Impact of HIV and COVID-19 epidemics on epidemiology: methods and practice

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Rakai Health Science Program

World Congress of Epidemiology 2024

Presentation Outline

Impact on Epidemiology

- Advancement in surveillance and data collection
- Evolution of epidemiological methods
- Focus on social determinants of health

Impact of Modelling and HIV control

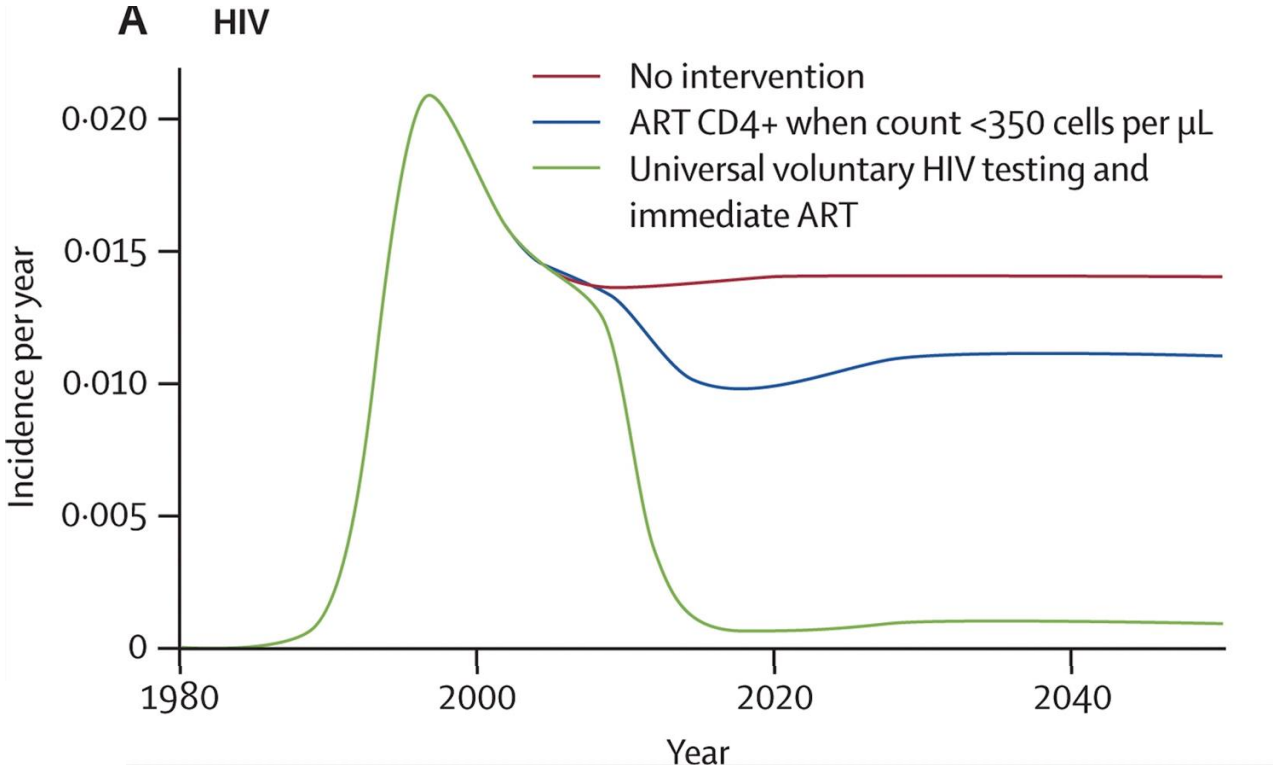
THE LANCET

Universal voluntary HIV testing with immediate antiretroviral therapy as a strategy for elimination of HIV transmission: a mathematical model

Reuben M Granich, Charles F Gilks, Christopher Dye, Kevin M De Cock, Brian G Williams

HIV Modelling Consortium

Universal voluntary testing and immediate ART could reduce HIV incidence by 1% per year and lead to elimination of HIV



SEIR Model: refinement and application to COVID-19 spread

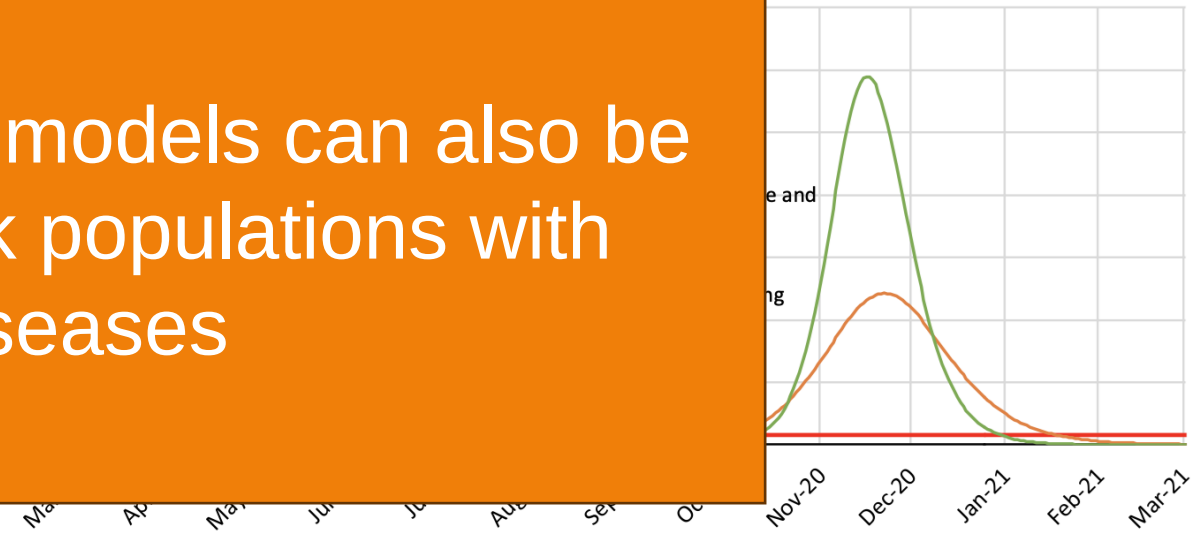
IMPERIAL

Report 9: Impact of non-pharmaceutical interventions (NPIs) to reduce COVID19 mortality and healthcare demand

Author(s): N Ferguson [1], D Laydon [1], G Nedjati Gilani [1], N Imai [1], K Ainslie [1], M Baguelin [1], S Bhatia [1], A Boonyasiri [1], ZULMA Cucunuba Perez [1], G Cuomo-Dannenburg [1], A Dighe [1], I Dorigatti [1], H Fu [1], K Gaythorpe [1], W Green [1], A Hamlet [1], W Hinsley [1], L Okell [1], S Van Elsland [1], H Thompson [1], R Verity [1], E Volz [1], H Wang [1], Y Wang [1], P Walker [1], P Winskill [1], C Whittaker [1], C Donnelly [1], S Riley [1], A Ghani [1]

- Using real-world data assessed impact (differer intensity
  - socia isolat lockd
- Implem will reduce transmission
- Huge policy implication

Big data and predictive models can also be used identify high risk populations with chronic diseases



Social determinants of health

- Both epidemics highlighted importance of social determinants of health in understanding and addressing spread and impact of disease
  - Socio-economic status
  - Access to healthcare
  - Social behaviours
- Will also be useful in understanding chronic diseases epidemiology

Covid-19 vaccine inequity

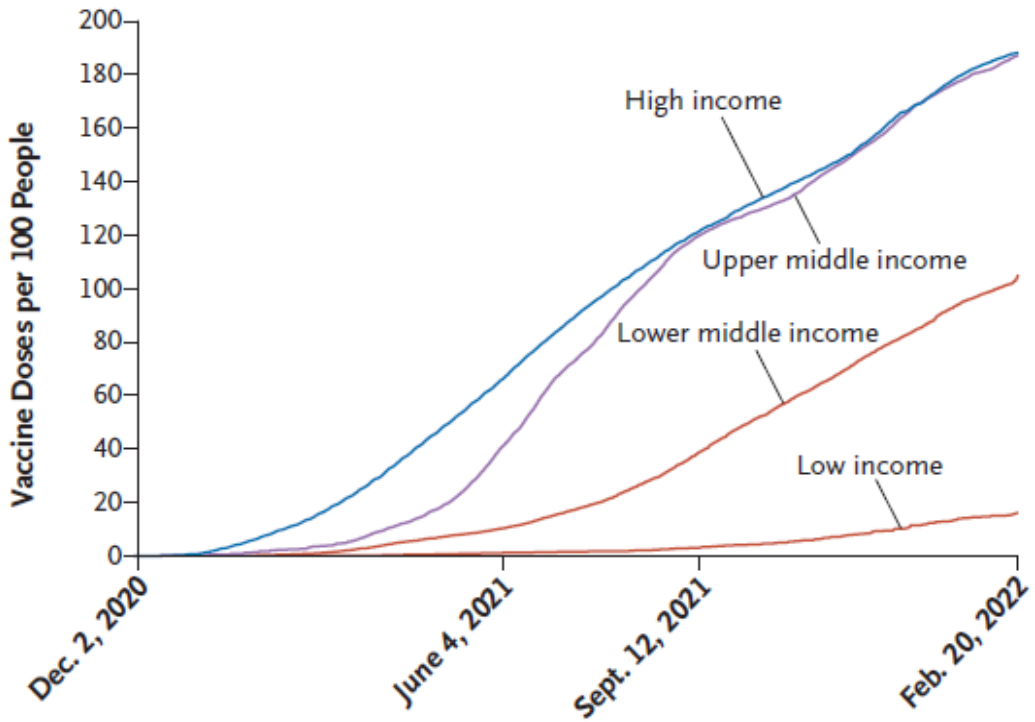


Figure 1. Covid-19 Vaccine Doses Administered in Countries Categorized by Income Level, December 2, 2020, through February 20, 2022.

Impact on Methods

- Interdisciplinary approaches

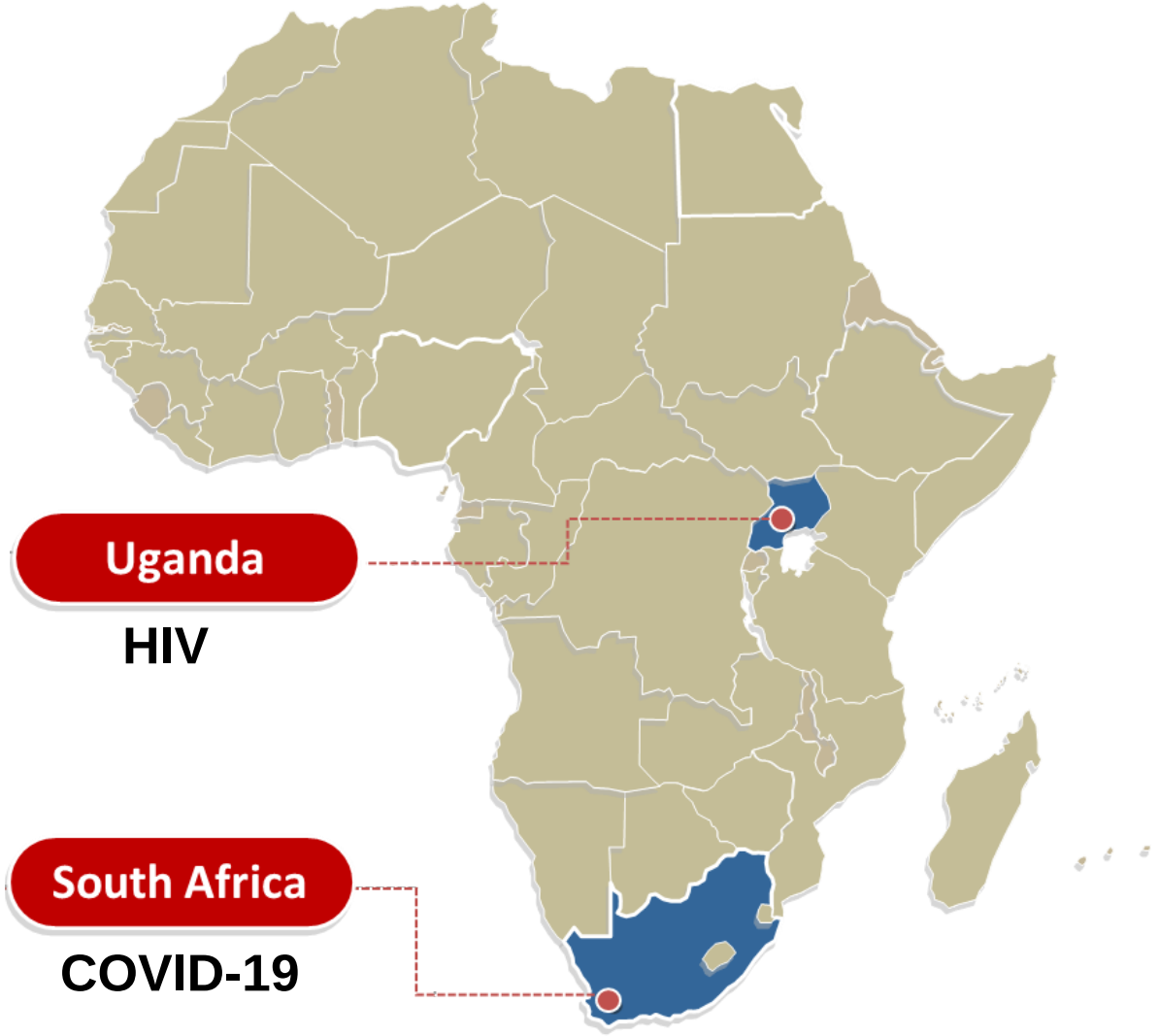
- Use of technology and digital tools

Lessons from HIV and COVID-19

Rakai Community-based Cohort, (RCCS)

Rakai Health Science Program, established community-based HIV surveillance cohort in Rakai (rural district Uganda) ≅ 20,000 individuals followed 35 years

Predominantly draw from South Africa, showcasing the country's experiences



HIV Viral load and transmission

Integration of Disciplines: Integration across virology, clinical care, and public health has led to breakthroughs in antiretroviral therapy (ART) and HIV prevention strategies

Social Science Contributions: Addressing behavioural and social factors has been crucial for effective HIV prevention and equitable access to care.

Viral Load Testing: Dr. Douglas Richman recognised for pioneering viral load testing, a key tool in monitoring HIV progression and treatment success

Epidemiological Insights: Epidemiologists provide critical insights into HIV transmission, guiding public health interventions and policies.

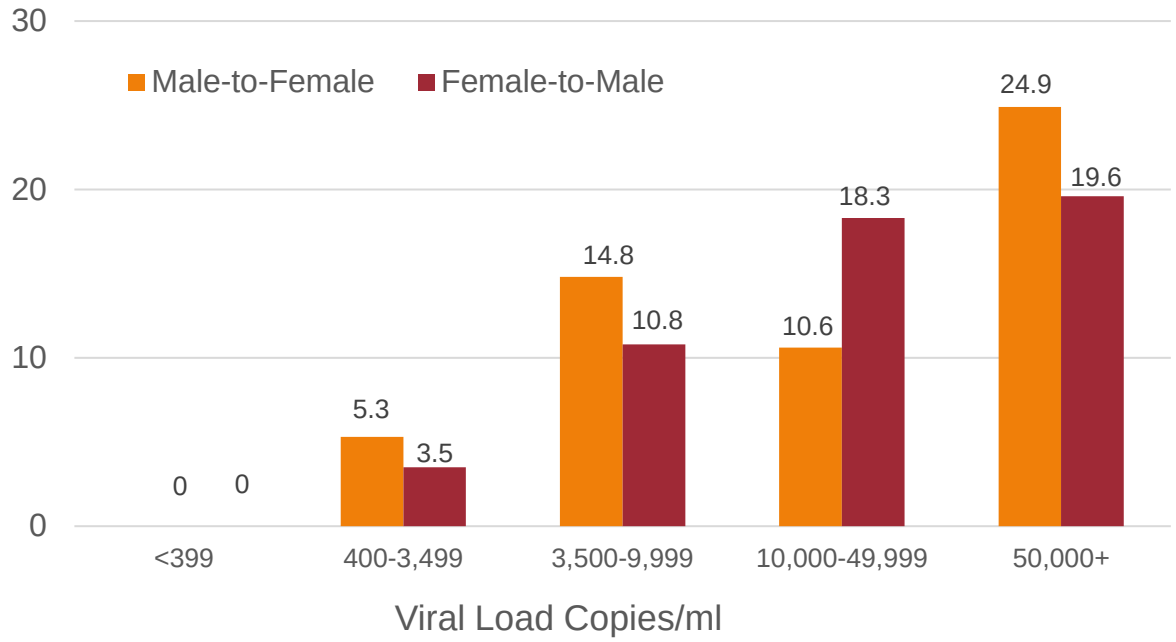
HIV Viral load and transmission

The NEW ENGLAND JOURNAL of MEDICINE

Viral Load and Heterosexual Transmission of Human Immunodeficiency Virus Type 1

Authors: Thomas C. Quinn, M.D., Maria J. Wawer, M.D., Nelson Sewankambo, M.B., David Serwadda, M.B., Chuanjun Li, M.D., Fred Wabwire-Mangen, Ph.D., Mary O. Meehan, B.S., Thomas Lutalo, M.A., and Ronald H. Gray, M.D., for the Rakai Project Study Group

Rate of heterosexual HIV transmission among couples, according to gender and viral load level of partner living with HIV



- Results from the Rakai studies lead to hypothesis testing:

Does early viral suppression lead to a reduction in HIV transmission? HPTN052

HPTN052: Immediate vs Delayed ART initiation

The NEW ENGLAND JOURNAL of MEDICINE

Prevention of HIV-1 Infection with Early Antiretroviral Therapy

Authors: Myron S. Cohen, M.D., Ying Q. Chen, Ph.D., Marybeth McCauley, M.P.H., Theresa Gamble, Ph.D., Mina C. Hosseinipour, M.D., Nagalingeswaran Kumarasamy, M.B., B.S., James G. Hakim, M.D., +28, for the HPTN 052 Study Team*

Table 2. Incidence of Partner-Linked and Any HIV-1 Transmission and Clinical and Composite Events.

Variable	Early Therapy			Delayed Therapy			Hazard or Rate Ratio (95% CI)*
	Events	Person-yr	Rate (95% CI)	Events	Person-yr	Rate (95% CI)	
	no.		%	*no.*		%	
Linked transmission							
Total	1	1585.3	0.1 (0.0–0.4)	27	1567.3	1.7 (1.1–2.5)	0.04 (0.01–0.27)
1 yr	1	819.0	0.1 (0.0–0.7)	16	813.3	2.0 (1.1–3.2)	0.06 (0.00–0.40)
2–3 yr	0	686.5	0.0 (0.0–0.5)	9	682.8	1.3 (0.6–2.5)	0.00 (0.00–0.50)
>3 yr	0	79.9	0.0 (0.0–4.6)	2	71.2	2.8 (0.3–10.1)	0.00 (0.00–4.75)

HR = 0.037 or 96.3% reduction in transmission difference. No difference whether index pt was M or F

HIV gene sequencing and transmission dynamics

- Gene sequencing used to detect and understand infectious disease transmission

Phylogenetics

- Collected circulating viruses in individuals in a defined geographic area
- Pooled together in an organized evolutionary history for entire region

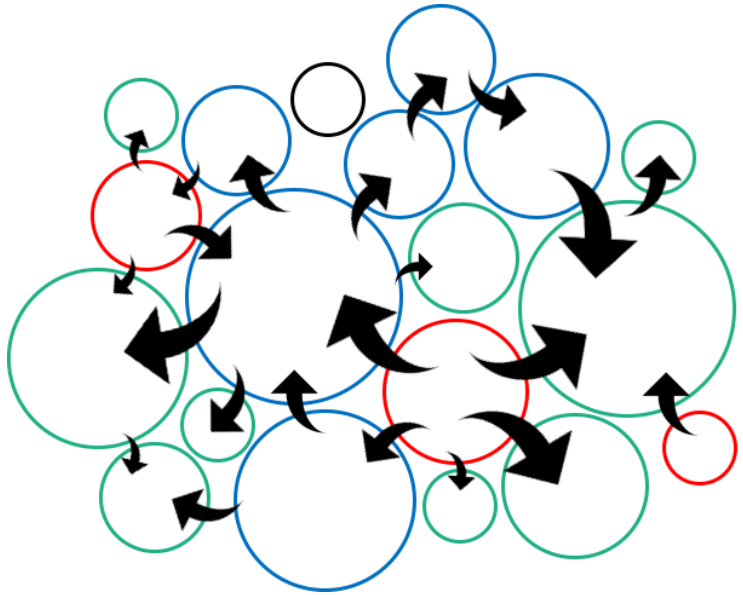
Phylodynamics

- Determine how close viruses are to each other in history
- For those with direct linkages between them, we look for **ancestral relationships** and infer direction of transmission

Genomic is also increasingly being used
understand genetic risk profile to chronic diseases

Phylogenetics and Networks for Generalised Epidemics in Africa (PANGEA)

Objective: Identify epidemiologic drivers of transmission at a population-level



Sample set: >30,000 deeply sequenced HIV viral genomes generated during HIV treatment scale-up through PANGEA-HIV consortium

MRC/UVRI and LSHTM Uganda Research Unit

MRC Medical Research Council

Uganda Virus Research Institute

London School of Hygiene & Tropical Medicine

University of Oxford

Johns Hopkins University

Rakai Health Sciences Program
Improved Health Through Research

The University of Edinburgh

Imperial College London

University of Washington
International Clinical Research Center

UCL

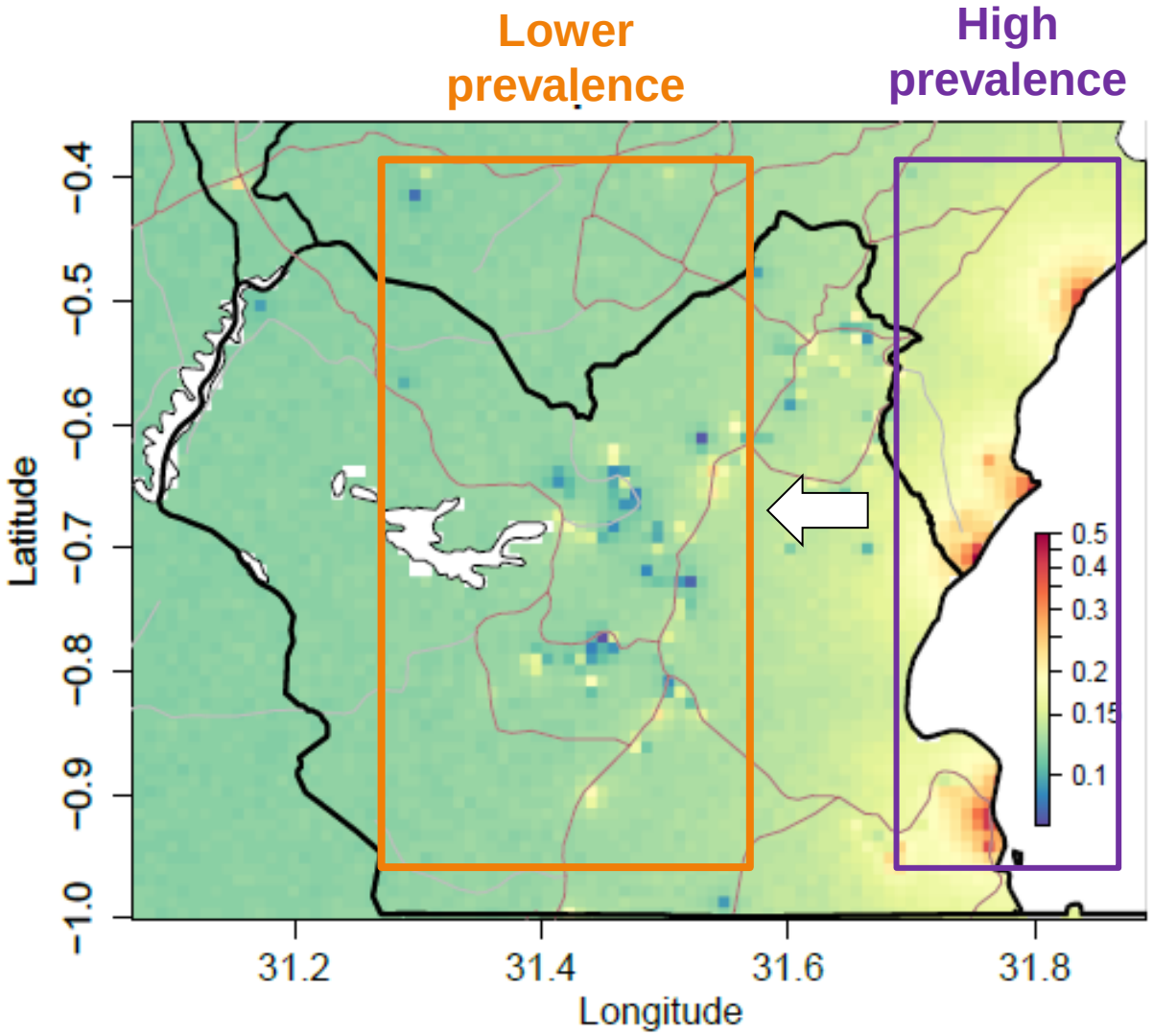
Zambart

Botswana Harvard AIDS Institute Partnership for HIV Research and Education

AHRI Africa Health Research Institute

Map: Dwyer-Lindgren et al 2019
Heatmap of HIV prevalence in Africa

What is the role of high prevalence zones in generalised epidemics?

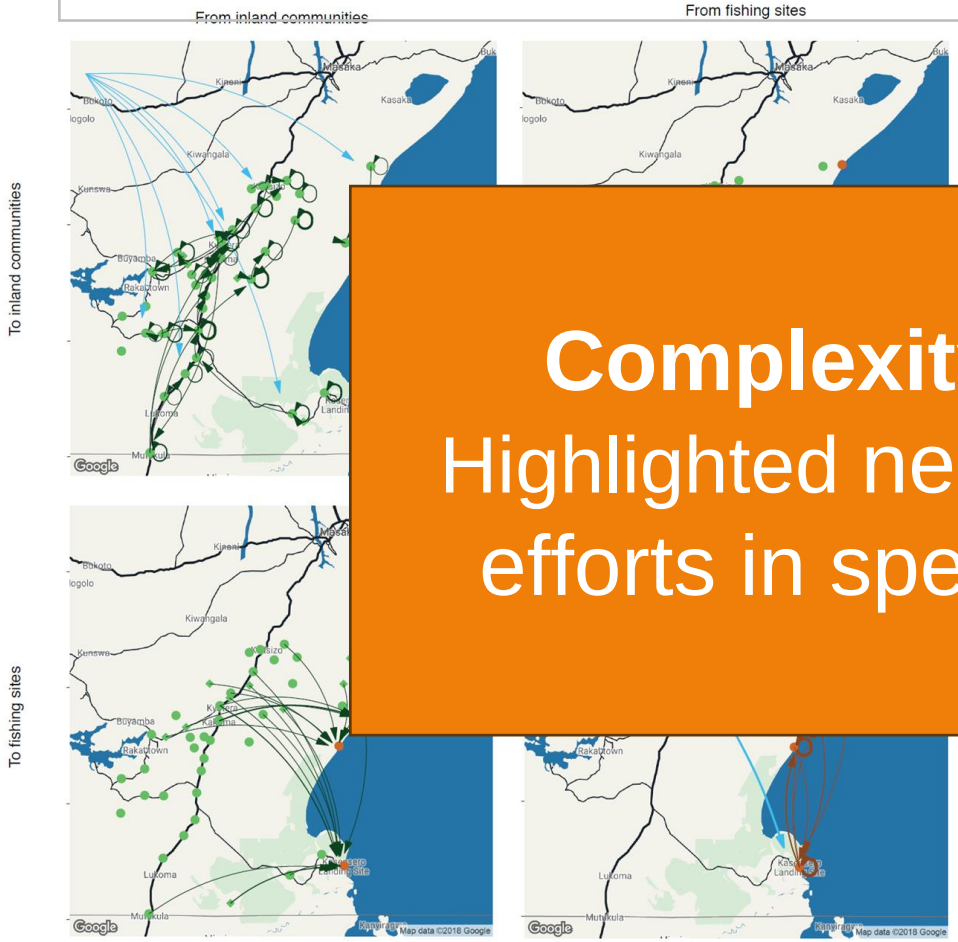


Geography of transmission flows

THE LANCET
HIV

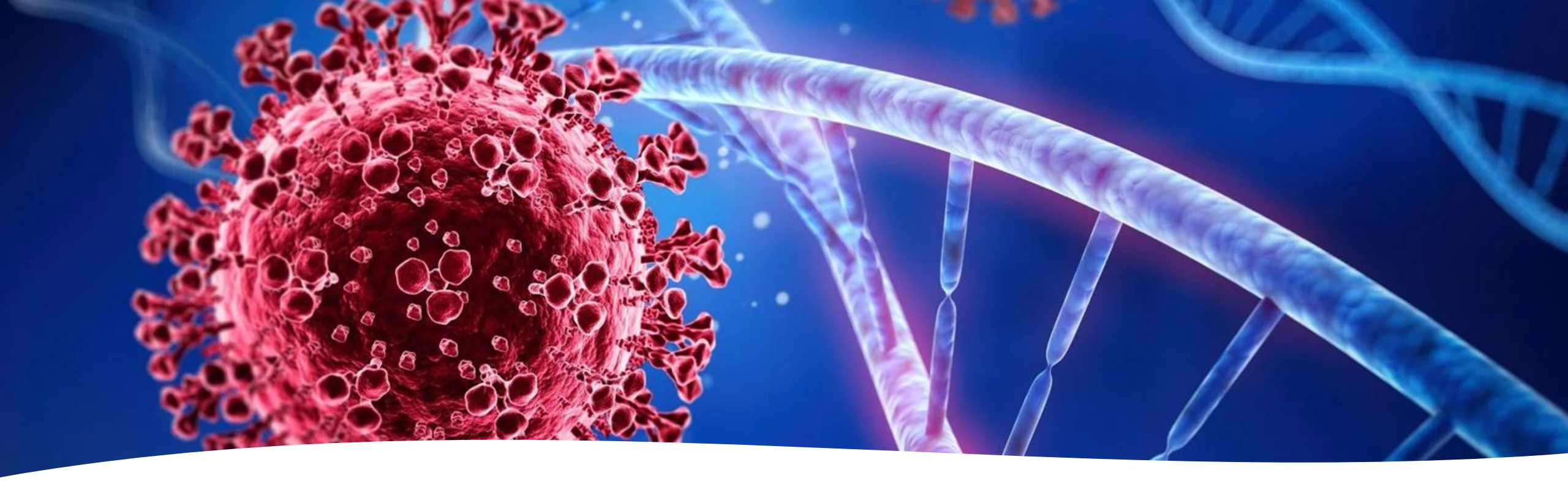
Quantifying HIV transmission flow between high-prevalence hotspots and surrounding communities: a population-based study in Rakai, Uganda

Oliver Ratmann, PhD [a] · Joseph Kagaayi, PhD [b] · Matthew Hall, PhD [c] · Tanya Golubchick, PhD [c] · Godfrey Kigozi, PhD [b] · Xiaoyue Xi, MSc [a] · et al.



Complexity of HIV transmission
Highlighted need for targeted prevention efforts in specific community contexts

- Significant transmission flow of
  nce hotspots
  n fishing
  of HIV
  ources
  rriving from
  n they were
  transmitting to them)



Complexity of gene sequencing and variants

- Use of gene sequencing of SARS-Cov-2 enabled discovery of variants that were critical in understanding.
  - Transmission dynamics and clinical presentation and natural history
  - Vaccine diagnostics and efficacy

2021: First epidemiological analysis of Omicron – showed higher transmissibility within a week

THE LANCET

Omicron SARS-CoV-2 variant: a new chapter in the COVID-19 pandemic

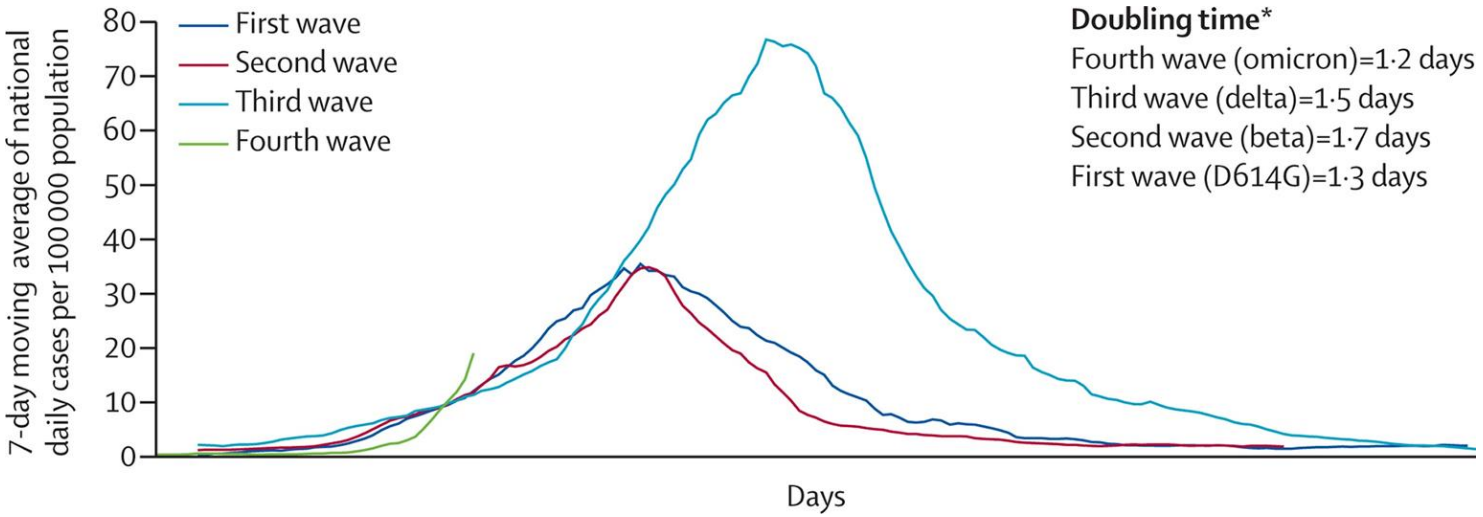
Salim S Abdool Karim [a,b] ✉ · Quarraisha Abdool Karim [a,b]

Published Online December 2, 2021 https://doi.org/10.1016/S0140-6736(21)02758-6

This online publication has been corrected. The corrected version first appeared at thelancet.com on January 6, 2021

On Nov 25, 2021, about 23 months since the first reported case of COVID-19 and after a global estimated 260 million cases and 5·2 million deaths,[1] a new SARS-CoV-2 variant of concern (VoC), omicron,[2] was reported. Omicron emerged in a COVID-19-weary world in which anger and frustration with the pandemic are rife amid widespread negative impacts on social, mental, and

The first sequenced omicron case was reported from Botswana on Nov 11, 2021, and a few days later another sequenced case was reported from Hong Kong in a traveller from South Africa.[8] Several sequences from South Africa followed, after initial identification that the new variant was associated with an S-gene target failure on a specific PCR assay because of a 69–70del deletion,

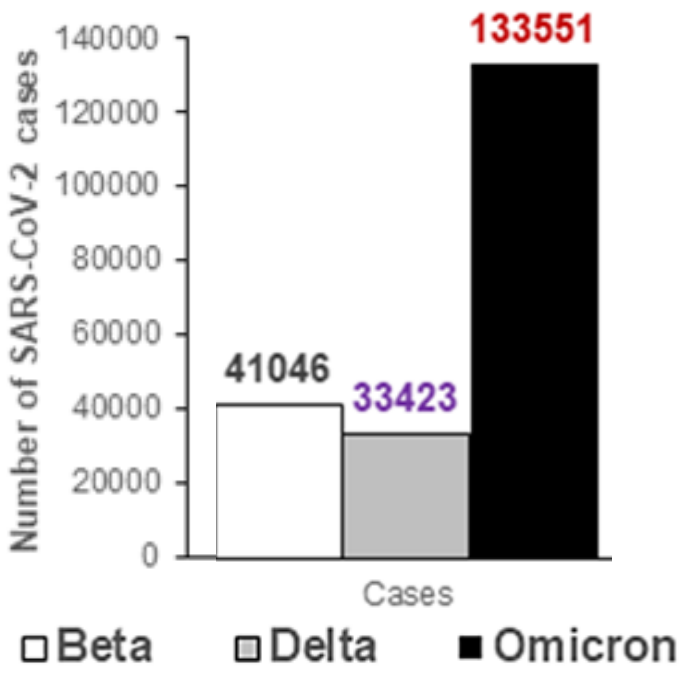


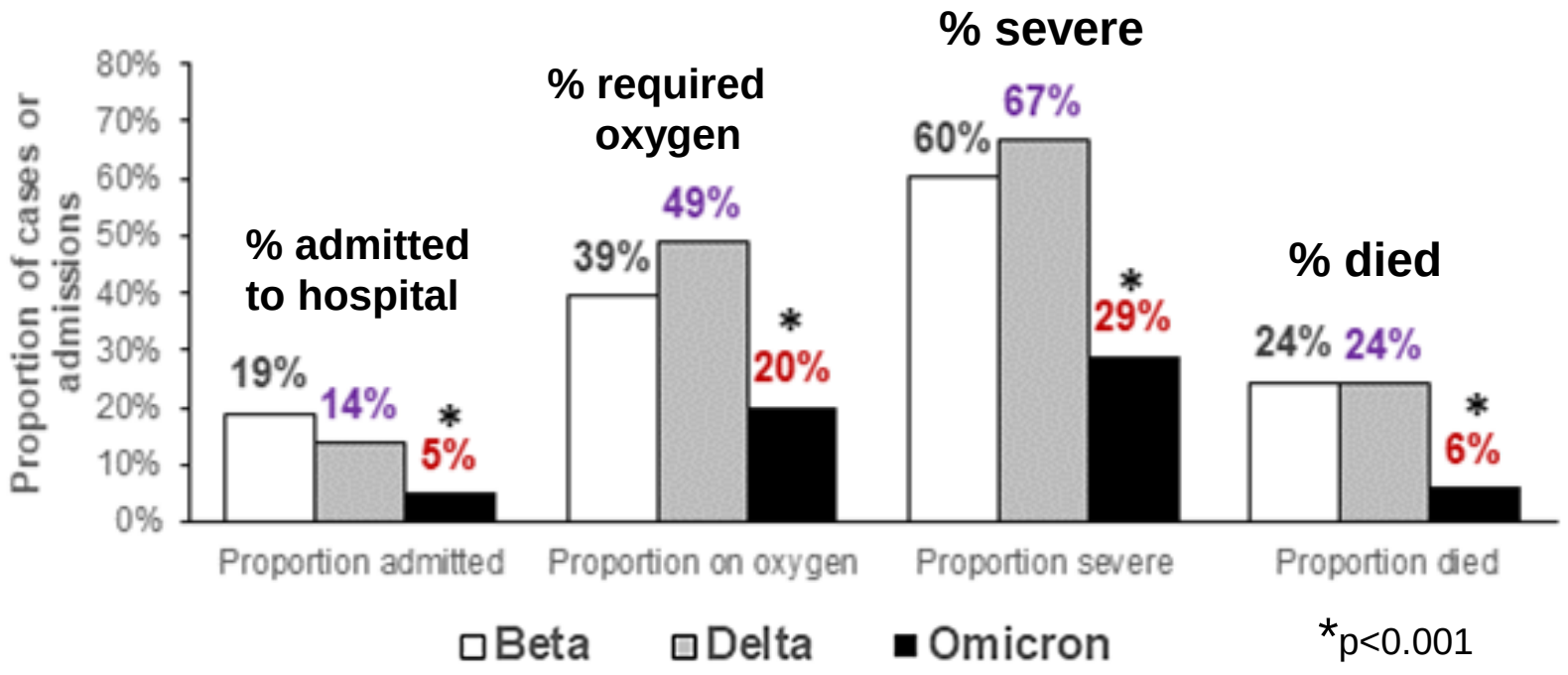
A month later in Jan 2022: Is Omicron more severe? NO!

THE LANCET
Global Health

Clinical severity of COVID-19 in patients admitted to hospital during the omicron wave in South Africa: a retrospective observational study

Waasila Jassat, Salim S Abdool Karim, Caroline Mudara, Richard Welch, Lovelyn Ozougwu, Michelle J Groome, Nevashan Govender, Anne von Gottberg, Nicole Wolter, Milani Wolmarans, Petro Rousseau, the DATCOV author group, Lucille Blumberg, Cheryl Cohen**



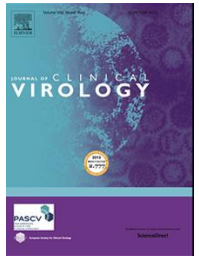


"Severe" defined as respiratory distress, oxygen, mechanical ventilation, high care / ICU care or death

Partnered with FIND / ACT-Accelerator to assess diagnostic tests as new variants emerged

Clinical Evaluation of Severe Acute Respiratory Syndrome Coronavirus 2 Rapid Antigen Tests During the Omicron Wave in South Africa

Natasha Samsunder,[1] Margaretha de Vos,[2] Sinaye Ngcapu,[1,3] Jennifer Giandhari,[4] Lara Lewis,[1] Ayesha B. M. Kharsany,[1,2] Cherie Cawood,[5] Tulio de Oliveira,[1,4,6,7] Quarraisha Abdool Karim,[1,8] Salim Abdool Karim,[1,8] Kogieleum Naidoo,[1,9] Camille Escadafal,[2] and Aida Sivro[1,3]



Performance of rapid antigen tests in identifying Omicron BA.4 and BA.5 infections in South Africa

Natasha Samsunder , Gila Lustig , Margaretha de Vos , Sinaye Ngcapu , Jennifer Giandhari , Derek Tshiabuila , San Emmanuel James , Lara Lewis , Ayesha BM Kharsany , Cherie Cawood , Tulio de Oliveira , Quarraisha Abdool Karim , Salim Abdool Karim , Camille Escadafal , Kogieleum Naidoo , Aida Sivro

BMC

Diagnostic and Prognostic Research

Field evaluations of four SARS-CoV-2 rapid antigen tests during SARS-CoV-2 Delta variant wave in South Africa

Natasha Samsunder[1], Gila Lustig[1], Slindile Ngubane[1], Thando Glory Maseko[1], Santhuri Rambaran[1], Sinaye Ngcapu[1,2], Stanley Nzuzo Magini[1], Lara Lewis[1], Cherie Cawood[3], Ayesha B. M. Kharsany[1,2], Quarraisha Abdool Karim[1,4], Salim Abdool Karim[1,4], Kogieleum Naidoo[1,5] and Aida Sivro[1,2,5,6,7*]

Impact on Practice

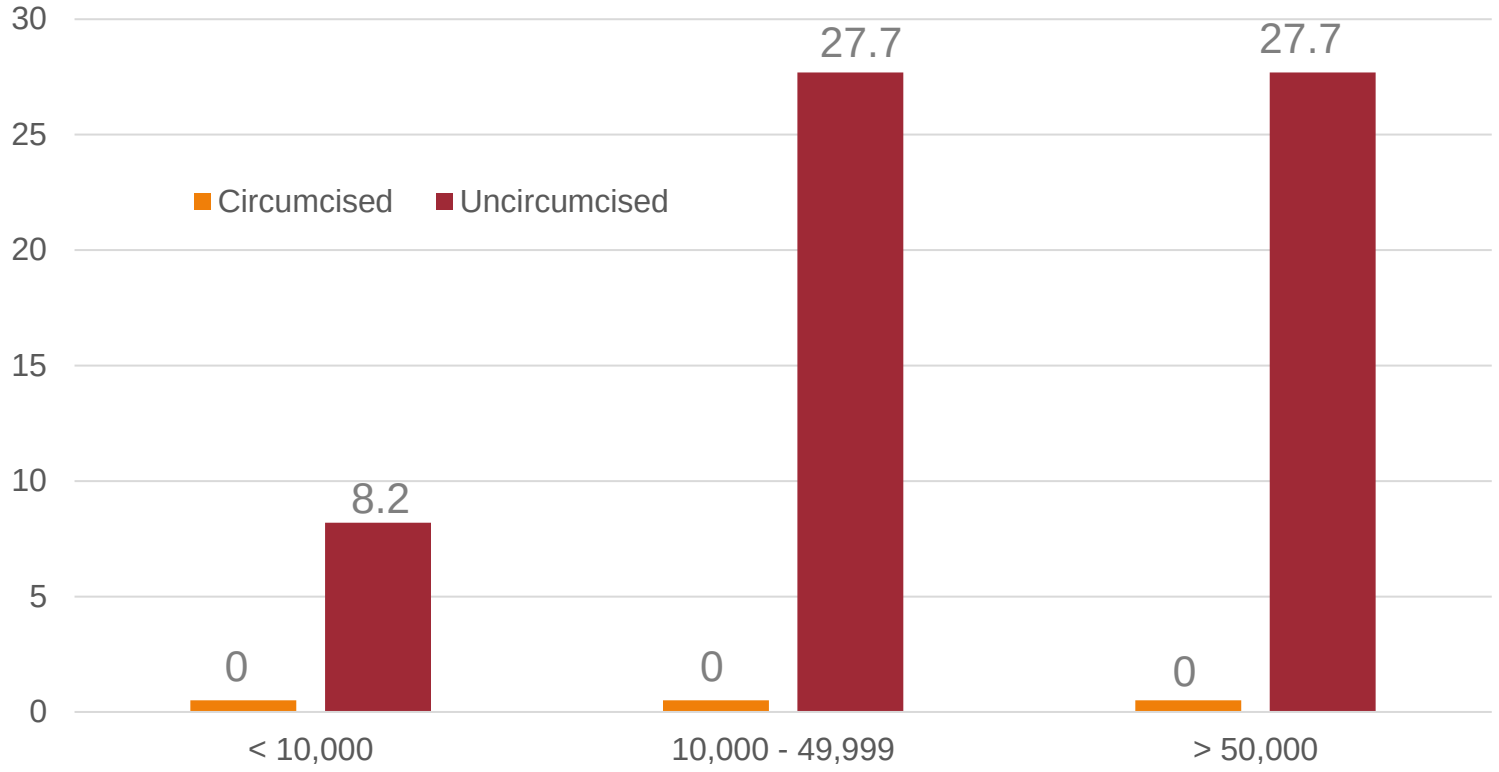
- Public health interventions
- Intervention evaluation
- Policy implications

Circumcision and HIV acquisition

AIDS

Male circumcision and HIV acquisition and transmission: cohort studies in Rakai, Uganda

Gray, Ronald H.[a]; Kiwanuka, Noah[c]; Quinn, Thomas C.[b]; Sewankambo, Nelson K.[d]; Serwadda, David[e]; Mangen, Fred Wabwire[e]; Lutalo, Tom[c]; Nalugoda, Fred[c]; Kelly, Robert[a]; Meehan, Mary[f]; Chen, Michael Z.[a]; Li, Chuanjun[a]; Wawer, Maria J.[*] for the Rakai Project Team



Circumcised
No transmissions

Uncircumcised
Transmission
16.7/100 py

Circumcision and HIV acquisition

THE LANCET

Male circumcision for HIV prevention in young men in Kisumu, Kenya: a randomised controlled trial

Robert C Bailey, Stephen Moses, Corette B Parker, Kawango Agot, Ian Maclean, John N Krieger, Carolyn F M Williams, Richard T Campbell, Jeckoniah O Ndinya-Achola

Male circumcision for HIV prevention in men in Rakai, Uganda: a randomised trial

Ronald H Gray, Godfrey Kigozi, David Serwadda, Frederick Makumbi, Stephen Watya, Fred Nalugoda, Noah Kiwanuka, Lawrence H Moulto Mohammad A Chaudhary, Michael Z Chen, Nelson K Sewankambo, Fred Wabwire-Mangen, Melanie C Bacon, Carolyn F M Williams, Pius (Steven J Reynolds, Oliver Laeyendecker, Thomas C Quinn, Maria J Wawer

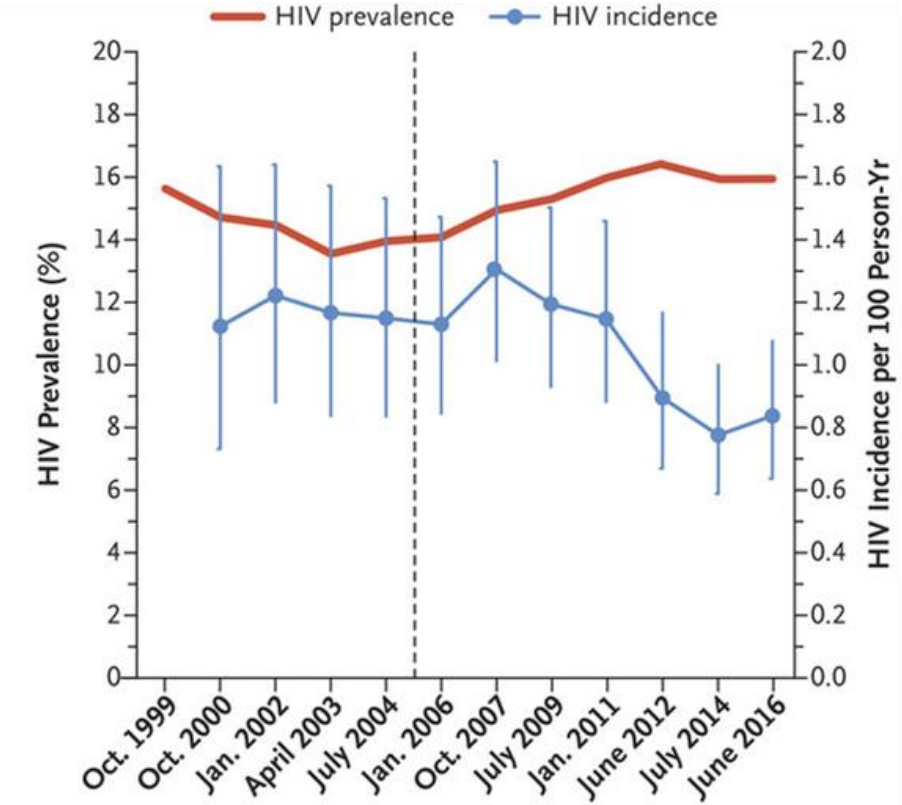
- 2007: WHO & UNAIDS officially recommended male circumcision for the prevention of HIV acquisition
- Increased funding for circumcision for HIV Prevention

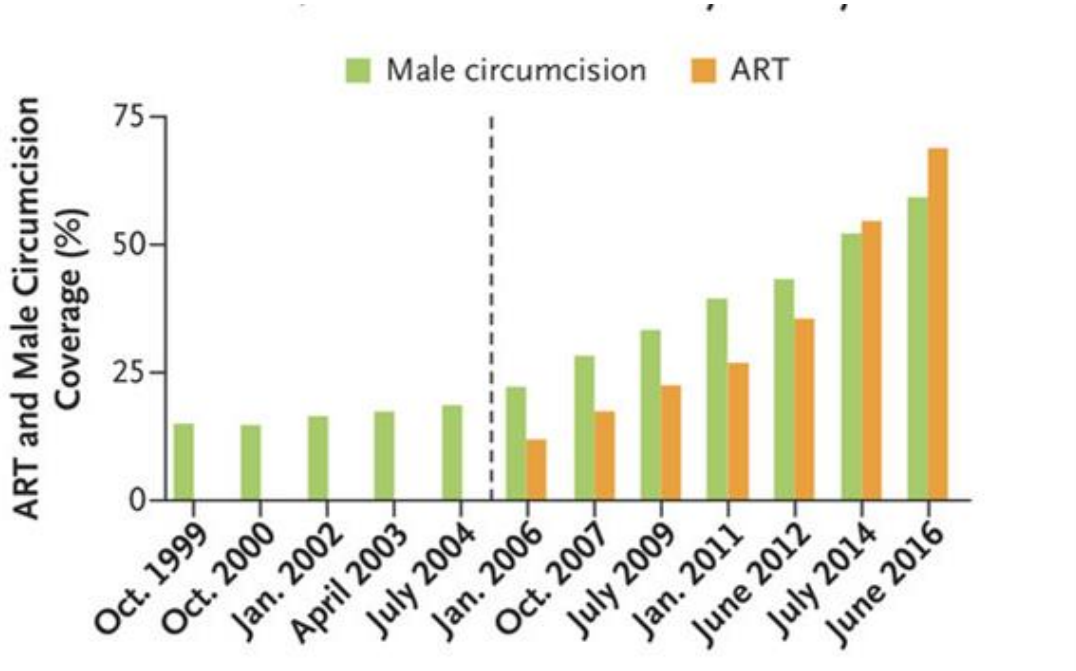
Monitoring circumcision impact and HIV treatment

The NEW ENGLAND JOURNAL of MEDICINE

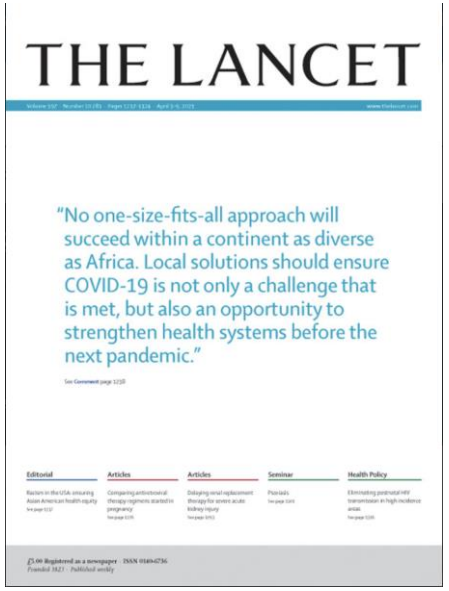
HIV Prevention Efforts and Incidence of HIV in Uganda

Authors: M. Kate Grabowski, Ph.D., David M. Serwadda, M.B., Ch.B., M.P.H., Ronald H. Gray, M.D., Gertrude Nakigozi, M.B., Ch.B., Ph.D., Godfrey Kigozi, M.B., Ch.B., Ph.D., Joseph Kagaayi, M.B., Ch.B., Ph.D., Robert Ssekubugu, M.S.P.H. , +16 , for the Rakai Health Sciences Program*





Variants changed the endgame scenarios: plan essential for a pandemic strategy



Vaccines and SARS-CoV-2 variants: the urgent need for a correlate of protection

Salim S Abdool Karim [1]

Research at the speed of the epidemic:
study design timing

David Skegg [1], Peter Gluckman [2], Geoffrey Boulton [3], Heide Hackmann [4], Salim S Abdool Karim [5], Peter Piot [6], Christiane Woopen [7]

2020: Impact of COVID-19 on TB and HIV care

INSIGHTS

PERSPECTIVES

By **Quarraisha Abdool Karim** and **Salim S. Abdool Karim**

Shortly after instituting coronavirus disease 2019 (COVID-19) mitigation measures, such as banning air travel and closing schools, the South African government implemented a national lockdown on 27 March 2020 when there were 402 cases and the number of cases was doubling every 2 days (*1*). This drastic step, which set out to curb viral transmission by restricting the movement of people and their interactions, has had several unintended consequences for the provision of health care services for other prevalent conditions, in particular the prevention and treatment of tuberculosis (TB) and HIV. Key resources that had

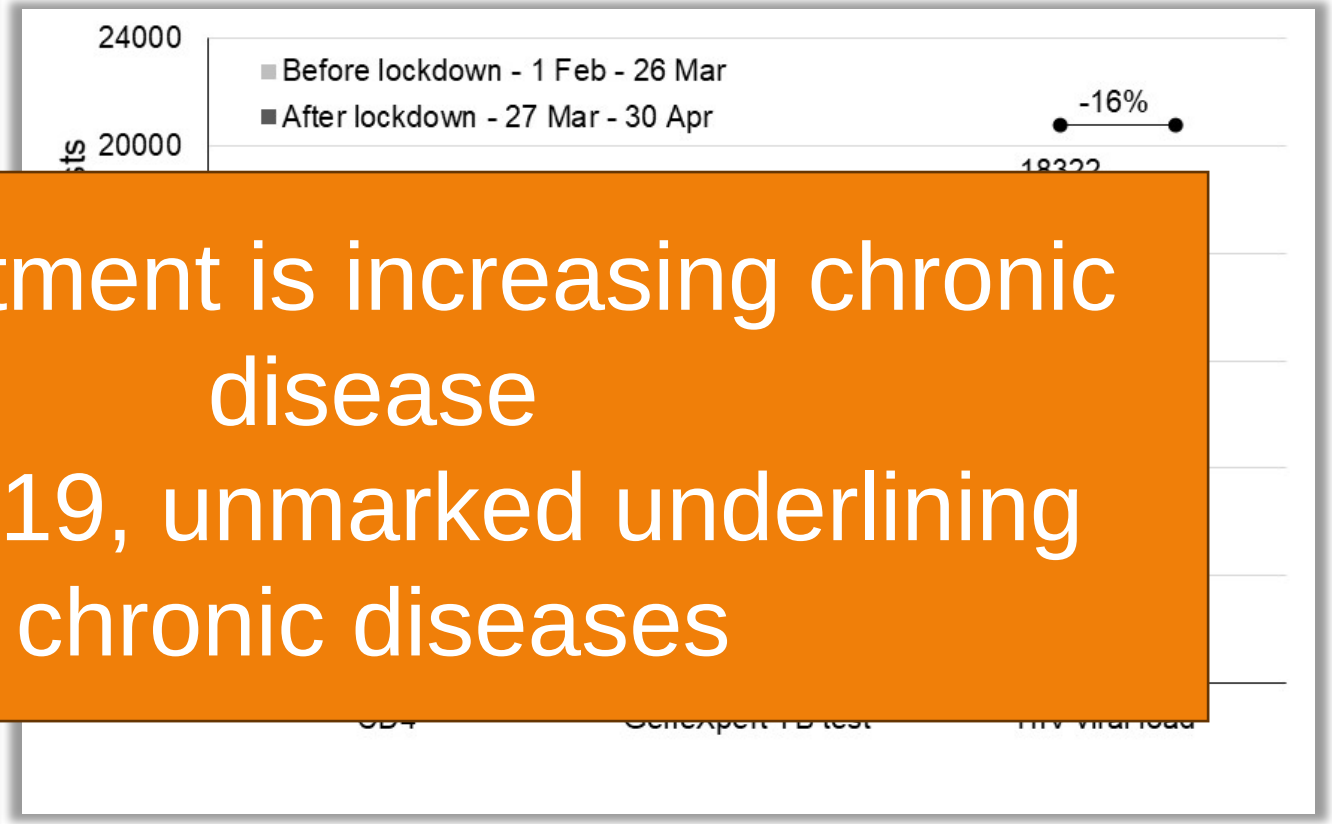
down, inadvertently threatened these gains in HIV and TB?

HIV and TB polymerase chain reaction (PCR) tests are key to treatment initiation and monitoring to achieve the United Nations goals for the control of HIV and TB. Disturbingly, these diagnostic tests declined during the lockdown. The 59% drop in the median number of daily GeneXpert TB tests—a cartridge-based PCR test capable of diagnosing TB within 2 hours while simultaneously testing for drug resistance—was

VIEWPOINT: COVID-19

COVID-19 affects HIV and tuberculosis care

The COVID-19 response should be balanced with the need to manage other diseases



HIV treatment is increasing chronic disease

COVID-19, unmarked underlining chronic diseases

Summary

HIV and COVID epidemics:

- Development of epidemiological models
- Highlighted social determinates of health dynamics of disease transmission
- Interdisciplinary approaches to understanding the epidemiology
- Evaluation of public health intervention, impact on policy and funding

Acknowledgement

Salim Abdool Karim, *CAPRISA,* generously provided the Covid-19 slides and made a thoughtful contribution to this presentation

Thokozile Malaba for her insights and clarity of the slide presentation

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Improved Health Through High Impact Research