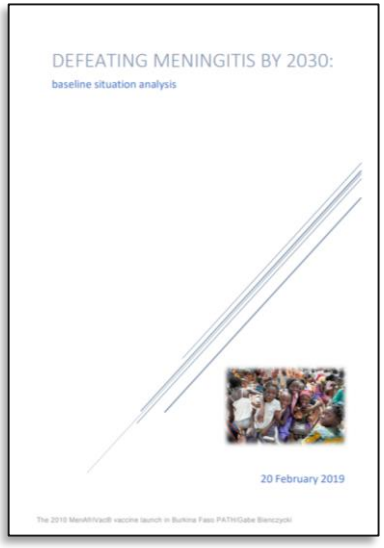
Global burden of meningitis, understanding modelled estimates and the Meningitis Progress Tracker

C. Wright

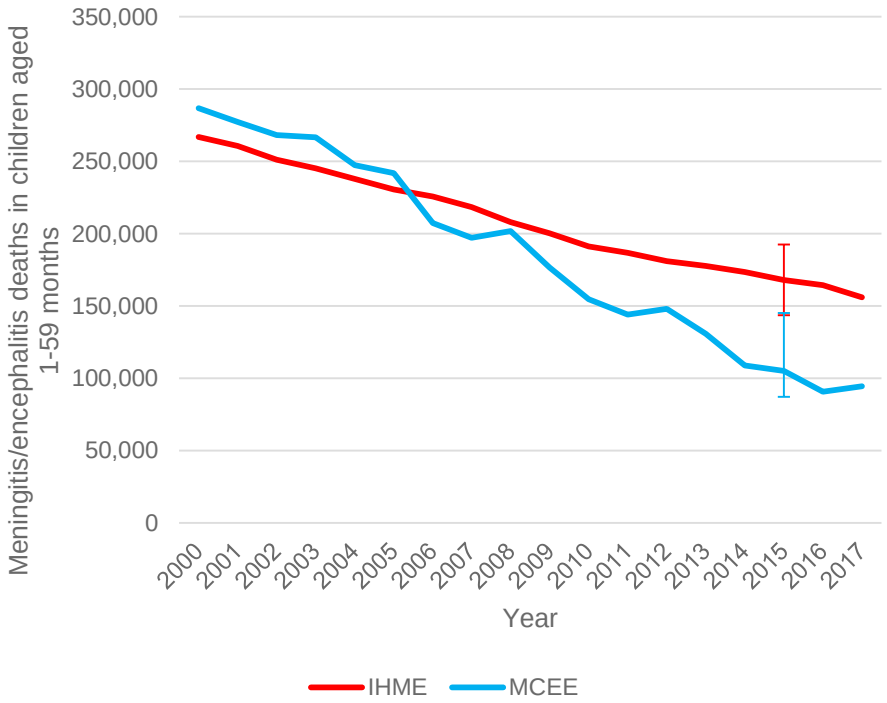
Meningitis Research Foundation, Bristol, UK

Modelling Initiatives

	GBD 2017	WHO GHE	MCEE	
			WHO-MCEE syndromic model	MCEE/JHU pathogen-specific model
Years	1990-2017	2000-2016	2000-2017	2000-2015
Age range	All ages	All ages	Under 5s	1-59 months
Relevant disease categories	Meningitis Neonatal sepsis and other neonatal infections	Meningitis Neonatal sepsis and infections	Meningitis/Encephalitis Sepsis and other infectious conditions of the newborn	Meningitis/Encephalitis
Parameters	Cases Incidence rate Prevalence Deaths Mortality rate DALYs	Deaths Mortality rate DALYs	Deaths Mortality rate	Cases Incidence rate Deaths Mortality rate
Aetiology	*Neisseria meningitidis* *Streptococcus pneumoniae* *Haemophilus influenzae* type b Other	No breakdown by aetiology	No breakdown by aetiology	*Streptococcus pneumoniae* *Haemophilus influenzae* type b



Sources agree that child deaths due to meningitis are **declining** and progress has been slower than for many other infectious diseases



Cause of death	IHME (GBD 2017)	MCEE (2000-2017)
Meningitis/ encephalitis	41%	62%
Measles	83%	81%
Tetanus	82%	82%
Diarrhoeal diseases	55%	63%
HIV/AIDS	68%	68%

Estimated reduction in under 5 mortality by cause and model 2000-2017

Under 5 meningitis mortality estimates vary between models and differences are greater in the neonatal period

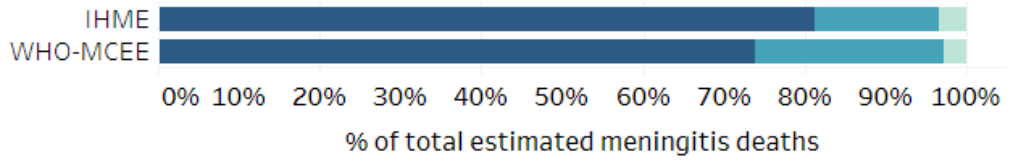
Meningitis Research Foundation

		GBD 2017		WHO-MCEE 2000-2017		Percent difference (n)*
		n	Rate†	*n*	Rate†	
All causes	Under 5	5,917,285 (5,723,776 – 6,120,099)	872.69 (844.15 – 902.60)	5,792,509 (5,573,633 – 6,123,477)	864.51[a]	2%
	1-59 months	3,354,404 (3,231,491 – 3,483,015)	502.51 (484.10 – 521.78)	3,122,698 (2,700,899 – 3,581,030)	476.41[a]	7%
	0-28 days	2,562,881 (2,478,272 - 2,655,261)	18.40 (17.20 – 19.58)	2,669,811 (2,542,447 – 2,872,734)	19.01 (18.10 – 20.50)	-4%
Infectious diseases**	Under 5	2,519,567 (2,379,024 – 2,671,856)	371.59 (350.86 – 394.05)	2,426,882 (2,279,602 – 3,169,783)	360.89[a]	4%
	1-59 months	1,967,826 (1,847,763 – 2,091,762)	294.79 (276.81 – 313.36)	1,810,771 (1,703,587 – 2,350,572)	274.00[a]	8%
	0-28 days	551,740 (510,918 - 603,527)	3.96 (3.60 – 4.38)	616,111 (605,290 – 877,610)	4.39 (4.31 – 6.25)	-11%
Meningitis & encephalitis	Under 5	190,515 (163,374 – 217,259)	28.10 (24.09 – 32.04)	142,498 (87,427 – 178,552)	21.15[a]	29%
	1-59 months	167,880 (143,529 – 192,447)	25.15 (21.50 – 28.83)	105,063 (86,845 – 144,870)	15.91[a]	46%
	0-28 days	22,636 (18,532 - 25,642)	0.16 (0.13 – 0.19)	37,435 (157 – 51,299)	0.27 (0.001 - 0.37)	-49%
Neonatal sepsis	Under 5	215,858 (186,657 – 275,821)	31.16 (27.53 - 40.68)	364,188 (282,744 – 524,021)	54.06[a]	-53%
	1-59 months	12,693 (10,626 – 16,586)	1.90 (1.59 – 2.48)	386[b] (14 – 579)	0.06[a]	188%
	0-28 days	198,580 (175,866 – 263,096)	1.43 (1.24 – 1.86)	363,802 (282,341 – 523,853)	2.59 (2.01 – 3.73)	-59%

97% of under 5 meningitis deaths are estimated to occur in countries with no or low quality national death registration systems

Global meningitis mortality rates

Source of data: GBD 2017



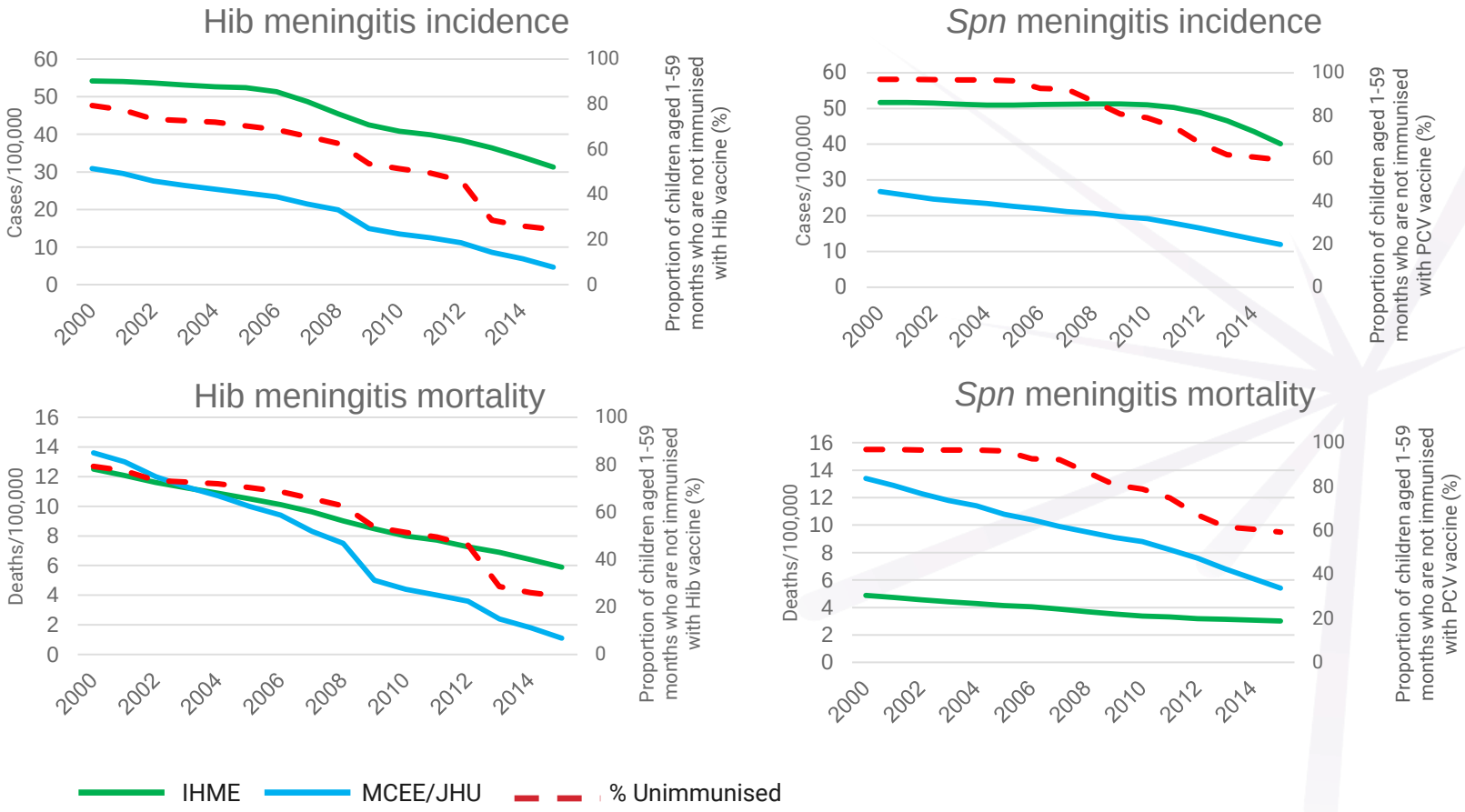
Source of quality of death registration data: WHO, World Health Statistics 2018

Difficult to distinguish between meningitis as a cause of death and other diseases using verbal autopsy

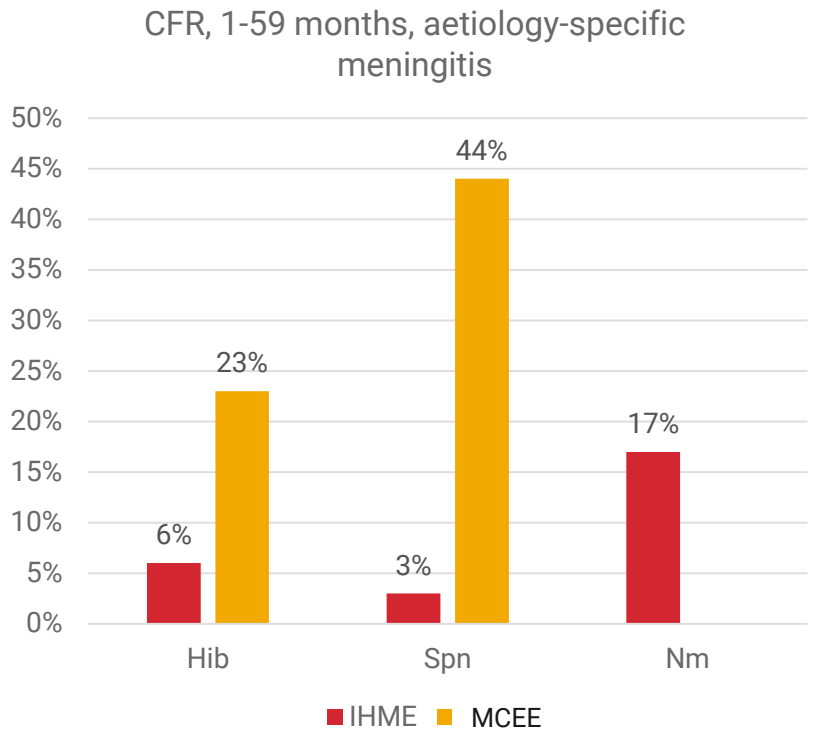
Meningitis Research Foundation

		DON'T KNOW 8	
906	Did the baby have convulsions?	YES ..... 1 NO ..... 2 DON'T KNOW 8	→ 908 → 908
907	How soon after birth did the convulsions start?	DAYS ..... ☐☐ DON'T KNOW 9 8	
908	Did the baby become stiff and arched backwards?	YES ..... 1 NO ..... 2 DON'T KNOW 8	
909	Did the child have bulging of the fontanelle?	YES ..... 1 NO ..... 2 DON'T KNOW 8	→ 911 → 911
910	How many days after birth did the baby have the bulging?	DAYS ..... ☐☐ DON'T KNOW 9 8	
911	Did the baby become unresponsive or unconscious?	YES ..... 1 NO ..... 2 DON'T KNOW 8	→ 913 → 913
912	How many days after birth did the baby become unresponsive or unconscious?'	DAYS ..... ☐☐ DON'T KNOW 9 8	
913	Did the baby have a fever?	YES ..... 1 NO ..... 2 DON'T KNOW 8	→ 915 → 915
914	How many days after birth did the baby have a fever?	DAYS ..... ☐☐ DON'T KNOW 9 8	

The incidence and mortality of Hib and pneumococcal meningitis differ according to model



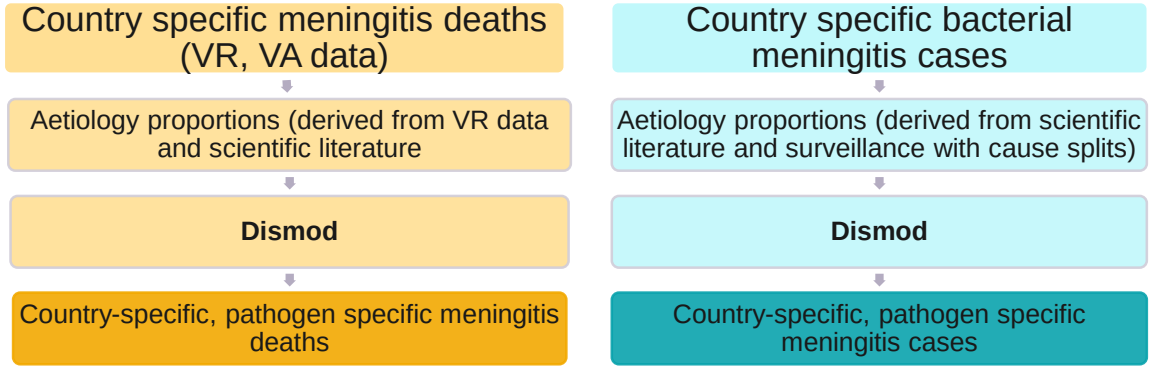
Calculated **case fatality ratios** from IHME estimates differ from published data for pneumococcal and Hib meningitis



Country	Nm meningitis	Spn meningitis	Hib meningitis	Source
United States	3.8%	9.4%	0%	Thigpen et al. (2011)
African Meningitis Belt (Niger)	7.4%	49.9%	30.5%	Boisier et al. 2007
Bangladesh	10%	22%	24%	Gurley et al. (2009)
*Global	-	44%	19%	Wahl et al. (2018)

IHME are the only group to model incidence independently from mortality

IHME (GBD2017)

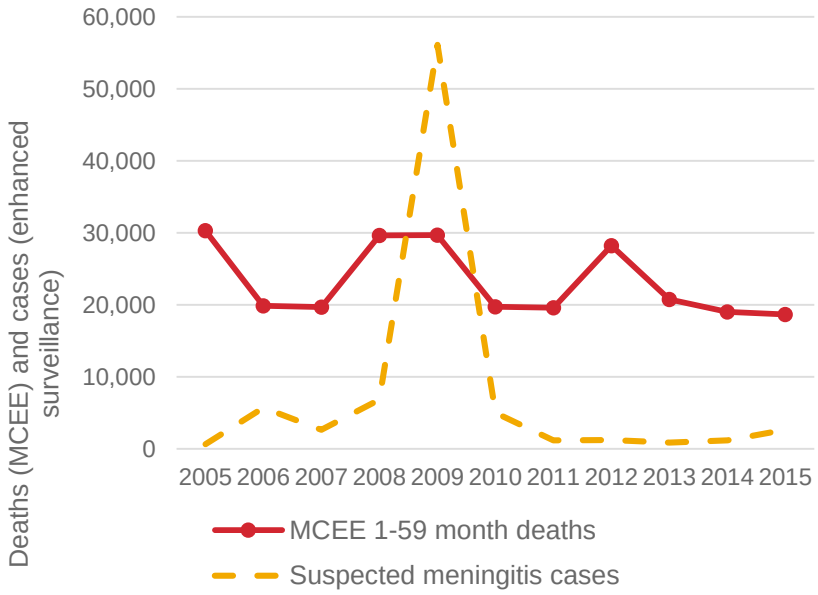


MCEE

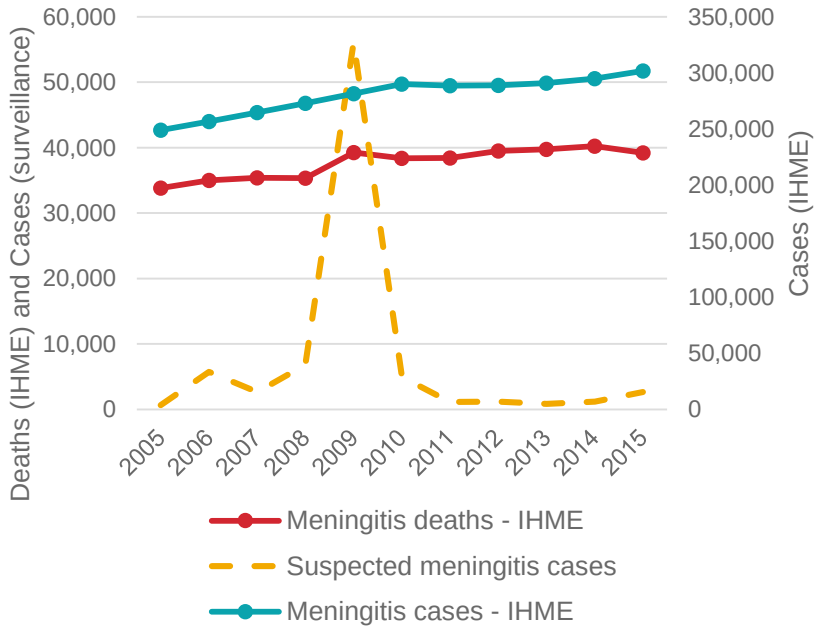
Trends from **modelled estimates differ from enhanced surveillance** data in Nigeria

Meningitis Research Foundation

MCEE estimated deaths in 1-59 months vs enhanced surveillance data



IHME estimated deaths and cases in all ages vs enhanced surveillance data



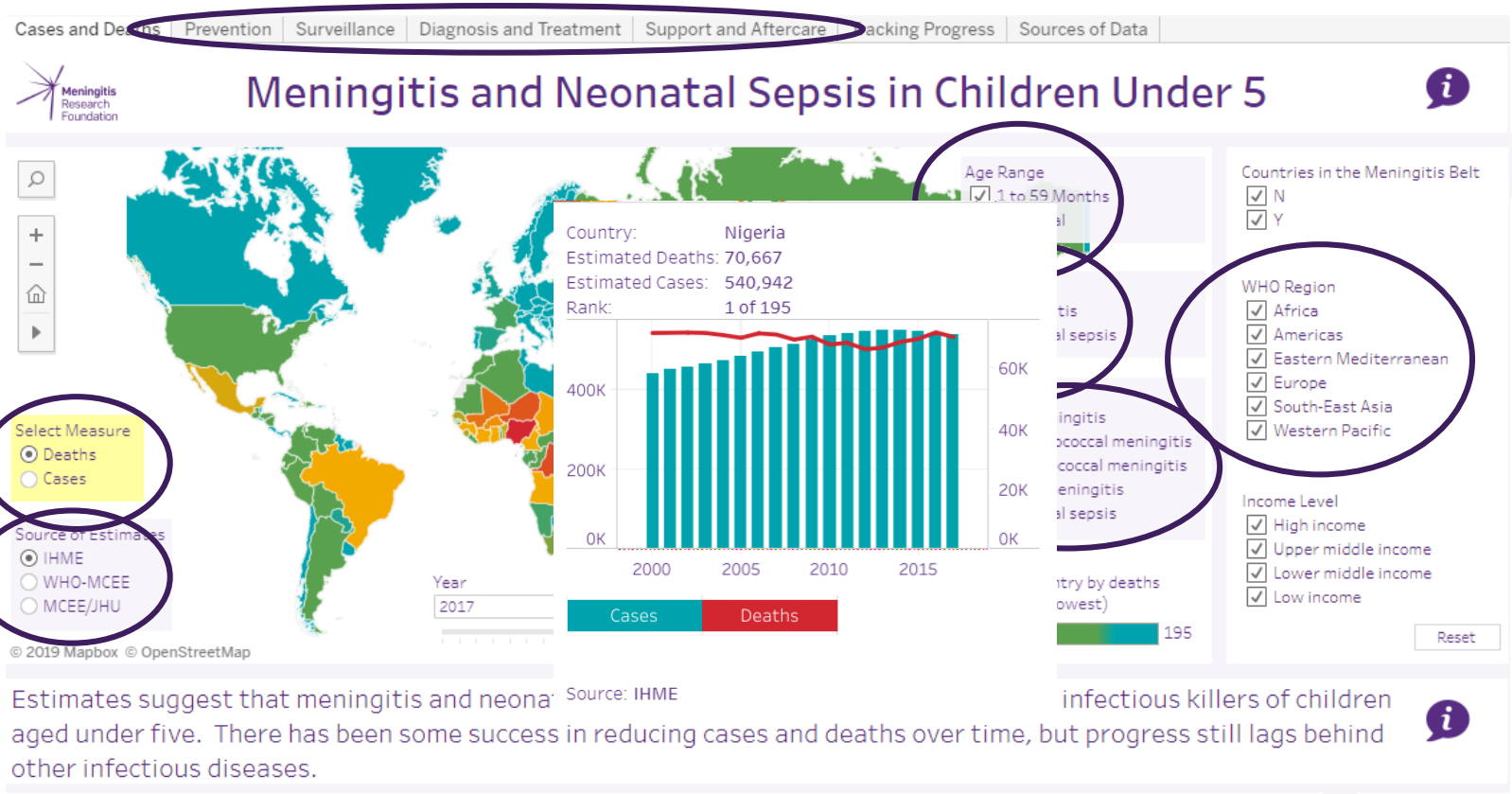
Source of enhanced surveillance data: Trotter et al (2017)

Tracking progress to 2030

Next steps were agreed in a data meeting held in November 2018:

- Models will be updated
  - IHME to consider PCV effects and CFR estimates in the next GBD model
  - MCEE/JHU to ascertain how pathogen-specific burden estimates, including meningococcal burden estimates, could be updated
- Targets for 2030 should be set based on percent reduction (i.e. slope), rather than absolute numbers of cases/deaths prevented.
- All sources of modelled estimates to be tracked in parallel

Meningitis Progress Tracker



https://www.meningitis.org/meningitis/meningitis-progress-tracker

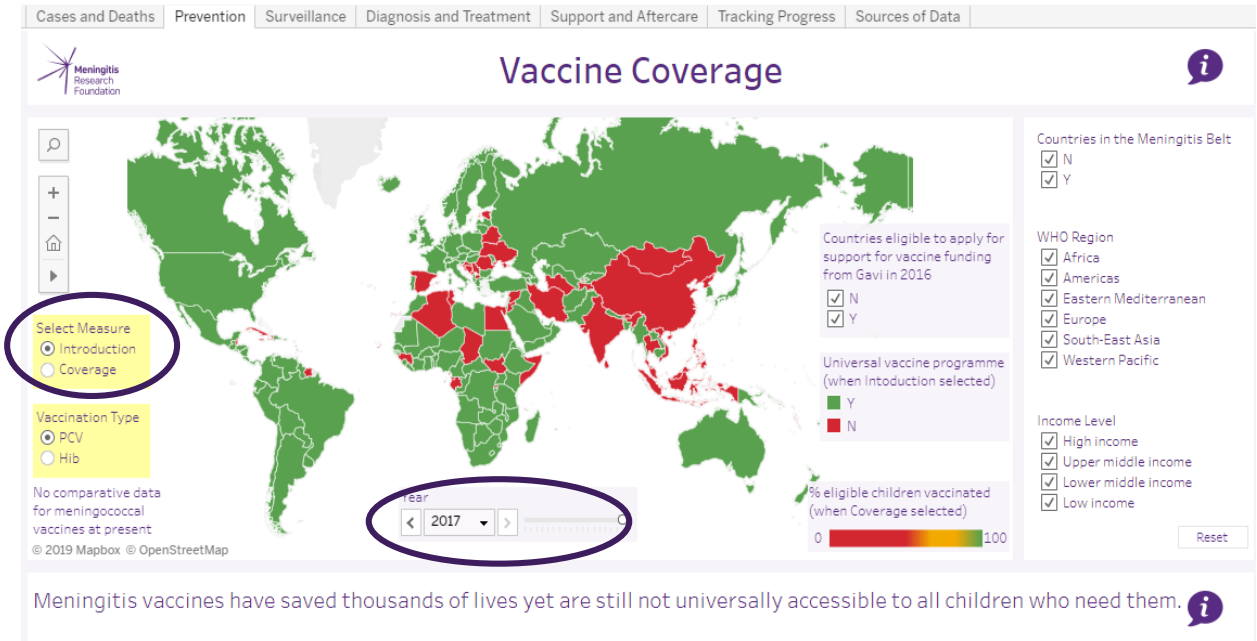
Prevention

Outputs

Achieve high and equitable vaccine coverage, introduce new vaccines, improve prevention and epidemic control

Outcomes

Enhanced access to improved vaccines and effective strategies for prevention and epidemic control



https://www.meningitis.org/meningitis/meningitis-progress-tracker

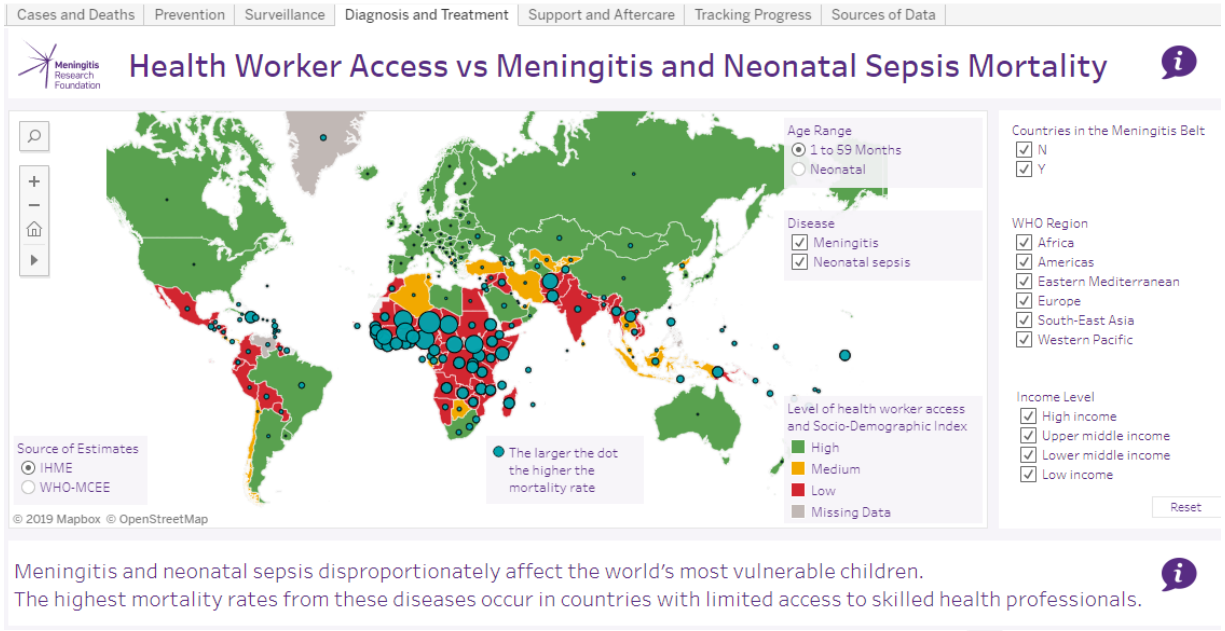
Diagnosis and Treatment

Outputs

Ensure availability of diagnostic tools, trained health workers, prompt quality-assured treatment

Outcomes

Improved tools and access to diagnosis and treatment



https://www.meningitis.org/meningitis/meningitis-progress-tracker

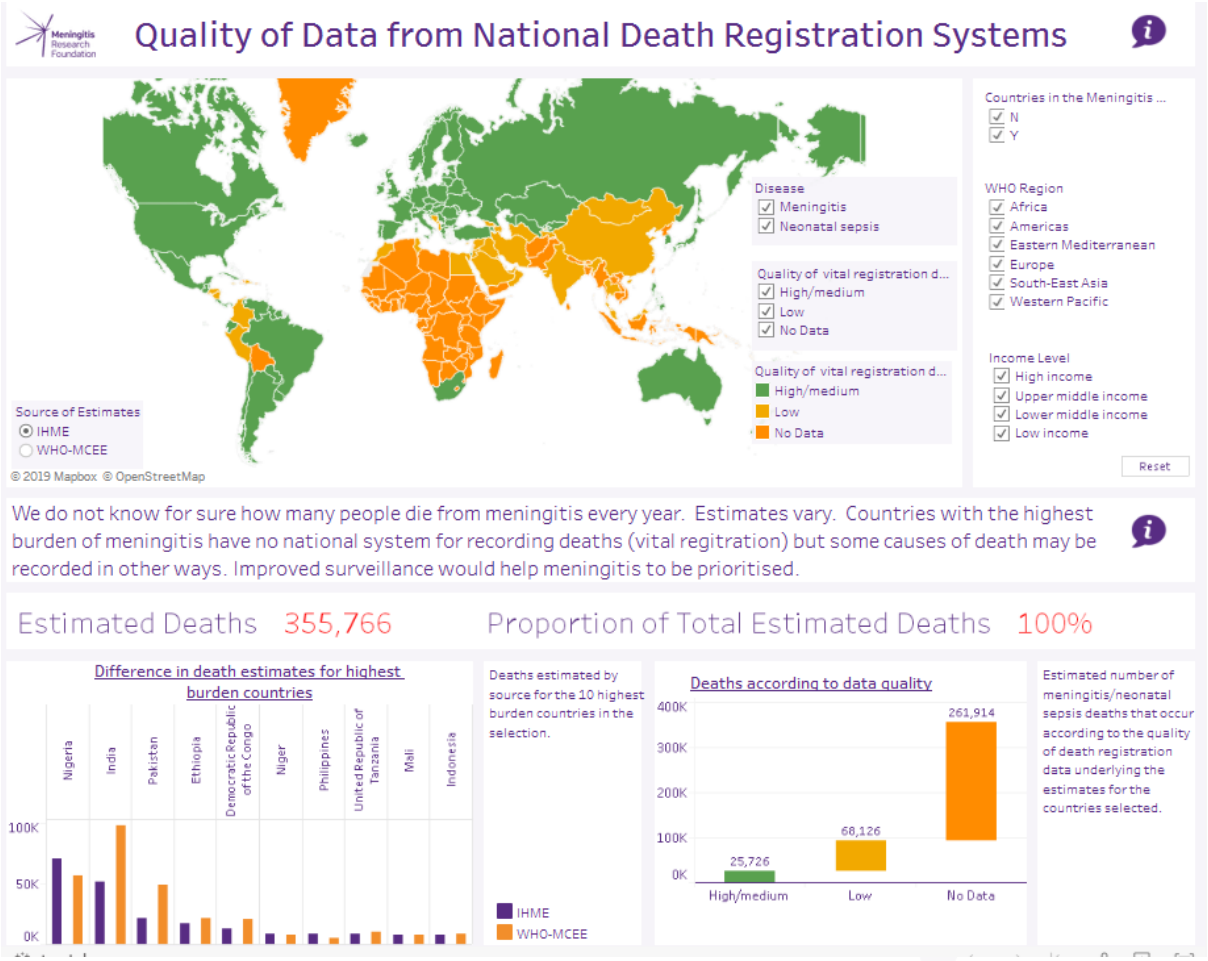
Surveillance

Outputs

Ensure surveillance of meningitis and sequelae at all levels

Outcomes

Improved monitoring of meningitis epidemiology through disease surveillance



https://www.meningitis.org/meningitis/meningitis-progress-tracker

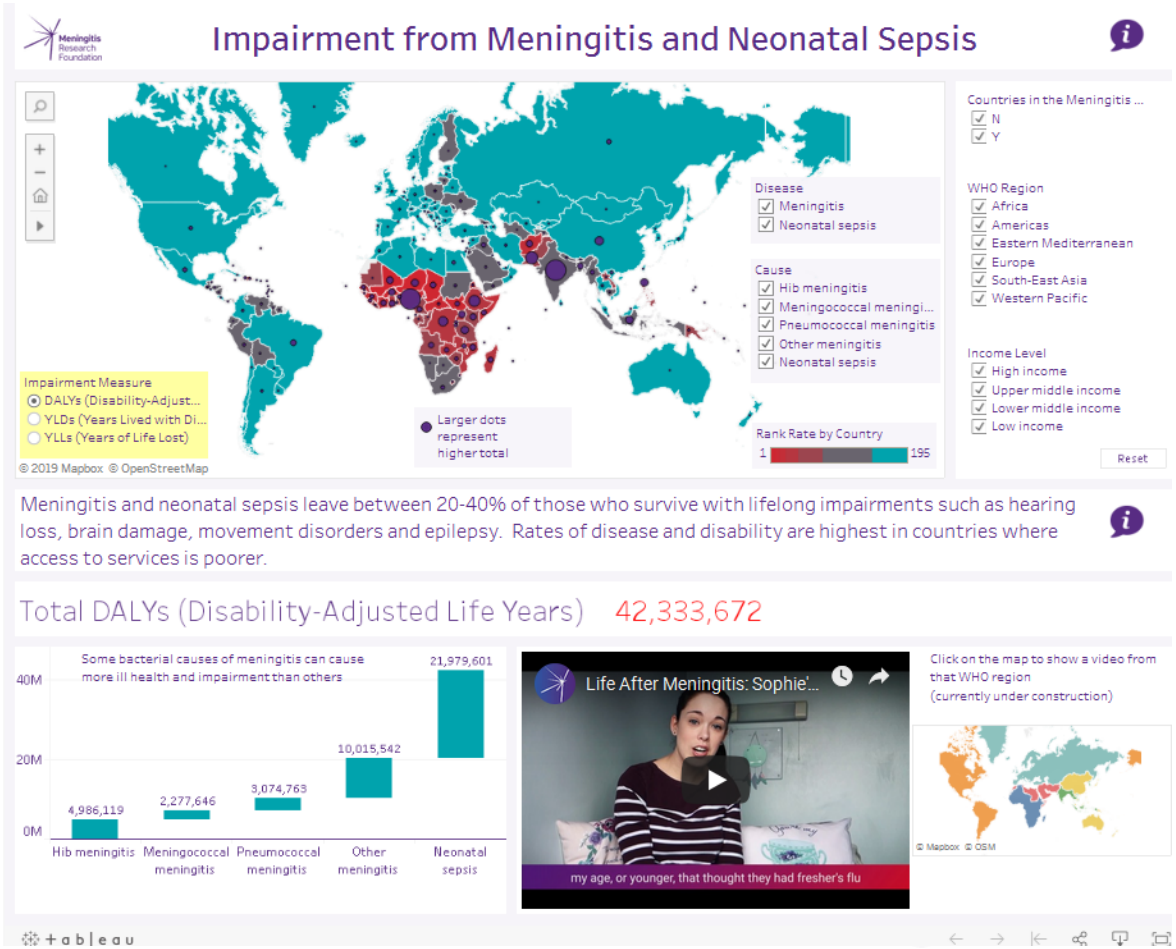
Support and after care

Outputs

Ensure management of sequelae and care for people affected by meningitis

Outcomes

Improved access to support and care for people and families affected by meningitis



https://www.meningitis.org/meningitis/meningitis-progress-tracker

Advocacy

Meningitis Research Foundation

Outputs

Ensure meningitis has a high global priority with awareness of meningitis and disability at all levels

Outcomes

Higher awareness through advocacy and engagement

"It is a very good idea, and what has been done so far is quite good – extending it to all age groups and adding some data on sequelae would make the tracker more powerful"

22,500 views of the MPT page online.

73 different countries have accessed the MPT.

"Great visuals…which is useful for making the burden argument for the development of new vaccines"

"A great resource for teaching"

https://www.meningitis.org/meningitis/meningitis-progress-tracker

Acknowledgements

- James Stuart, WHO
- Caroline Trotter, University of Cambridge
- Peter Phillips, Keytree
- Natacha Blake, Linda Glennie, Jason Parker, Rob Dawson, Vinny Smith, Meningitis Research Foundation
- Li Liu, Yue Chu and Brian Wahl, Johns Hopkins School of Public Health
- Nick Kassabaum, Hmwe Kyu and Han Yong Wunrow, IHME
- Colin Mathers, WHO