



9^º
**CONGRESSO
COSEMSBA**
DESAFIOS DA GESTÃO MUNICIPAL
NA ATUAL CONJUNTURA DO SUS



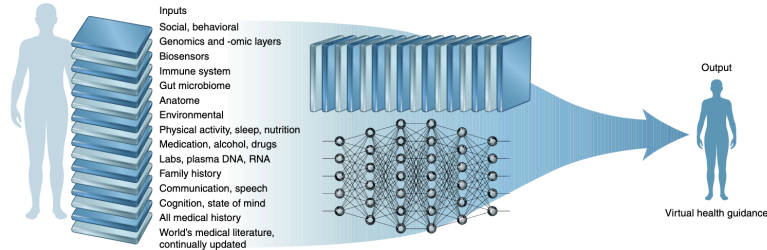
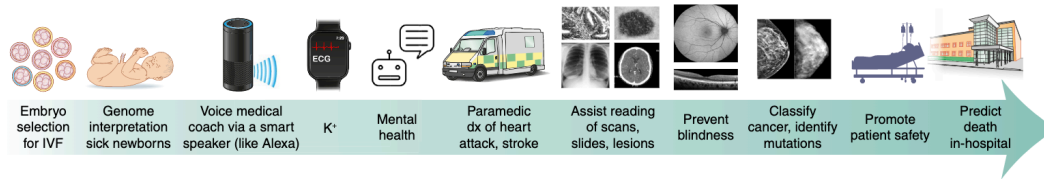
Saúde Digital: Necessidades e Perspectivas

Manoel Barral-Netto
CIDACS - Fiocruz Bahia



Dezembro 2022

Convergência de inteligência artificial e humana ao longo do ciclo vital



“Longe de tornar o julgamento humano desnecessário, o aumento do poder dos algoritmos computacionais requer um aumento proporcional do pensamento crítico”

Sabina Leonelli.

"A Pesquisa Científica na Era do BigData" Ed. Fiocruz, 2022

Topol, E. (2019). High-performance medicine: the convergence of human and artificial intelligence Nature Medicine 25(1) <https://dx.doi.org/10.1038/s41591-018-0300-7>

Saúde Digital - Dados para que?

Saúde Pública de Precisão: mais que saúde orientada pela genômica

Digital Technologies: Shaping the future of global health;

... strategic and innovative use of digital technologies will be an essential enabling factor towards ensuring that **1 billion more people benefit from universal health coverage**, that **1 billion more people are better protected from health emergencies**, and that **1 billion more people enjoy better health and well-being** (WHO's triple billion targets ...).



Global Strategy
on Digital Health
2020-2024

Digital technologies for:

- Optimized resource allocation;
- Health surveillance;
- Predict, map and monitor disease patterns;
- Monitor and report adverse effects.



Centro de Integração de Dados e Conhecimento para Saúde @ Fiocruz BA

Sistema complexo de manejo de dados com segurança da informação
princípios éticos e proteção da privacidade.



- Center for Data and Knowledge Integration for Health - Est. 2016;
- Developing and consolidating its data center operational procedures and governance;
- Stringent requirements for access includes appropriate security arrangements, exclusive use for a previously specified purpose, appropriate credentials from the requesting researcher/institution and the sound ethical basis of the research in question.

THE NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Mortality from Congenital Zika Syndrome
— Nationwide Cohort Study in Brazil

DATA TO EVALUATE THE IMPACT OF SOCIAL PROTECTION POLICIES

DATA FOR INVESTIGATING SOCIAL DETERMINANTS OF HEALTH
Socioeconomic determinants of leprosy new case detection
in the 100 Million Brazilian Cohort: a population-based
linkage study

Lancet Glob Health 2019;
7: e1226–36
Published Online
July 19, 2019
[http://dx.doi.org/10.1016/S2214-109X\(19\)30260-8](http://dx.doi.org/10.1016/S2214-109X(19)30260-8)

The effect of primary health care on tuberculosis in a
nationwide cohort of 7.3 million Brazilian people:
a quasi-experimental study

Lancet Glob Health 2022;
10: e390–97
Published Online
January 24, 2022
[https://doi.org/10.1016/S2214-109X\(21\)00550-7](https://doi.org/10.1016/S2214-109X(21)00550-7)

DATA TO EVALUATE THE EFFECTIVENESS OF COVID-19 VACCINES IN THE REAL WORLD

OPEN

Vaccine effectiveness of heterologous CoronaVac
plus BNT162b2 in Brazil

Two-dose ChAdOx1 nCoV-19 vaccine protection against
COVID-19 hospital admissions and deaths over time:
a retrospective, population-based cohort study in Scotland
and Brazil

Lancet 2022; 399: 25–35
Published Online
December 20, 2021
[https://doi.org/10.1016/S0140-6736\(21\)02754-9](https://doi.org/10.1016/S0140-6736(21)02754-9)

Vaccination plus
previous infection:
protection during the
omicron wave in Brazil

Lancet Infect Dis 2022
Published Online
May 16, 2022
[https://doi.org/10.1016/S1473-3099\(22\)00288-2](https://doi.org/10.1016/S1473-3099(22)00288-2)



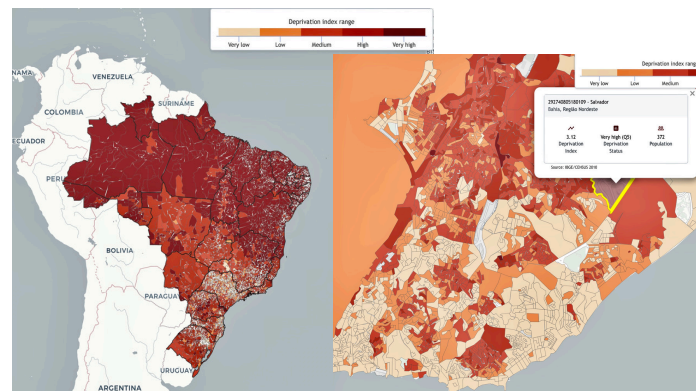
Determinantes sociais da saúde

Identification of areas on primary level alert

Analyses of social economical determinants of health (small-areas deprivation index)



Brazilian Privation Index:
 calculated with information
 on income, education, and
 household characteristics to
 accurately monitor and
 evaluate the conditions of
 deprivation on the
 population's health.



**The 100 million
 Brazilians cohort for
 studying social
 determinants of
 health and the
 evaluation of social
 policies and
 programs on health**

<https://cidacs.bahia.fiocruz.br/ibp/painel-en/>

- Rasella, et. al. *Lancet* 382, 57–64 (2013);
- Pescarini et al. *Am J Epidemiol* 189, kwaa127- (2020).;
- Barreto, M. L.(CIDACS): Linking Health and Social Data in Brazil. *International Journal of Population Data Science* 10.23889/ijpds.v4i2.1140 (2019);
- Allik et al.,Creating small-area deprivation indices: a guide for stages and options. *J Epidemiol Commun H* 74, 20 (2020).



Saúde Pública de Precisão

Alguns exemplos na pandemia:

- **Telecoronavirus;**
- **Efetividade das vacinas anti-COVID-19 no Brasil;**
- **AESOP - Detecção precoce de surtos**





Bridging Learning in Medicine and Citizenship During the COVID-19 Pandemic: A Telehealth-Based Case Study

Thiago Cerqueira-Silva ^{1,2} ; Roberto Carreiro ³ ; Victor Nunes ¹ ; Louran Passos ⁴ ; Bernardo F Canedo ⁵ ; Sofia Andrade ⁵ ; Pablo Ivan P Ramos ³ ; Ricardo Khourj ^{1,2} ; Carolina Barbosa Souza Santos ^{1,6} ; Jedson Dos Santos Nascimento ⁴ ; Aurea Angélica Paste ¹ ; Ivan De Mattos Paiva Filho ^{7,8} ; Marília Santini-Oliveira ⁹ ; Álvaro Cruz ^{1,6} ; Manoel Barral-Netto ^{1,2} ; Viviane Boaventura ^{1,2}

JMIR Public Health Surveill. 2021 Mar 4;7(3):e24795. doi: 10.2196/24795.

version (number 20) of the flowchart, detailing clinical conditions that could lead to potentially poor outcomes.

Figure 1. Summary of the Telecoronavirus flowchart used by volunteers, detailing clinical conditions that could lead to potentially poor outcomes (Bahia, Brazil).

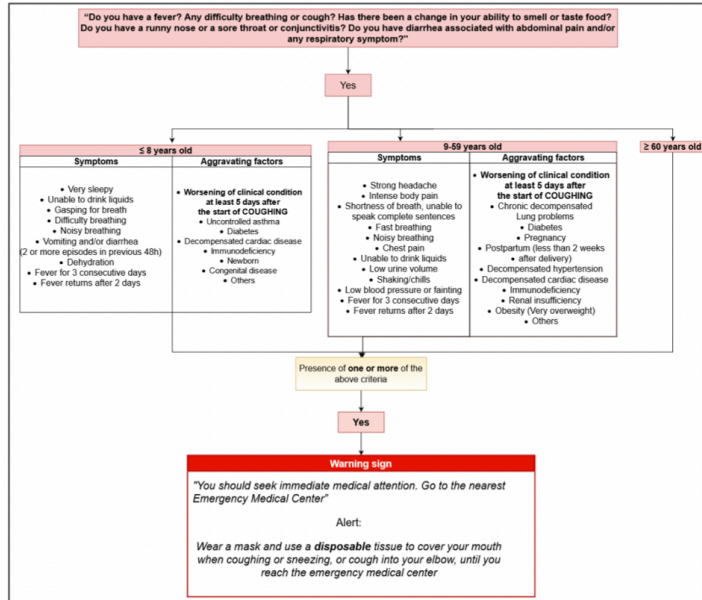
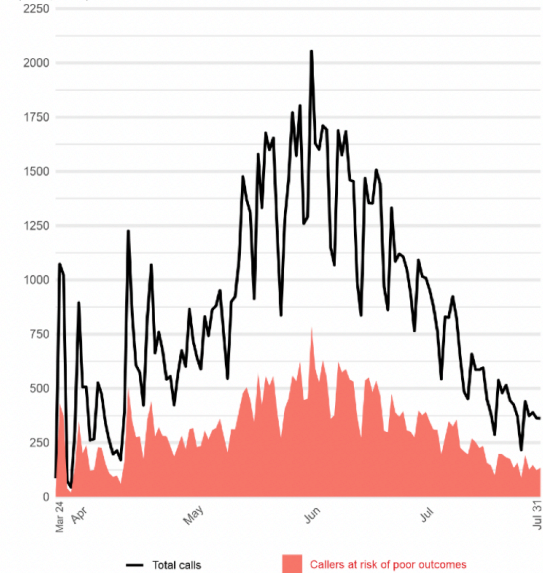


Figure 2. Total number of calls received daily by Telecoronavirus, including the numbers of callers deemed at risk of poor outcomes between March 24 and July 31, 2020 (Bahia, Brazil).



Telecoronavirus - Uso de dados em modelagem

MS enviado

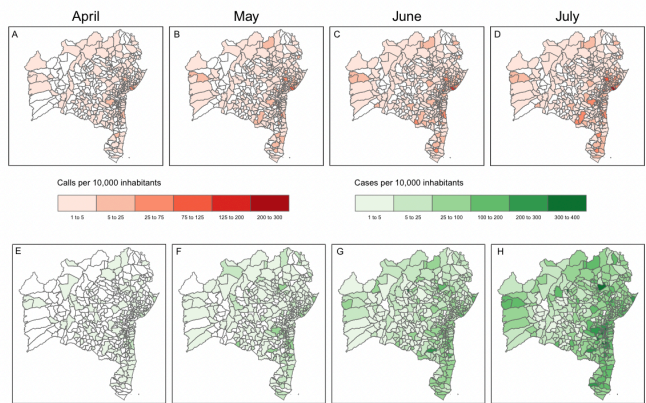
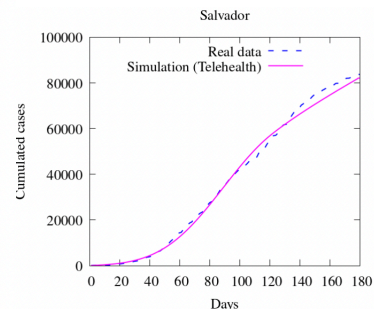
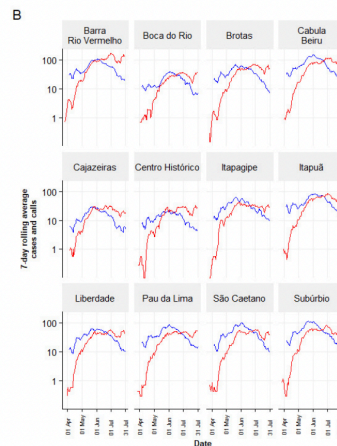
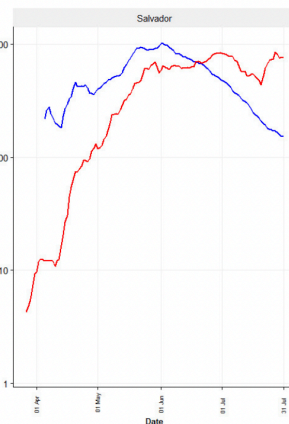


Figure 5: Spatial distribution of calls related to COVID-19-like symptoms and notifications by months of operation of the Telecoronavirus in Bahia state.



— Calls at Telecoronavirus — Confirmed cases of COVID-19



Avaliação da efetividade vacinal

Métodos, Análise e Ética

Base de dados

- eSUS-Notifica: Casos suspeitos e confirmados de COVID-19;
- SIVEP-Gripe: Casos de síndrome respiratória aguda grave;
- PNI: Vacinação contra COVID-19.
- **Linkage**: Determinístico através de uma chave única fornecida pelo DATASUS.

Desenho e Análise Estatística

- Estudo caso x controle teste-negativo;
- Processamento de dados e análises no R;
- Regressão logística
 - Modelo linear generalizado
 - Condicional
 - Modelo aditivo generalizado.

Aspectos éticos

- Dados manipulados em ambiente seguro.
- Aprovação na CONEP número 4.921.308



Efeito da idade e redução temporal da proteção

VOLUME 6, 100154, FEBRUARY 01, 2022

Influence of age on the effectiveness and duration of protection of Vaxzevria and CoronaVac vaccines: A population-based study

Thiago Cerqueira-Silva ¹ • Vinicius de Araújo Oliveira ¹ • Viviane S. Boaventura ¹ • Julia M. Pescarini • Juracy Bertoldo Júnior • Tales Mota Machado • et al. [Show all authors](#) • [Show footnotes](#)

[Open Access](#) • Published: December 21, 2021 • DOI: <https://doi.org/10.1016/j.iana.2021.100154> •

ARTICLES | VOLUME 399, ISSUE 10319, P25-35, JANUARY 01, 2022

Two-dose ChAdOx1 nCoV-19 vaccine protection against COVID-19 hospital admissions and deaths over time: a retrospective, population-based cohort study in Scotland and Brazil

Prof Srinivasa Vittal Katikireddi, PhD * • Thiago Cerqueira-Silva * • Eleftheria Vasileiou, PhD * • Prof Chris Robertson, PhD * • Sarah Amele, PhD • Jiafeng Pan, PhD • et al. [Show all authors](#) • [Show footnotes](#)

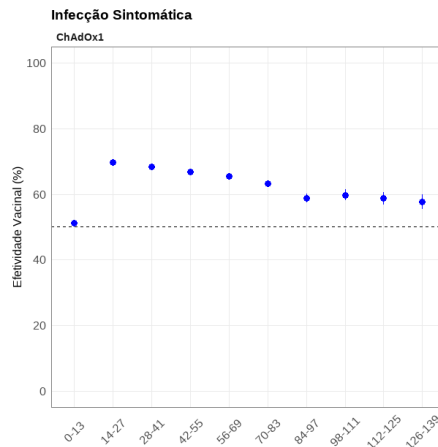
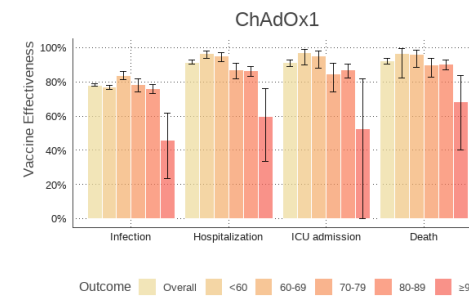
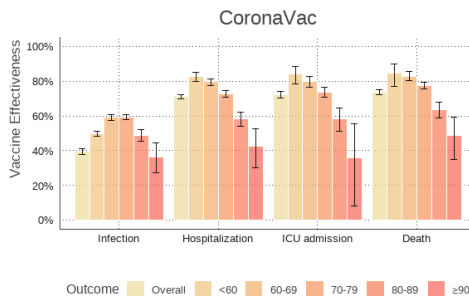
[Open Access](#) • Published: December 20, 2021 • DOI: [https://doi.org/10.1016/S0140-6736\(21\)02754-9](https://doi.org/10.1016/S0140-6736(21)02754-9) •

Article | [Open Access](#) | [Published: 09 February 2022](#)

Vaccine effectiveness of heterologous CoronaVac plus BNT162b2 in Brazil

Thiago Cerqueira-Silva, Srinivasa Vittal Katikireddi, Vinicius de Araújo Oliveira, Renzo Flores-Ortiz, Juracy Bertoldo Júnior, Enny S. Paixão, Chris Robertson, Gerson O. Penna, Guilherme L. Werneck, Maurício L. Barreto, Neil Pearce, Aziz Sheikh, Manoel Barral-Netto & Viviane S. Boaventura [✉](#)

Nature Medicine **28**, 838–843 (2022) | [Cite this article](#)



Efeito da infecção prévia e decaimento tempo-dependente da proteção

ARTICLES | VOLUME 22, ISSUE 6, P791-801, JUNE 01, 2022

Effectiveness of CoronaVac, ChAdOx1 nCoV-19, BNT162b2, and Ad26.COV2.S among individuals with previous SARS-CoV-2 infection in Brazil: a test-negative, case-control study

Thiago Cerqueira-Silva, MD * · Jason R Andrews, MD * · Prof Viviane S Boaventura, MD · Otavio T Ranzani, PhD · Vinicius de Araújo Oliveira, MD · Enny S Paixão, PhD · et al. [Show all authors](#) · [Show footnotes](#)

Published: March 31, 2022 · DOI: [https://doi.org/10.1016/S1473-3099\(22\)00140-2](https://doi.org/10.1016/S1473-3099(22)00140-2)



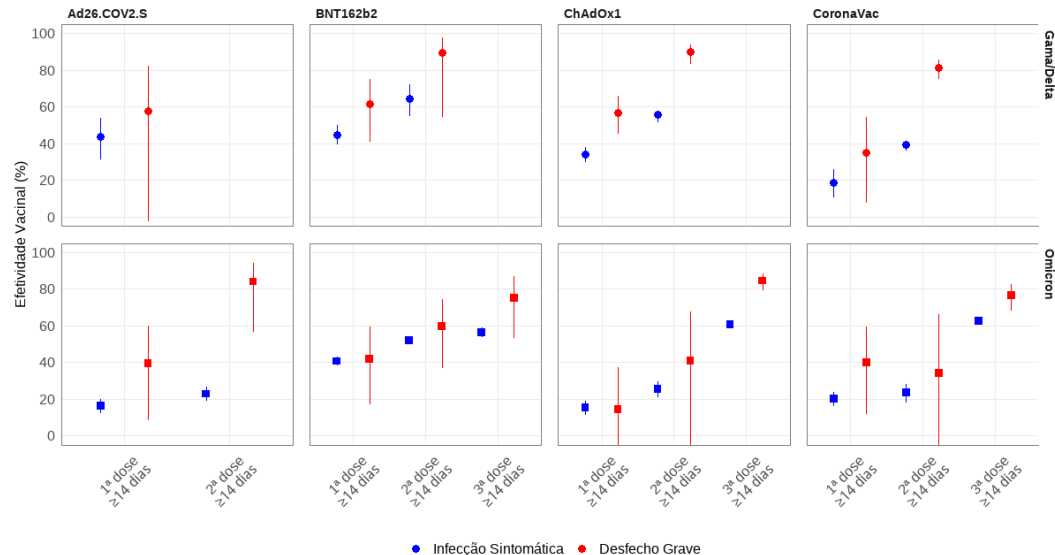
CORRESPONDENCE | VOLUME 22, ISSUE 7, P945-946, JULY 01, 2022

Vaccination plus previous infection: protection during the omicron wave in Brazil

Thiago Cerqueira-Silva · Vinicius de Araujo Oliveira · Enny S Paixão · Pilar Tavares Veras Florentino · Gerson O Penna · Neil Pearce · et al. [Show all authors](#)

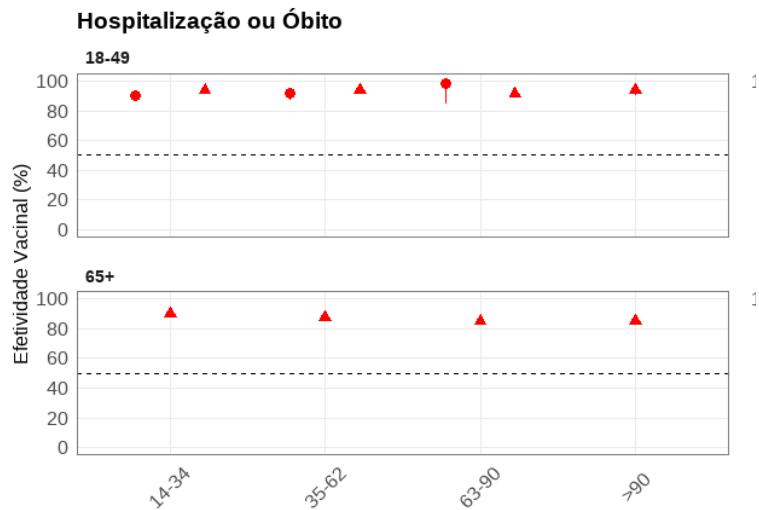
Published: May 16, 2022 · DOI: [https://doi.org/10.1016/S1473-3099\(22\)00288-2](https://doi.org/10.1016/S1473-3099(22)00288-2)

Grupo de referência: Indivíduos com infecção prévia não vacinados

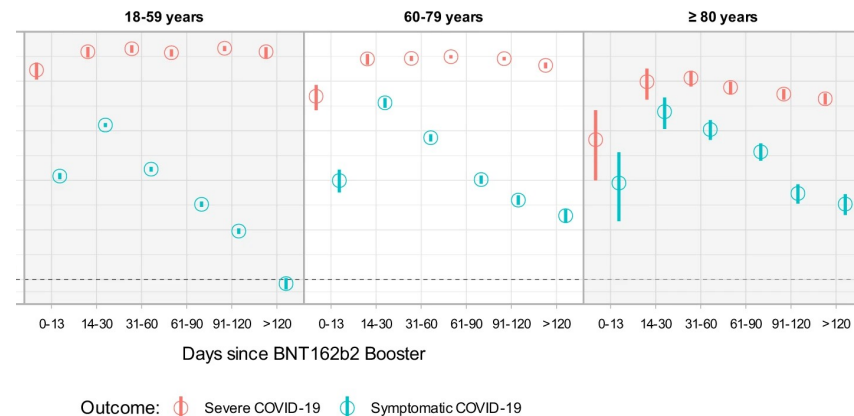


Dose de Reforço Pfizer

Restabelecimento da proteção contra hospitalização ou óbito, com evidência de decaimento nos idosos



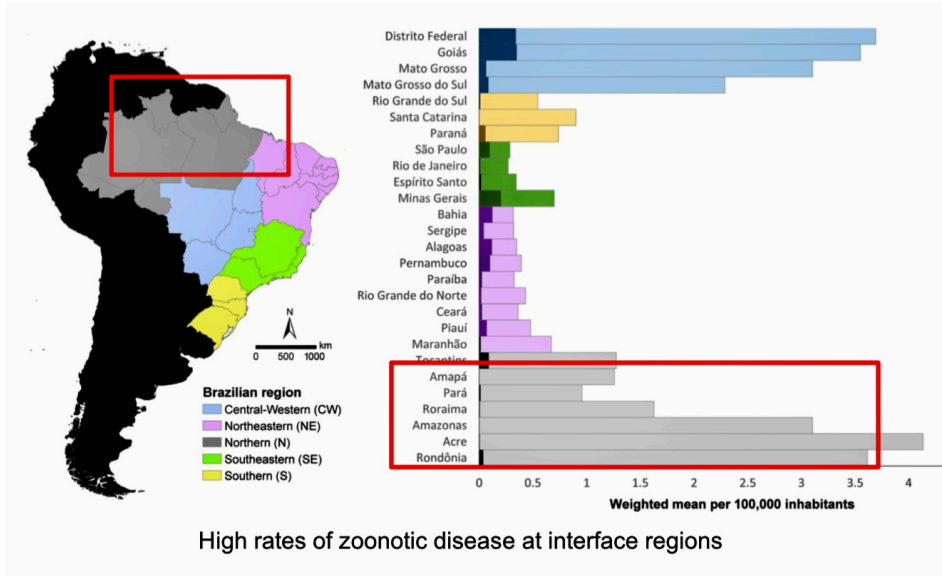
Duration of protection of CoronaVac (2x) + BNT162b2 booster - Omicron



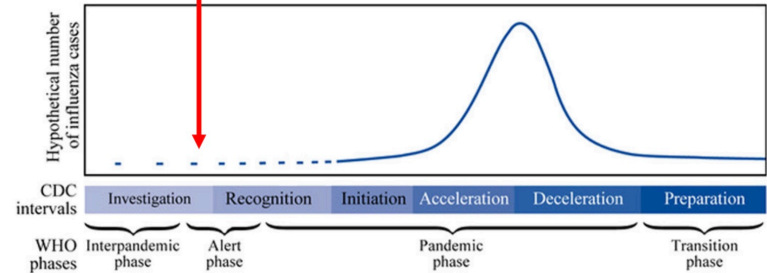
- **Effectiveness of BNT162b2 booster after CoronaVac primary regimen in pregnant people during omicron period in Brazil.** Florentino PTV, et al. *Lancet Infect Dis* (2022)
- **Vaccine effectiveness of CoronaVac against COVID-19 among children in Brazil during the Omicron period.** Florentino PTV, et al.. *Nat Commun* 13, 4756 (2022). <https://doi.org/10.1038/s41467-022-32524-5>
- **Vaccine effectiveness of two-dose BNT162b2 against symptomatic and severe COVID-19 among adolescents in Brazil and Scotland over time: a test-negative case-control study.** Florentino PTV, et al.. *Lancet Infect Dis* 2022 Published online August 8, 2022 [10.1016/S1473-3099\(22\)00451-0](https://doi.org/10.1016/S1473-3099(22)00451-0)
- **Duration of protection of CoronaVac plus heterologous BNT162b2 booster in the Omicron period in Brazil.** Cerqueira-Silva T. et al. *Nat Commun* 13, 4154 (2022). <https://www.nature.com/articles/s41467-022-31839-7>
- **Vaccination plus previous infection: protection during the omicron wave in Brazil.** Cerqueira-Silva T. et al. *Lancet Infect Dis* 2022 [https://doi.org/10.1016/S1473-3099\(22\)00288-2](https://doi.org/10.1016/S1473-3099(22)00288-2) [https://www.thelancet.com/pdfs/journals/laninf/PIIS1473-3099\(22\)00288-2.pdf](https://www.thelancet.com/pdfs/journals/laninf/PIIS1473-3099(22)00288-2.pdf)
- **CoronaVac vaccine is effective in preventing symptomatic and severe Covid-19 in pregnant women in Brazil: a test-negative case-control study.** Enny S. Paixao^{*}, Kerry LM Wong, Flavia Jôse Oliveira Alves, Vinicius de Araújo Oliveira, Thiago Cerqueira-Silva, Juracy Bertoldo Júnior, Tales Mota Machado, Elzo Pereira Pinto Junior, Viviane S Boaventura, Gerson O. Penna, Guilherme Loureiro Werneck, Laura C. Rodrigues, Neil Pearce, Mauricio L. Barreto, Manoel Barral-Netto. *BMC Medicine* (2022) 20:146 <https://doi.org/10.1186/s12916-022-02353-w>
- **Effectiveness of CoronaVac, ChAdOx1 nCoV-19, BNT162b2, and Ad26.COVS.2.S among individuals with previous SARS-CoV-2 infection in Brazil: a test-negative, case-control study.** Cerqueira-Silva T. et al. *Lancet Infect Dis* 2022. [https://doi.org/10.1016/S1473-3099\(22\)00140-2](https://doi.org/10.1016/S1473-3099(22)00140-2)
- **Vaccine effectiveness of heterologous CoronaVac plus BNT162b2 in Brazil.** Cerqueira-Silva T. et al. *Nat Med* 28, 838–843 2022 <https://doi.org/10.1038/s41591-022-01701-w>
- **Two-dose ChAdOx1 nCoV-19 vaccine protection against COVID-19 hospital admissions and deaths over time: a retrospective, population-based cohort study in Scotland and Brazil.** Srinivasa Vittal Katikireddi V., Cerqueira-Silva T. et al. *Lancet* 2022; 399: 25–35. doi:10.1016/S0140-6736(21)02754-9
- **Influence of age on the effectiveness and duration of protection of Vaxzevria and CoronaVac vaccines: A population-based study.** Cerqueira-Silva T. et al.. *The Lancet Regional Health - Americas* 2022;6: 100154 <https://doi.org/10.1016/j.lana.2021.100154>



Novas epi/pandemias podem se originar no Brasil

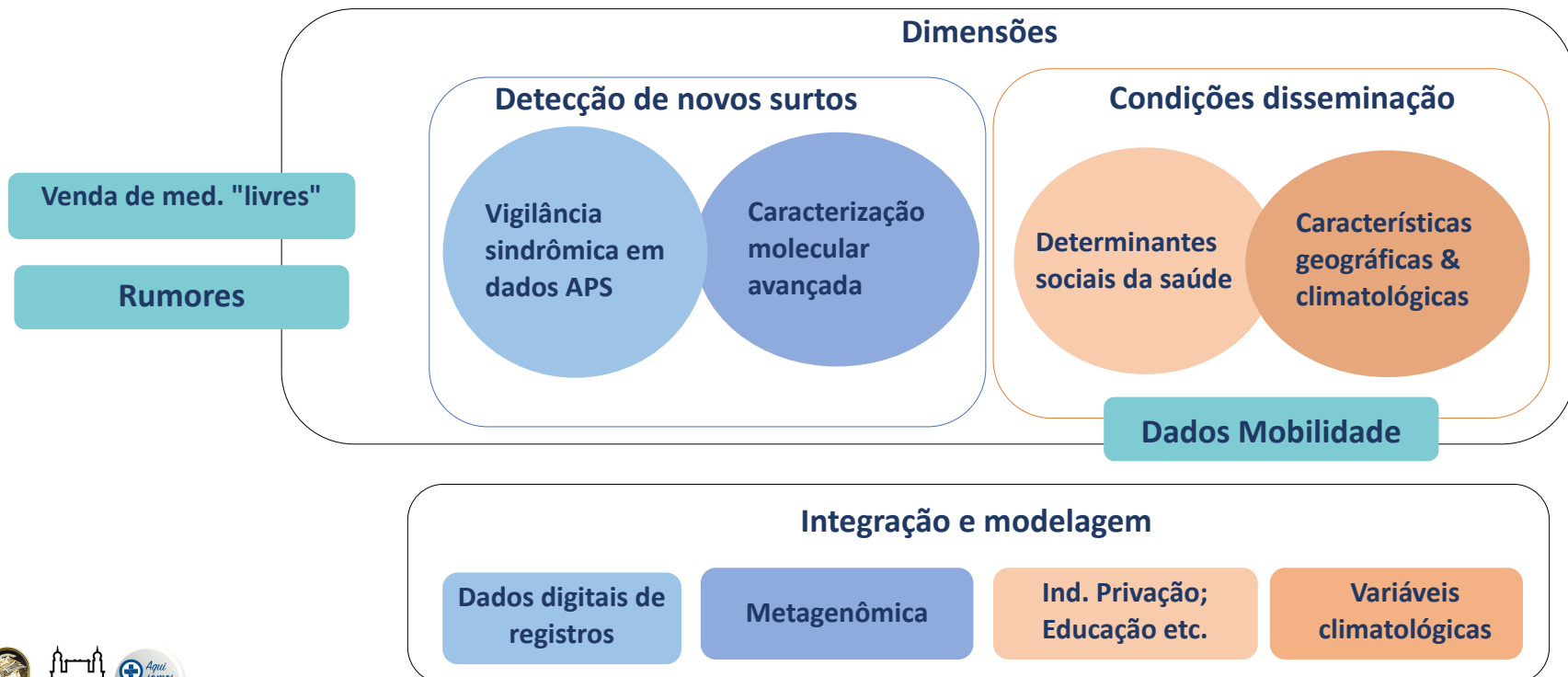


We need to act Early



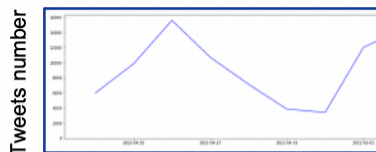
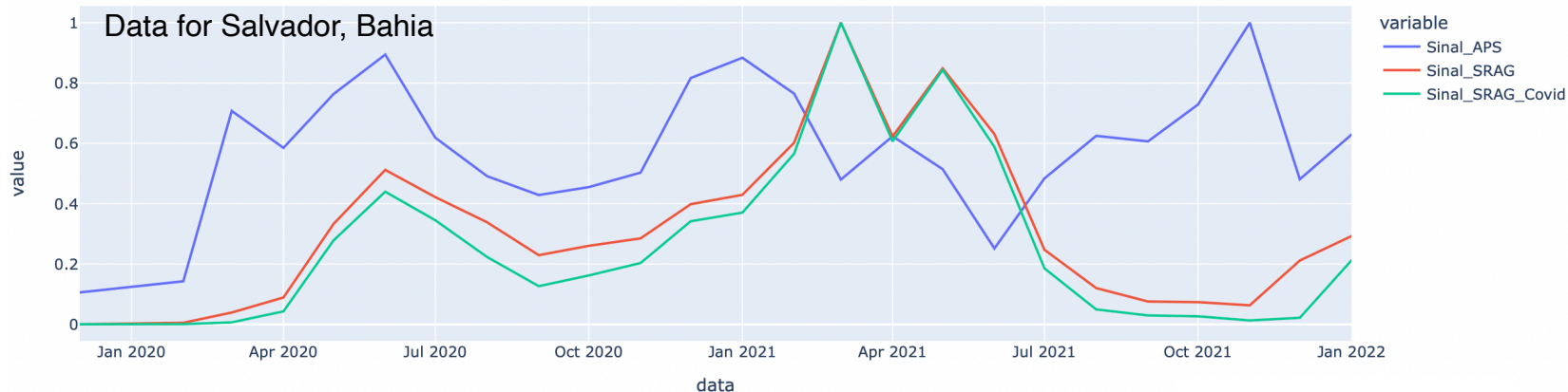
Vinck et al. *Science Advances*, 2022. 10.1126/sciadv.abo5774

Elementos para caracterização de surtos e avaliação do risco de disseminação



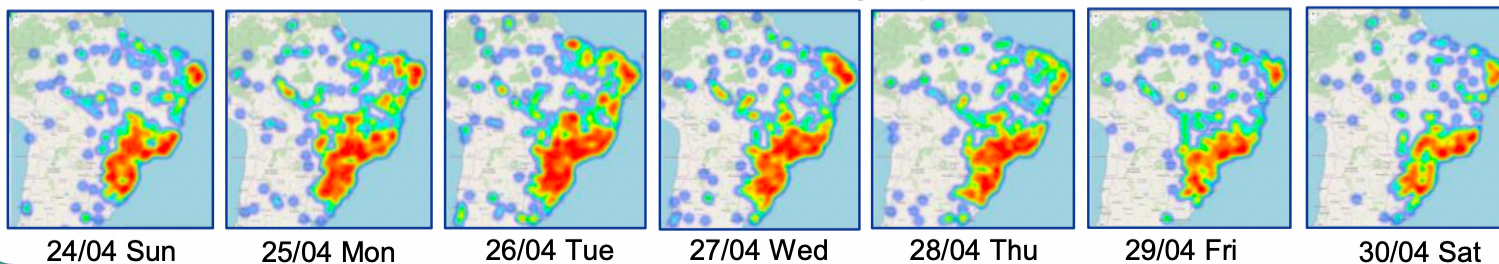
Vigilância nacional contínua de dados epidemiológicos

Dados nacionais da APS no nível municipal



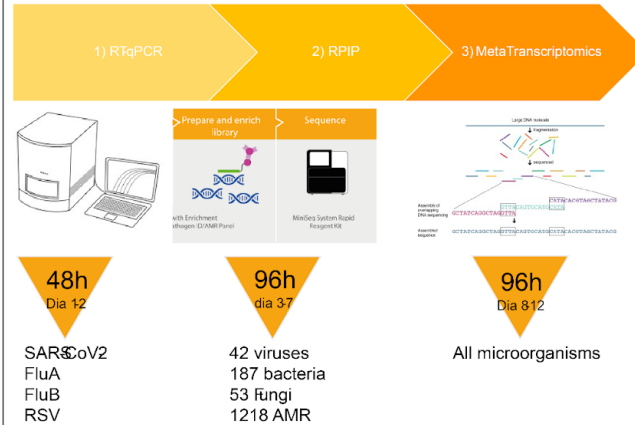
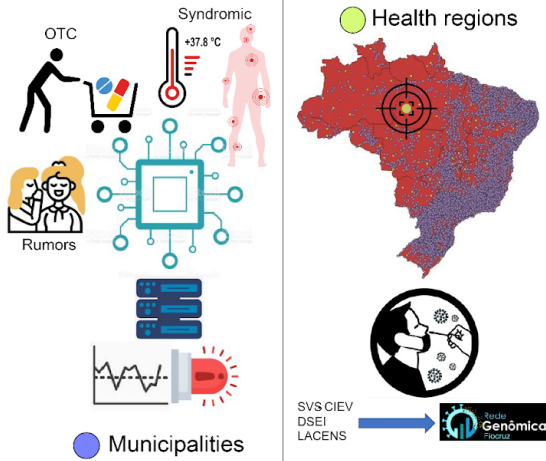
Epidemiological Week 17

AESOP first phase: heatmap sample of tweets obtained with symptoms

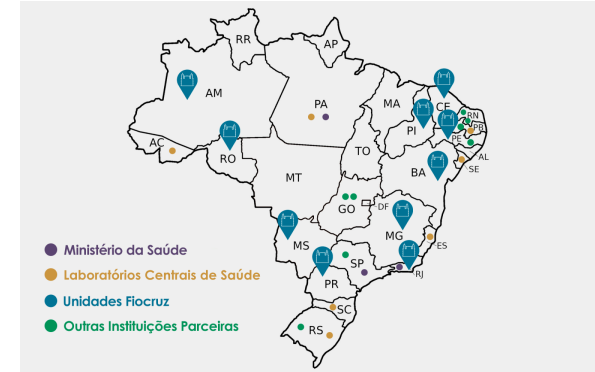


Etapas de sensibilidade e especificidade do AESOP

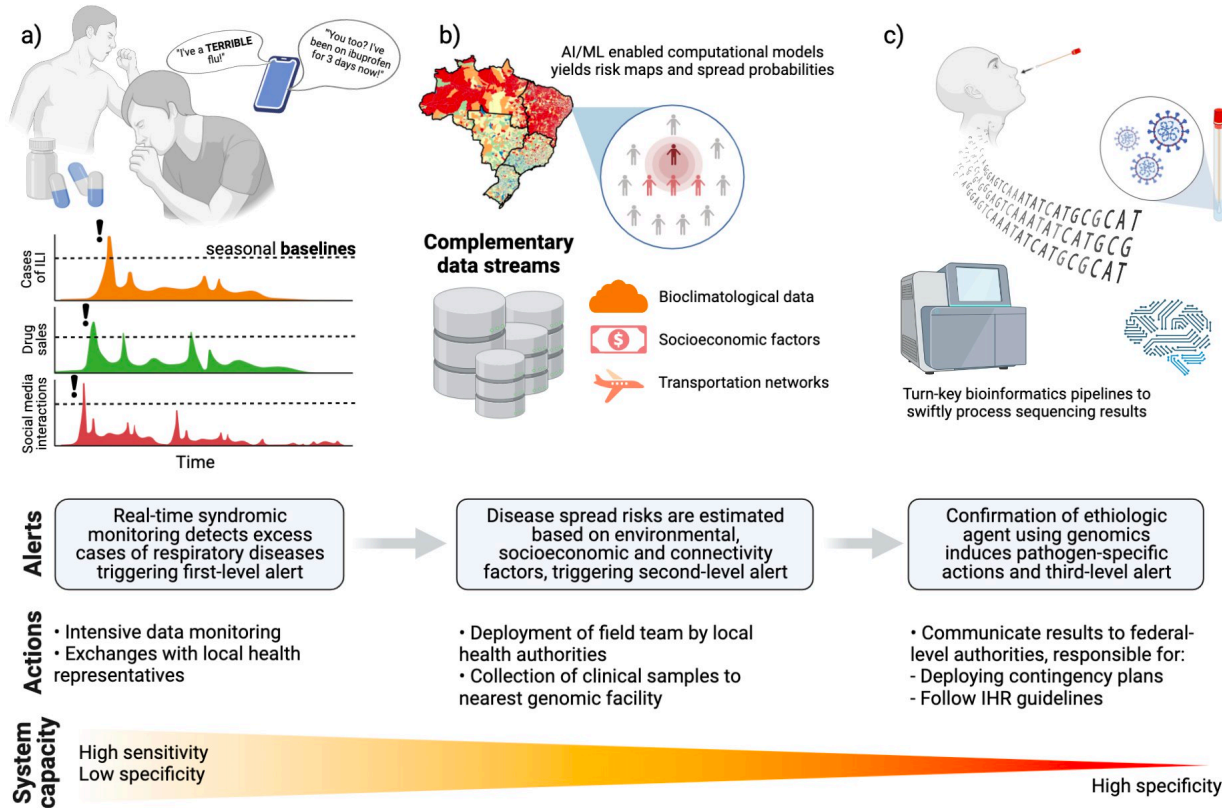
From clinically-related signs to molecular pathogen characterization



Fiocruz Genomic Network



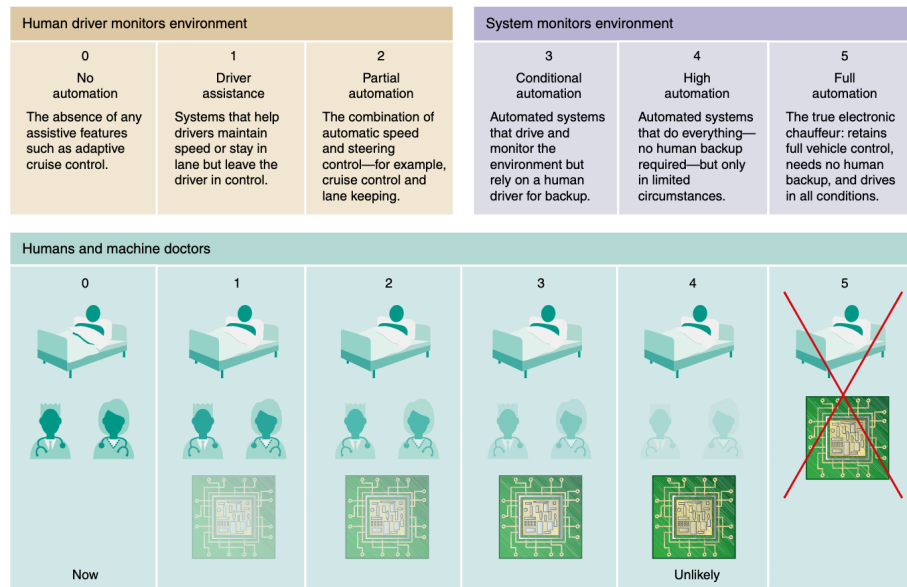
AESOP - Visão geral



A Saúde Digital requer literacia digital dos prof de saúde e dos cidadãos

A capacitação digital é fundamental para promover a equidade

- A Saúde Digital já está presente e em expansão crescente;
- O avanço da Saúde Digital terá impacto nas profissões da saúde;
- Não ocorrerá a curto prazo uma substituição total de pessoal, mas haverá uma menor necessidade numérica;
- Além do pessoal da saúde, os cidadãos precisam de letramento digital para garantir a sua autonomia.



Topol, E. (2019). High-performance medicine: the convergence of human and artificial intelligence Nature Medicine 25(1)<https://dx.doi.org/10.1038/s41591-018-0300-7>



Como garantir a incorporação equânime da Saúde Digital no SUS?

