    - Model was used to estimate global prevalence of HBsAg, so it did not consider the impact of "new" cases of HBV entering through immigration
    - Model is able to take into account the impact of immigration if data is available
- Compare modeled overall, age- and sex-specific HBsAg prevalence to reported NHANES 2007–2012 data
  - » Model predicts HBsAg prevalence within the reported CIs except for age group 6–19, where modeled prevalence is slightly higher
    - It was assumed that HBsAg prevalence collected in 1988–1994 was representative of prevalence in 1991. Because this was in the early years of the era of vaccination, even a few years of difference in the year of calibration can have a considerable impact on modeled outputs





*Roberts H, Kruszon-Moran D, Ly KN, et al. Prevalence of chronic hepatitis B virus (HBV) infection in U.S. households: National Health and Nutrition Examination Survey (NHANES), 1988–2012. Hepatology 2016; **63**(2): 388–97.*

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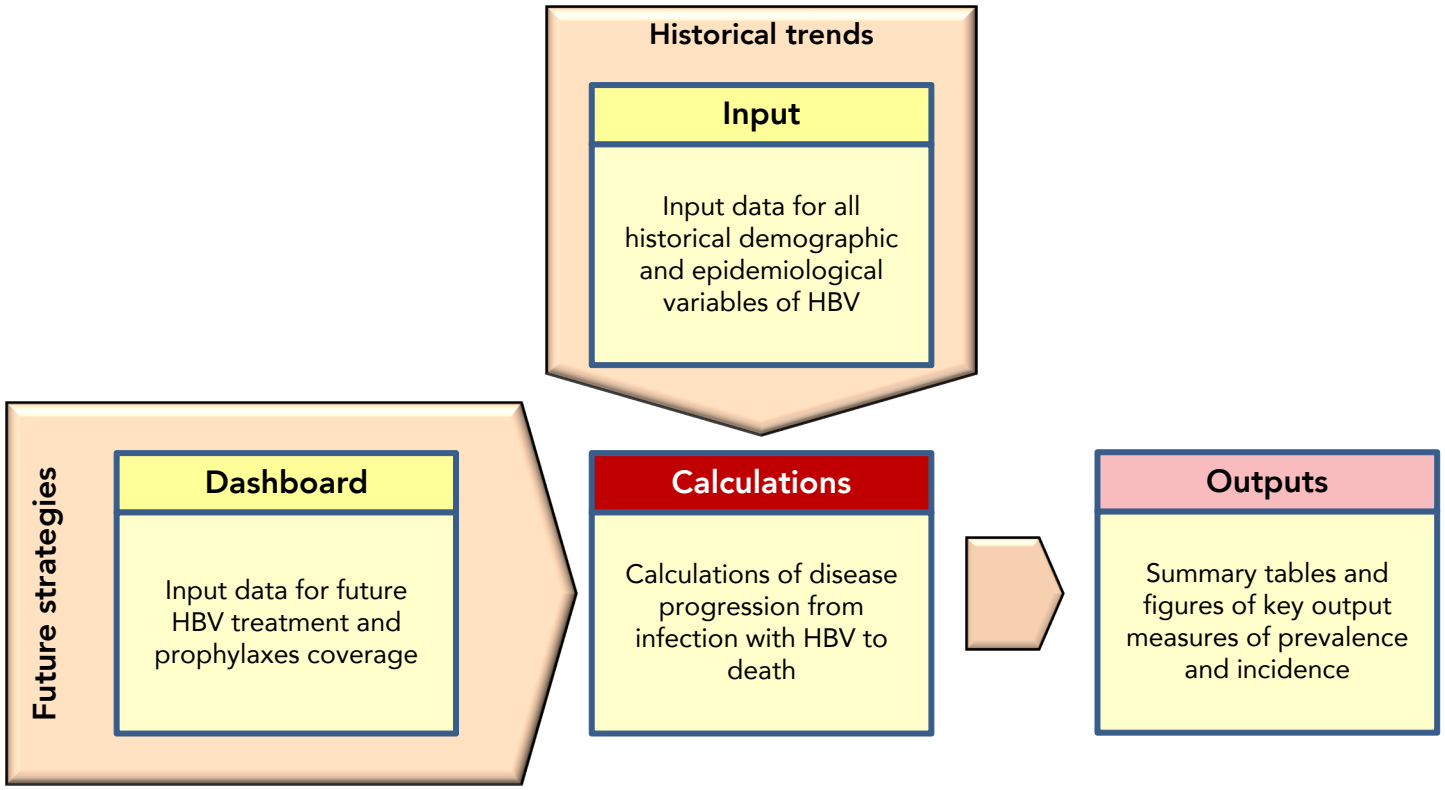
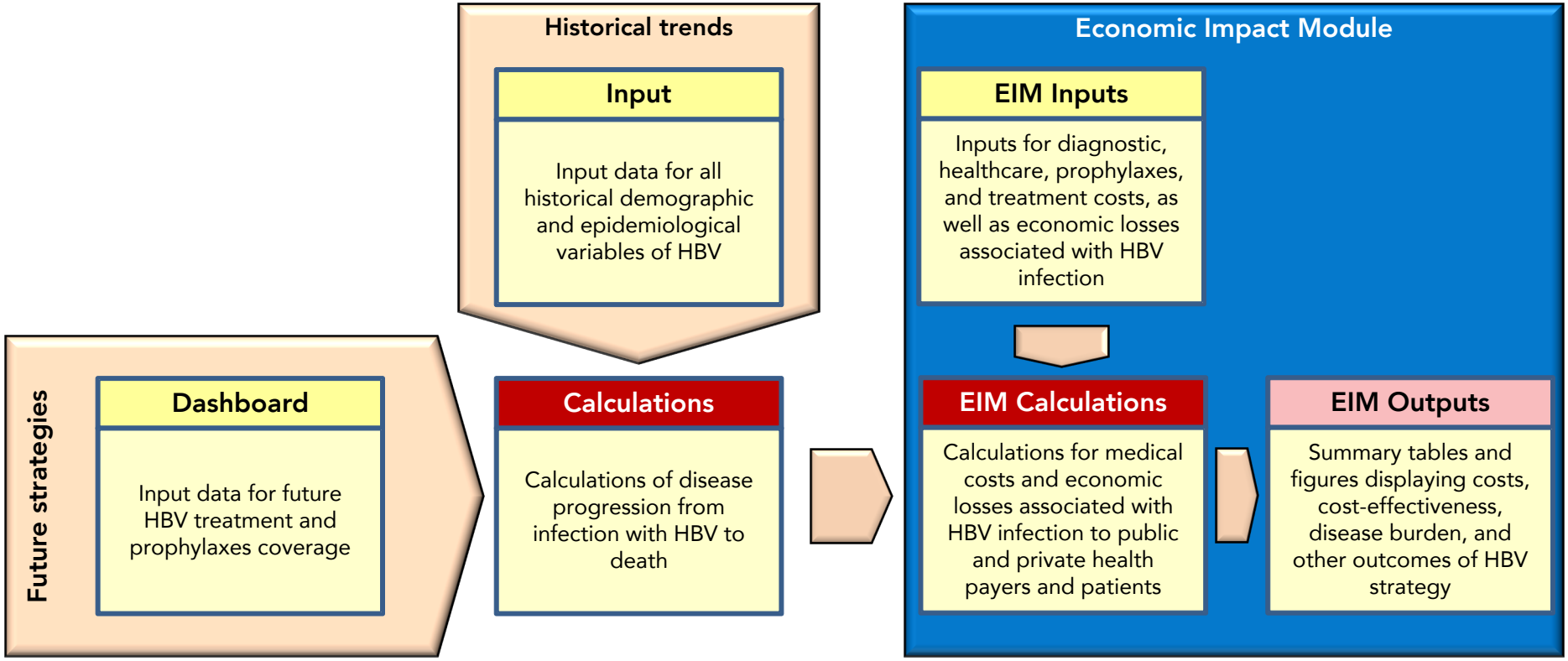
PRoGReSs — Economic Impact Module — Overview



PRoGReSs — Economic Impact Module — Overview



Inputs — Medical costs

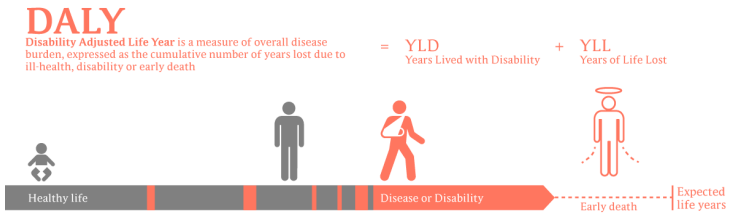
- **Medical costs**: monetary costs associated with managing chronic HBV infection and its sequelae
  - » Prophylaxes
    - Vaccination — *per vaccination*
    - HBIG — *per dose*
    - Peripartum antiviral treatment of women — *per treatment*
  - » Diagnostic
    - Screening (e.g., HBsAg test) — *per screen*
    - Laboratory (e.g., HBV DNA test) — *annual, per treated patient*
  - » Healthcare — *annual, per diagnosed patient*
    - Inpatient
    - Outpatient
    - Medication, excluding antiviral treatment
  - » Antiviral treatment — *annual, per treated patient*

Inputs — Medical costs

- **Medical costs**: monetary costs associated with managing chronic HBV infection and its sequelae
  - » Prophylaxes costs are specified by
    - Scenario
    - Time (to reflect change in price)
  - » Treatment and laboratory costs are specified by
    - Scenario (i.e., base case *vs* strategy)
    - Stage of liver disease
    - Time (to reflect change in price)
  - » Healthcare costs are specified by
    - Stage of liver disease
  - » All costs are further divided into
    - Costs paid by public or private health payers
    - Share paid by patient (copayment)

Inputs — Health effects and economic losses

- Health effects are denominated in disability-adjusted life years (DALYs)
  - » DALY = Years of Life Lost (YLL) + Years Lost due to Disability (YLD)
    - Years of Life Lost (YLL)
      - **Number of deaths** — HBV-related deaths calculated in PRoGReSs
      - **Life expectancy at age of death** — available from national census data or extrapolated based on estimates from UN World Population Prospects
      - **Discount rate** — depends on analysis
    - Years Lost due to Disability (YLD)
      - **Number of incident cases** by stage of liver disease — calculated in PRoGReSs
      - **Disability weight** — published estimates
      - **Duration of disability** — calculated in PRoGReSs



Infographic by Planemad, distributed under a CC-BY-SA-3.0 license

$$YLL = \frac{N}{r}(1 - e^{-rL})$$

where:
N = number of deaths.
L = standard life expectancy at age of death (years).
r = discount rate (e.g. 3% corresponds to a discount rate of 0.03).

$$YLD = \frac{I \times DW \times L\,(1-e^{-rL})}{r}$$

where:
I = number of incident cases (-).
DW = disability weight (-).
L = duration of disability (years).
r = discount rate.

World Health Organization. The Global Burden of Disease concept. Geneva, Switzerland WHO:2015. Available at: www.who.int/quantifying_ehimpacts/publications/en/9241546204chap3.pdf

Inputs — Health effects and economic losses

- Following parameters are used for calculating DALYs

Parameter	Value	Source
Disability weights Decompensated cirrhosis Hepatocellular carcinoma Liver transplant	 0.178 0.466† 0.024‡	GBD 2016
Discount rate	3%	WHO 2003
Age-weighting modulation constant	0 (none)	

*Abajobir AA, Abate KH, Abbafati C, et al. Global, regional, and national incidence, prevalence, and years lived with disability for 328 diseases and injuries for 195 countries, 1990–2016: a systematic analysis for the Global Burden of Disease Study 2016. The Lancet; **390**(10100): 1211–59.*

World Health Organization. Making choices in health: WHO guide to cost-effectiveness analysis. Geneva, Switzerland: WHO; 2003.

World Health Organization. The Global Burden of Disease concept. Geneva, Switzerland WHO:2015. Available at: www.who.int/quantifying_ehimpacts/publications/en/9241546204chap3.pdf

† *Weighted average of disability weights for terminal and controlled phases of liver cancer due to hepatitis C. It was assumed 85% of hepatocellular carcinoma cases were terminal (disability weight of 0.54) and 15% of cases were controlled (disability weight of 0.049)*

‡ *Disability weight for end-stage renal disease, with kidney transplant was used*

Inputs — Health effects and economic losses

- Economic losses associated with living with HBV infection are calculated in EIM
- Assume value of one DALY averted equals the GNI per capita* of country (Dalal 2013)
- Economic losses are calculated only for DALYs incurred at ages 20–69

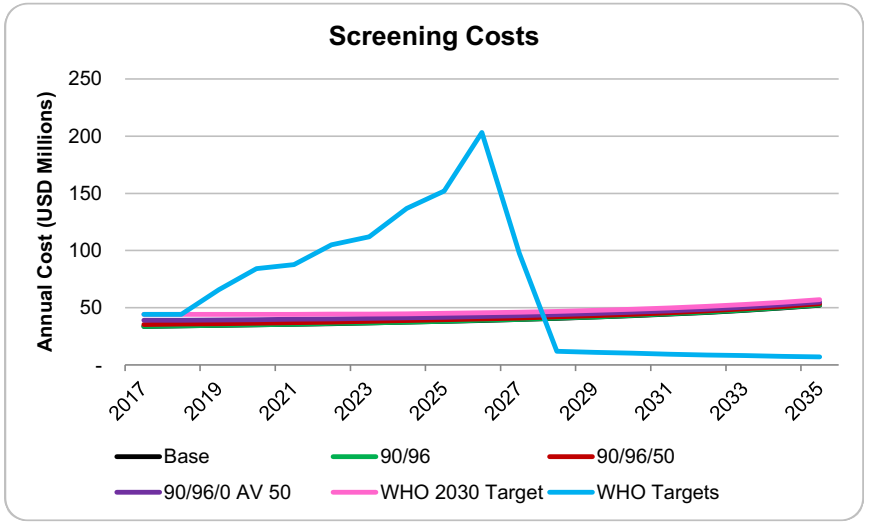
*Dalal K, Lin Z, Gifford M, Svanström L. Economics of Global Burden of Road Traffic Injuries and Their Relationship with Health System Variables. International Journal of Preventive Medicine 2013; **4**(12): 1442–50*

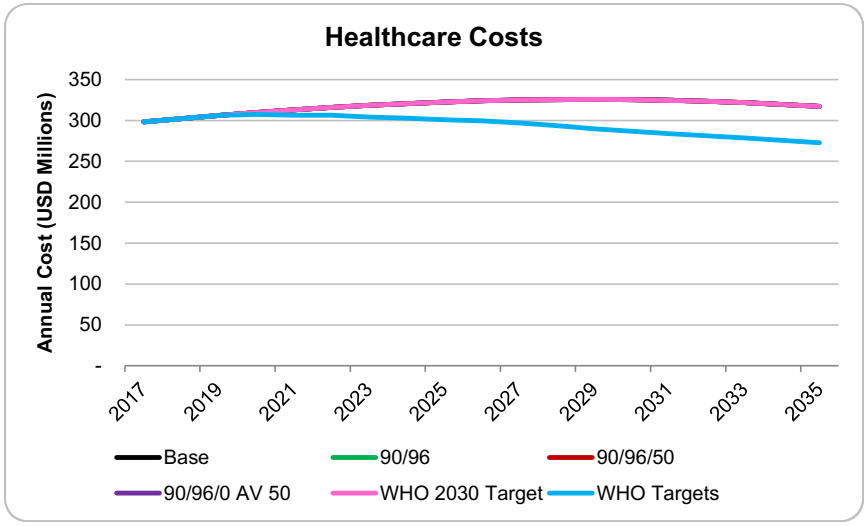
The World Bank. 2016. GNI per capita, Atlas method (current US$). Available at: data.worldbank.org/indicator/NY.GNP.PCAP.CD

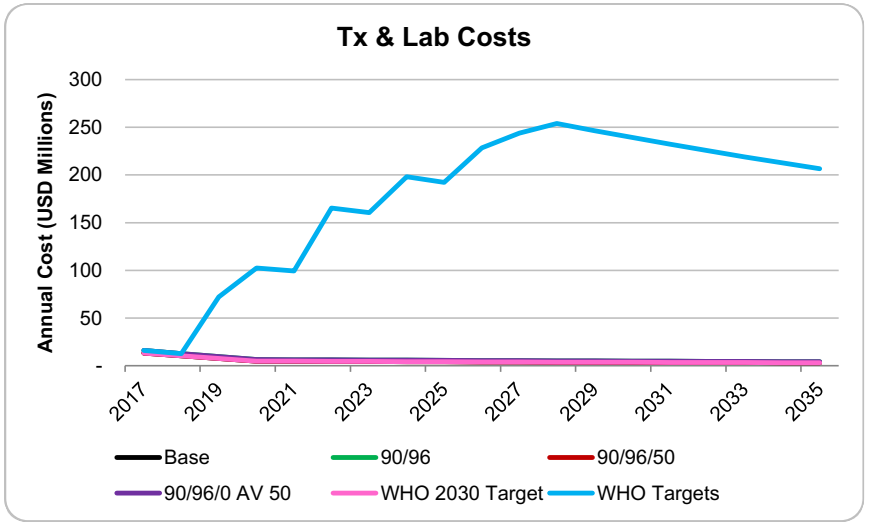
* *GNI per capita is used instead of GDP per capita because it reflects the average per-capita income in country*

The WHO Targets scenario combines an aggressive prophylaxes strategy with screening and treatment requiring upfront investment

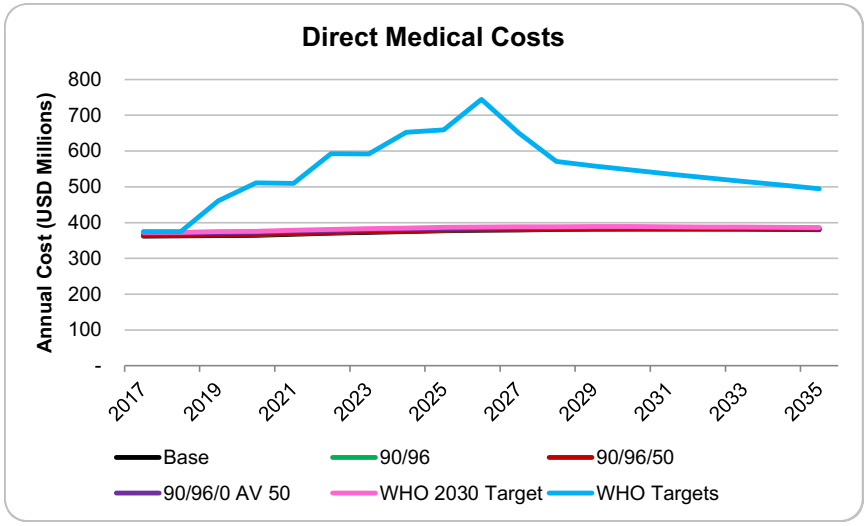
- While screening costs do not decrease below base until 2028, savings in healthcare costs are seen almost immediately

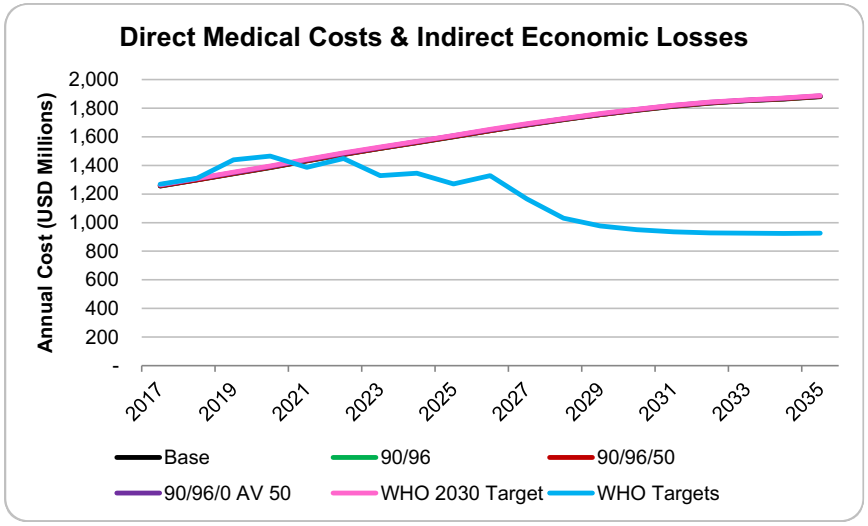


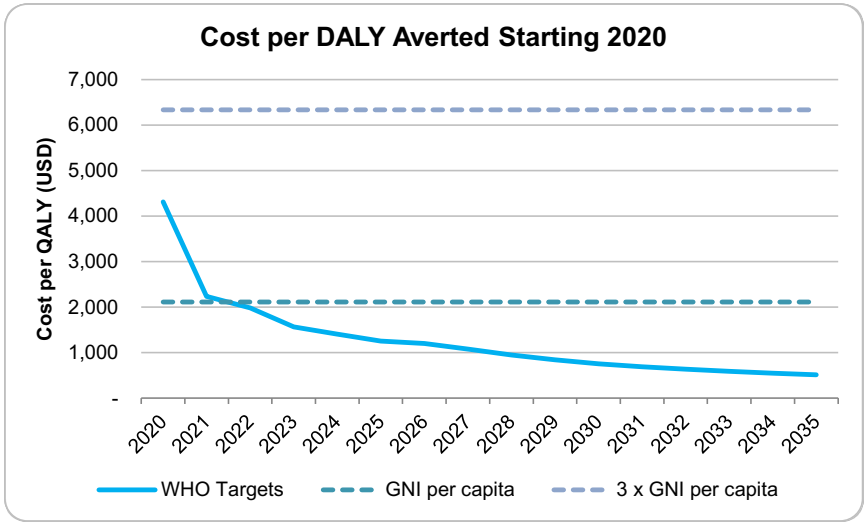


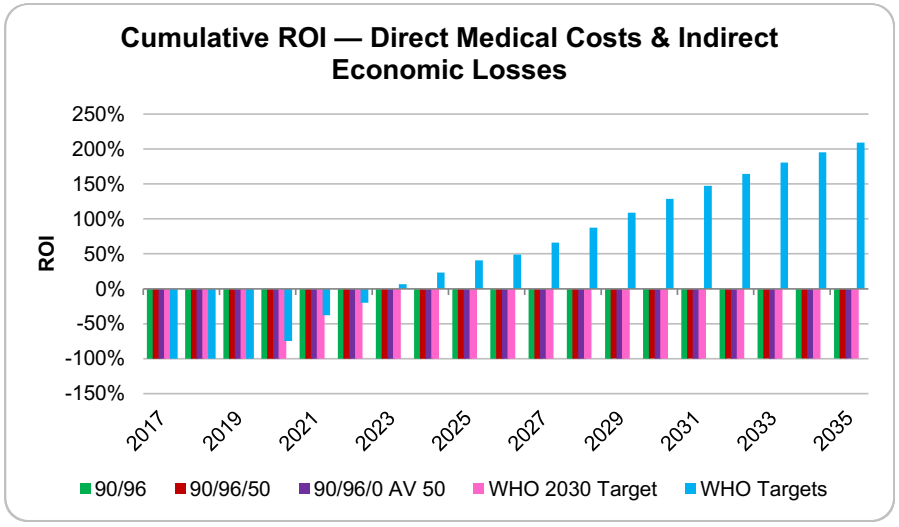


The combined scenario becomes cost-effective by 2020 and highly cost-effective by 2022









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United States – In 2015, it was estimated that there were a maximum of 40,000 additional cases of chronic hepatitis B due to immigration

- The largest number of immigrants came from Mexico, and the largest number of chronic cases, 7,526, came from the Philippines

Country of birth	Immigrants	Cases of HBV
Mexico	158,619	210
China	74,558	5,940
India	64,116	1,820
Philippines	56,478	7,526
Cuba	54,396	323
Dominican Republic	50,610	1,258
Viet Nam	30,832	3,405
Iraq	21,107	1,068
El Salvador	19,487	221
Pakistan	18,057	462
Total	**1,050,031**	**39,963**

These countries accounted for 52% of the total number of immigrants

United States. Department of Homeland Security Yearbook of Immigration Statistics: 2015.Washington, D.C.: U.S. Department of Homeland Security, Office of Immigration Statistics, 2016.

United States- Total immigration and the country of origin have remained relatively constant from 2006-2015

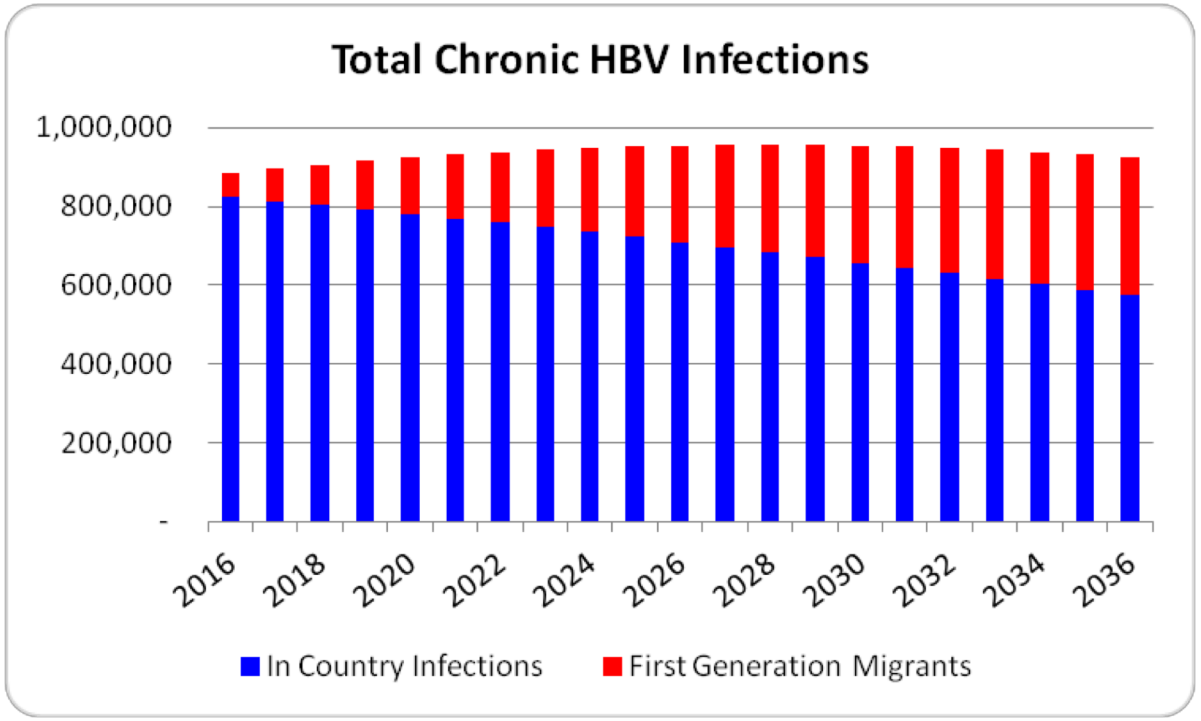
Table 3.
PERSONS OBTAINING LAWFUL PERMANENT RESIDENT STATUS BY REGION AND COUNTRY OF BIRTH: FISCAL YEARS 2006 TO 2015

Region and country of birth	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
REGION										
Total	1,266,129	1,052,415	1,107,126	1,130,818	1,042,625	1,062,040	1,031,631	990,553	1,016,518	1,051,031
Africa	117,421	94,710	105,915	127,046	101,355	100,374	107,241	98,304	98,413	101,415
Asia	440,335	397,834	399,027	413,312	422,063	451,593	429,599	400,548	430,508	419,297
Europe	146,292	106,566	103,782	105,476	88,801	83,850	81,671	86,556	83,266	85,803
North America	413,992	339,294	393,196	375,180	336,553	333,902	327,771	315,660	324,354	366,126
Oceania	7,384	6,101	5,263	5,578	5,345	4,980	4,742	5,277	5,112	5,404
South America	137,971	106,516	98,549	102,860	87,178	86,096	79,401	80,945	73,715	72,309
Unknown	2,734	1,394	1,394	1,366	1,330	1,245	1,206	3,263	1,150	677
Mexico	173,749	148,640	189,989	164,920	139,120	143,446	146,406	135,028	134,052	158,619
China, People's Republic	87,307	76,655	80,271	64,238	70,863	87,016	81,784	71,798	76,089	74,558
India	61,369	65,353	63,352	57,304	69,162	69,013	66,434	68,458	77,908	64,116
Philippines	74,606	72,596	54,030	60,029	58,173	57,011	57,327	54,446	49,996	56,478
Cuba	45,614	29,104	49,500	38,954	33,573	36,452	32,820	32,219	46,679	54,396
Dominican Republic	38,068	28,024	31,879	49,414	53,870	46,109	41,566	41,311	44,577	50,610
Vietnam	30,691	28,691	31,497	29,234	30,632	34,157	28,304	27,101	30,283	30,832
Iraq	4,337	3,765	4,795	12,110	19,855	21,133	20,369	9,552	19,153	21,107
El Salvador	31,782	21,127	19,659	19,909	18,806	18,667	16,256	18,260	19,273	19,487
Pakistan	17,418	13,492	19,719	21,555	18,258	15,546	14,740	13,251	18,612	18,057

United States. Department of Homeland Security Yearbook of Immigration Statistics: 2015.Washington, D.C.: U.S. Department of Homeland Security, Office of Immigration Statistics, 2016.

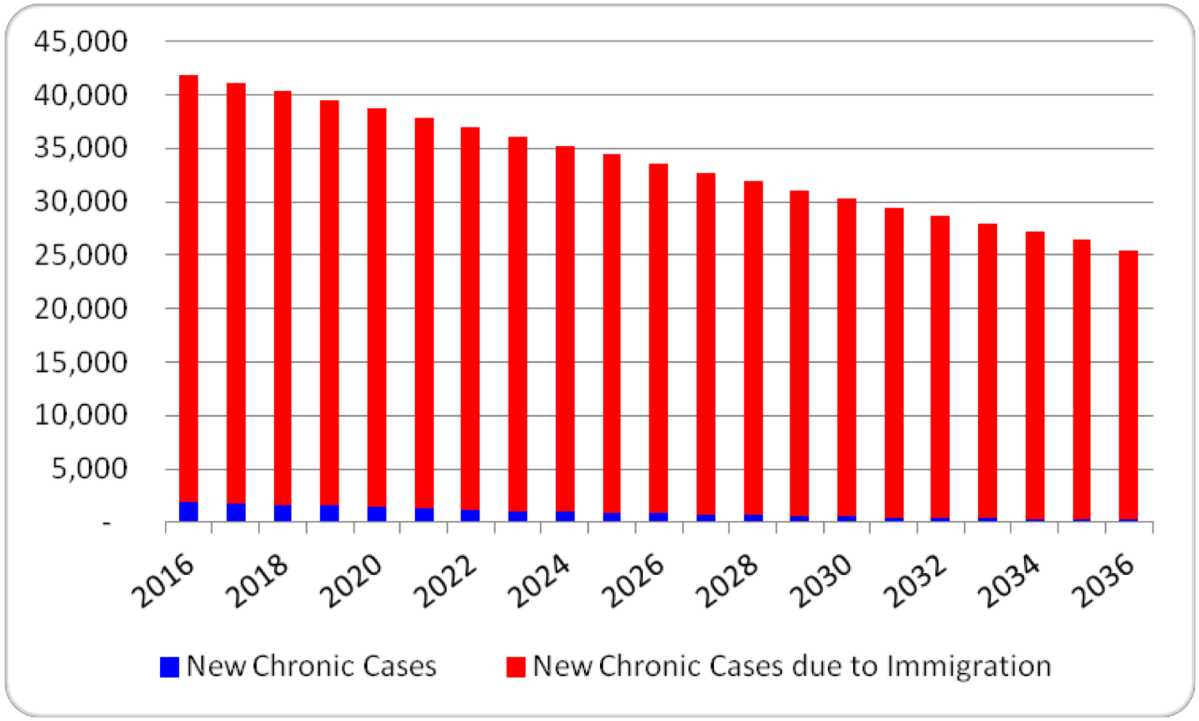
Outputs – Prevalence is expected to stabilize and then begin decreasing when including immigration

- In 2016, it is estimated that the there were 885,000 chronic hepatitis B infections in the United States. By 2027, the total infected population is expected to stabilize at approximately 955,000 before beginning to decrease in 2030 to 926,000 in 2036



Outputs - Incidence of chronic hepatitis B is expected to decrease through 2036 as the impact of vaccination is observed globally

- In 2016, the incidence of chronic hepatitis B was estimated to be 42,000 dropping to 25,000 by 2036
  - » 95% of new chronic cases were due to immigration in 2016, but this increased to 99% by 2032



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Q & A

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