The Investment Case for Measles Eradication

Dr. Kimberly M. Thompson
Kid Risk, Inc., www.kidrisk.org
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Measles eradication feasibility

- WHO
  - 2010 - “SAGE concluded that measles can and should be eradicated. A goal for measles eradication should be established with a proposed target date based on measurable progress made towards existing goals and targets.” (WER 2011; 86(1-2):11)
- International Taskforce for Disease Eradication
  - 14th meeting (2009) – “…measles eradication is biologically possible, using tools that are currently available, as already demonstrated in the Americas…” (http://www. cartercenter.org/ resources/pdfs/news/health_publications/itfde/ITFDEsum0609.pdf)
  - 24th meeting (2015) – “The ITFDE still firmly believes that both measles and rubella eradication are technically feasible, but the very high contagiousness of measles is the biggest challenge to success, and measles and rubella eradication would require a sustained global commitment and a clear accountability framework such as exists for the GPEI.” (WER 2016; 91(6):69)

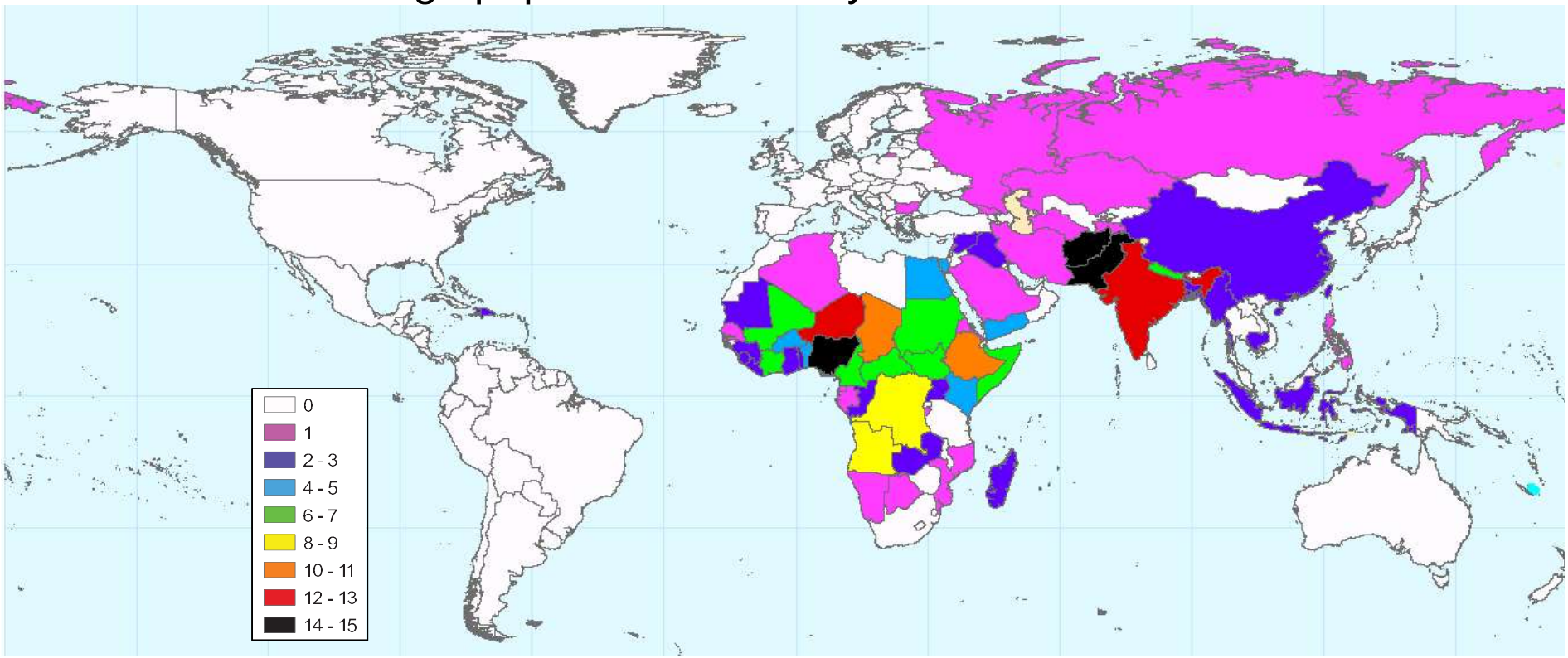
Lessons learned from polio eradication

- When it comes to infectious diseases, we're all in this together
- Achieving large regional/global goals requires sustained commitment and coordination
- Real progress toward goals requires a focus on performance and accountability
- One size doesn't fit all
- Must manage population immunity to transmission, target under-vaccinated populations, and focus on prevention
- It's not over until it's over, need innovation and research until the very end

Experience with polio 2000-2014

Thompson KM, Kalkowska DA, Duintjer Tebbens RJ. Managing population immunity to reduce or eliminate the risks of circulation following the importation of live polioviruses. Vaccine. 2015;33(3):1568-77.

- Insufficient population immunity to prevent circulation of reintroduced virus led to polio cases in over 50 countries in 2000-2014
- Stopping endemic transmission once was NOT enough - must achieve and maintain high population immunity



Number of calendar years during 2000-2014 that each country reported at least one paralytic polio case caused by a WPV or cVDPV indicating insufficient population immunity to stop or prevent transmission, including years with endemic circulation

Map for measles – 2008

Council on Foreign Relations, http://www.cfr.org/interactives/GH_Vaccine_Map/#map

- Reported vaccine-preventable outbreaks

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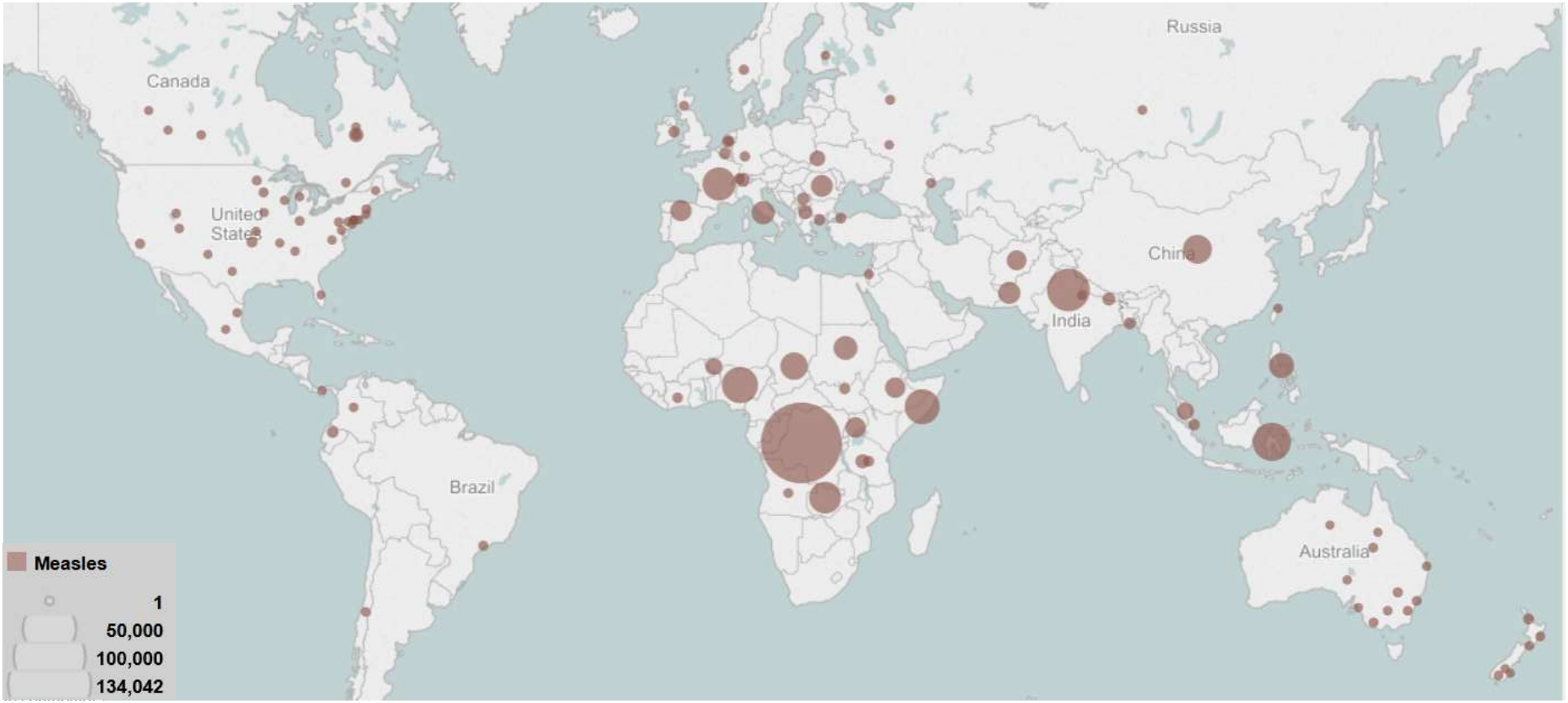


Map for measles – 2012

Council on Foreign Relations, http://www.cfr.org/interactives/GH_Vaccine_Map/#map

- Reported vaccine-preventable outbreaks

Map for measles – 2013

Council on Foreign Relations, http://www.cfr.org/interactives/GH_Vaccine_Map/#map

- Reported vaccine-preventable outbreaks

Map for measles – 2014

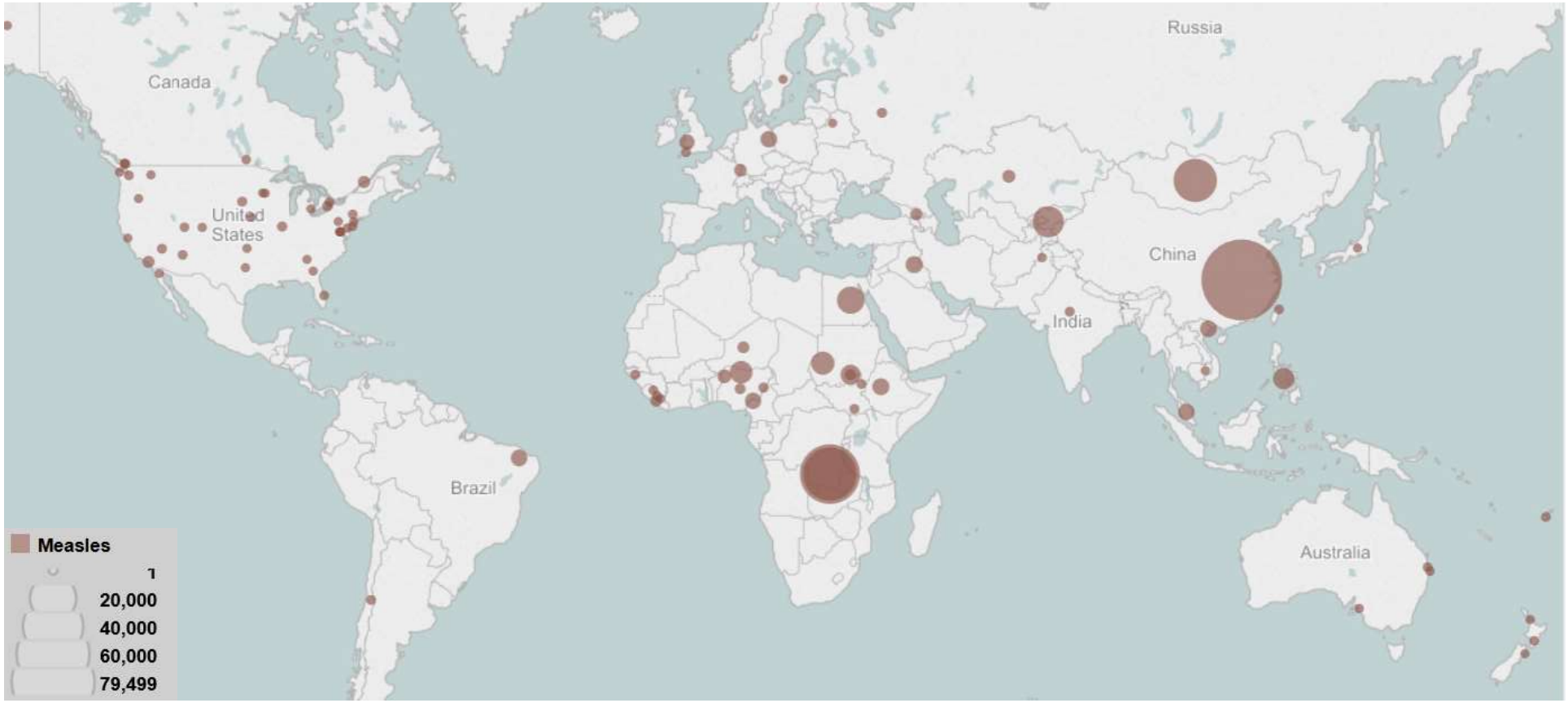
Council on Foreign Relations, http://www.cfr.org/interactives/GH_Vaccine_Map/#map

- Reported vaccine-preventable outbreaks

Map for measles – 2015

Council on Foreign Relations, http://www.cfr.org/interactives/GH_Vaccine_Map/#map

- Reported vaccine-preventable outbreaks



Map for measles – 2008-2015

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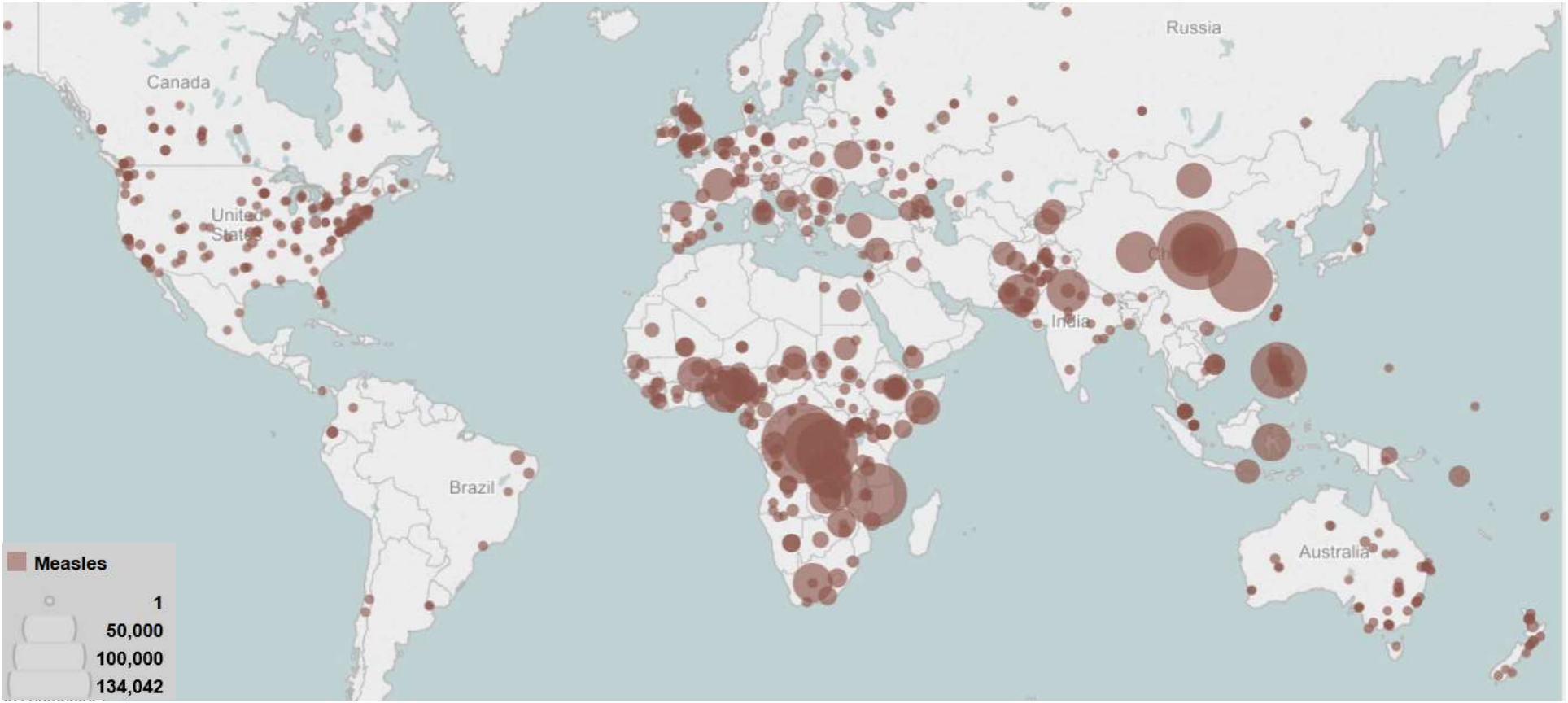
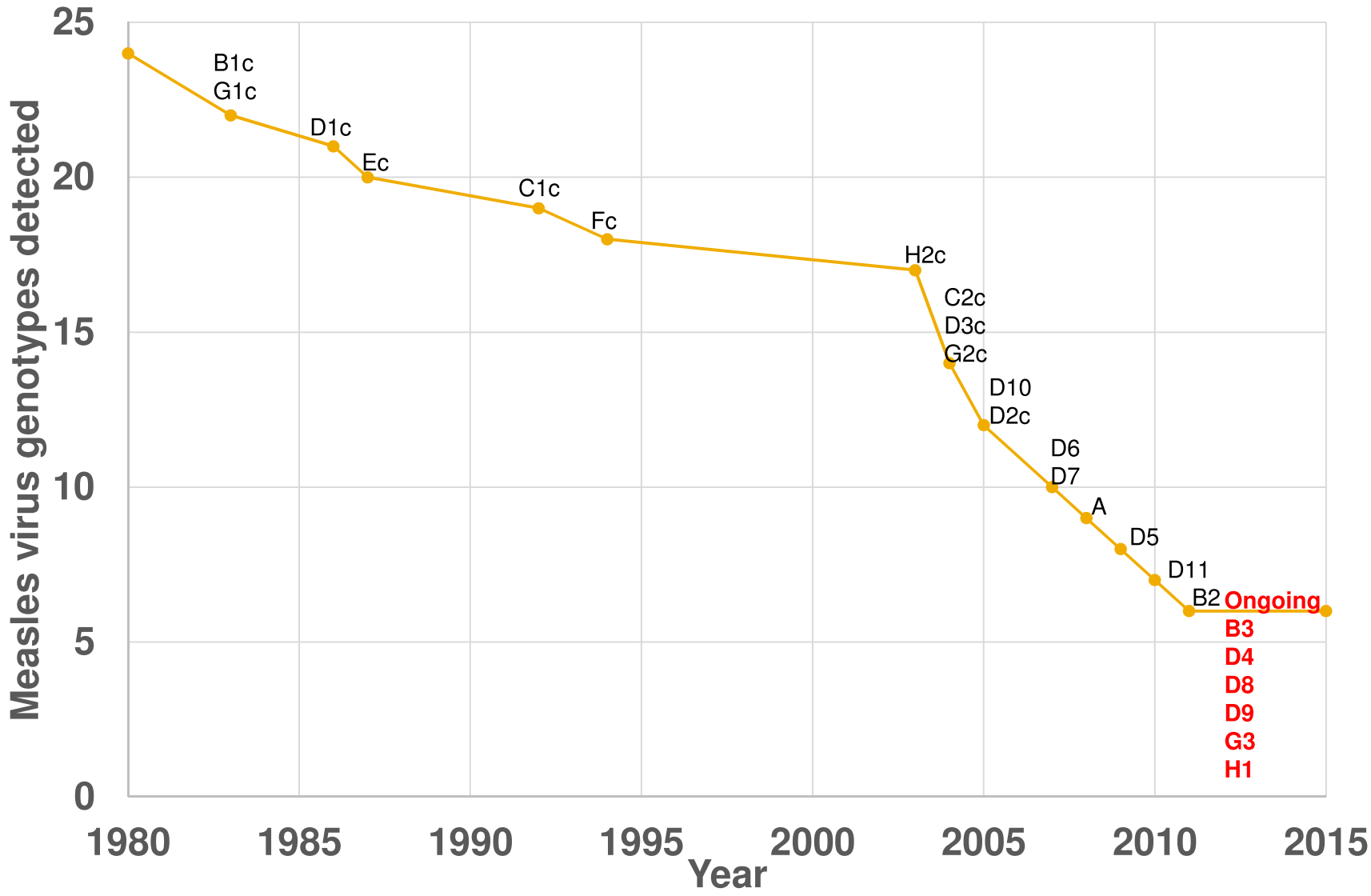


Measles transmission

- Importations can restart transmission in under-vaccinated populations and lead to expensive outbreaks
- All countries remain vulnerable to measles importations until eradication (déjà vu polio)
- Good news… impact of high control visible in the reduction of the number of reported measles virus genotypes

From 24 to 6 genotypes of measles reported for 1980-2015

Data from World Health Organization, Weekly Epidemiological Review 2015; 90(30):373–380



Economic studies of measles vaccination

- Measles immunization highly cost-effective and net beneficial
  - Thompson KM, Odahowski CL. Systematic review of health economic analyses of measles and rubella immunization interventions. Risk Analysis 2014; Dec 24. doi: 10.1111/risa.12331.
  - Ozawa S et al. Return on investment from childhood immunization in low- and middle-income countries, 2011–20. Health Affairs 2016; 35(2): 199-207.

"The highest returns were associated with averting measles, at 58 times the cost (uncertainty range: 28-105) through two routine immunization doses and outreach campaigns" (94 countries)

- Economic literature demonstrates "high control" is not optimal if eradication is feasible
  - Geoffard P-Y, Philipson T. Disease eradication private versus public vaccination. American Economic Review 1997;87(1):222-230.
  - Barrett S. Eradication versus control: the economics of global infectious disease policies. Bulletin of the World Health Organization 2004;82(9):683-688.
  - Thompson KM, Duintjer Tebbens RJ. Eradication versus control for poliomyelitis: An economic analysis. The Lancet 2007;369(9570):1363-71.

  yet the world is currently in control mode for measles
  - Thompson KM, Odahowski CL. The costs and valuation of health impacts of measles and rubella risk management policies, Risk Analysis, 2015: Aug 6. doi: 10.1111/risa.12459.

"immunization activities will cost governments and donors over 2013$US 2.3 billion per year for the foreseeable future" (at the current "plateau" that still leads to millions of estimated infections and over 100,000 estimated deaths per year)

Eradication vs. control

Thompson KM, Odahowski CL. The costs and valuation of health impacts of measles and rubella risk management policies, *Risk Analysis*, 2015: Aug. 6, doi: 10.1111/risa.12459.
Thompson KM, Badizadegan ND. Modeling the transmission of measles and rubella and the economic case for investment in their eradication, Risk Analysis, Submitted.

- Significantly higher treatment costs per measles infection than per immunization dose (for adverse events) (factor of >1000)
- Significantly higher disability-adjusted life year (DALY) loss per measles infection than per immunization dose (for adverse events) (factor of >2000)
- Eradication would save all treatment costs for measles infections (>$2 billion per year) and prevent DALY losses (>15 million DALYs per year valued at >$63 billion)
- After eradication, countries could potentially reduce routine immunization schedules to only one measles dose given at age with minimal interference from maternal antibodies (i.e., assuming very high sustained coverage (95%) everywhere reduces annual immunization cost by over $1 billion per year)

Eradication vs. control

- What would it take to achieve measles elimination by 2020?
  - All countries would need to achieve vaccination coverage levels that raise population immunity over their threshold required to stop transmission AND maintain this by 2019, must reach under-vaccinated populations
  - Assume all countries order 100% of vaccine required to immunize all children living within their borders with two doses and commit to elimination as of 2016
  - Building on polio infrastructure with existing knowledge of missed children, with real commitment and estimated incremental $2 billion per year it might be possible
  - Not possible without real commitment and resources, currently no sign of either at the global level

Eradication vs. control

- Preliminary results for 2013-2052
  - Control at 2013 level implies vaccine + treatment costs of ~$370 billion (undiscounted) or ~$220 billion (discounted at 3%) with cost of eradication by 2025 (assuming a real global commitment) of ~$190 billion (undiscounted) or ~$140 billion (discounted at 3%)
  - Eradication represents the best option considering vaccination and treatment costs alone (i.e., without valuing the health benefits in economic terms) with benefits of eradication ~$180 billion (undiscounted) or ~$80 billion (discounted at 3%)
  - Including valuation of the DALYs prevented implies trillions of dollars saved, which exceeds the expected incremental net benefits of polio investments for same time period (~$15 billion)
  - Without a global commitment to eradication, regions and countries that eliminate will incur high costs for outbreak response and maintenance of high population immunity

Insights

- Existing studies show eradication represents a better health and financial option, but the world is currently leaving money on the table
- Innovations needed to
  - increase performance and accountability (e.g., encourage countries to reach all children with measles (and rubella) vaccine in the most cost-effective ways – different strategies for under-vaccinated children)
  - identify faster, better, and/or cheaper tools for measles immunization
  - Improve surveillance for infection and ability to detect immunity

http://www.kidrisk.org
(16 MR-related publications to date)

Kid Risk, Inc.

Doing our best for children

Better Decisions

Contact information:
Address:
Kid Risk, Inc.
10524 Moss Park Rd.
Suite 204-364
Orlando, FL 32832
Phone: 617-680-2836

Kid Risk, Inc. Officers:
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Radboud J. Duintjer Tebbens, Ph.D., Vice President
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Kimberly M. Thompson, Sc.D.

Research on globally-coordinated investments in measles and rubella management

The partners of the Measles and Rubella Initiative (M&RI) provided funds that they received from the Bill and Melinda Gates Foundation to the World Health Organization for the development of investment cases for globally-coordinated efforts to reduce the burdens of measles, rubella, and congenital rubella syndrome (CRS), including consideration of the options of eradication for either or both viruses (i.e., measles and/or rubella). In October 2011, Kid Risk, Inc. received a grant from the WHO to perform the work. Given the relative novelty of constructing investment cases to support the global coordination of investments to manage infectious diseases, we engaged interested stakeholders in an analytic-deliberative process to identify the appropriate content for inclusion in investment cases and ensure effective and appropriate synthesis of the evidence. We prepared a draft outline and description of the proposed content for an investment case for global coordination of efforts to manage infectious diseases and we invited input from all interested stakeholders through a survey.

We thank many contributors for support of our measles and rubella modeling efforts. Our measles and rubella research led to peer-reviewed publications related to the following topics (publication dates):

- **NEW** - review of measles and rubella immunization and exposure histories (2015, published on-line August 6)
- **NEW** - costs and valuation of health impacts of measles and rubella risk management policies (2015, published on-line August 5)
- **NEW** - impact of outbreak response activities for the 2014 Ohio Amish measles outbreak (2015, published on-line June 22)
- **NEW** - systematic review of measles and rubella serology studies (2015, published on-line June 16)
- **NEW** - characterization of heterogeneity in childhood immunization coverage in Central Florida (2015, published on-line June 2)
- review of measles and rubella health economics analyses (2015, published on-line December 2014)
- optimal global vaccine stockpile design for vaccine-preventable diseases with application to measles and cholera (2015, published on-line August 2014)
- characterization of disability-adjusted life years (DALYs) for infants born with congenital rubella syndrome (CRS) (2015, published on-line August 2014)
- characterization of adverse outcomes following rubella infection in pregnancy (2015, published on-line August 2014)
- valuing the efforts required to achieve the measles and rubella goals of the Global Vaccine Action Plan (2013)
- characterization of national and global decision options for managing measles and rubella population immunity (2012)
- measles and rubella research priorities (2012)
- valuing prevention in global health by managing population immunity for vaccine-preventable diseases (2012)
- results of a stakeholder engagement process to identify the desired content for investment cases to support globally-coordinated disease management activities (2012)
- development of the concept of an eradication investment case (2011)
- characterizing the challenges associated with evaluating the economics of disease elimination and eradication efforts (2011)

You can also learn some basics about measles, rubella, and CRS and read the Measles and Rubella Strategic Plan, 2012-2020.

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- **Co-authors**

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