Digital Health Algorithms

Transforming Care and Advancing Health Equity

Rainer Tan, MD, PhD

Department of Vulnerabilities and Social Medicine - Unisanté

Rainer.Tan@unisante.ch

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Photo: Magali Rochat

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Challenges of primary care

Limited training, mentorship & supervision[1-3]

Limited diagnostic tests[4]

Staff shortages
Budget constraints
High Case loads[1,2]

Ref: [1]Kruk, Health Policy, 2008; [2]Brugha, Health Polcy Plan, 1998; [3]Mullan, Lancet, 2007; [4]Fleming, Lancet 2021

Photo: Magali Rochat

Challenges of primary care

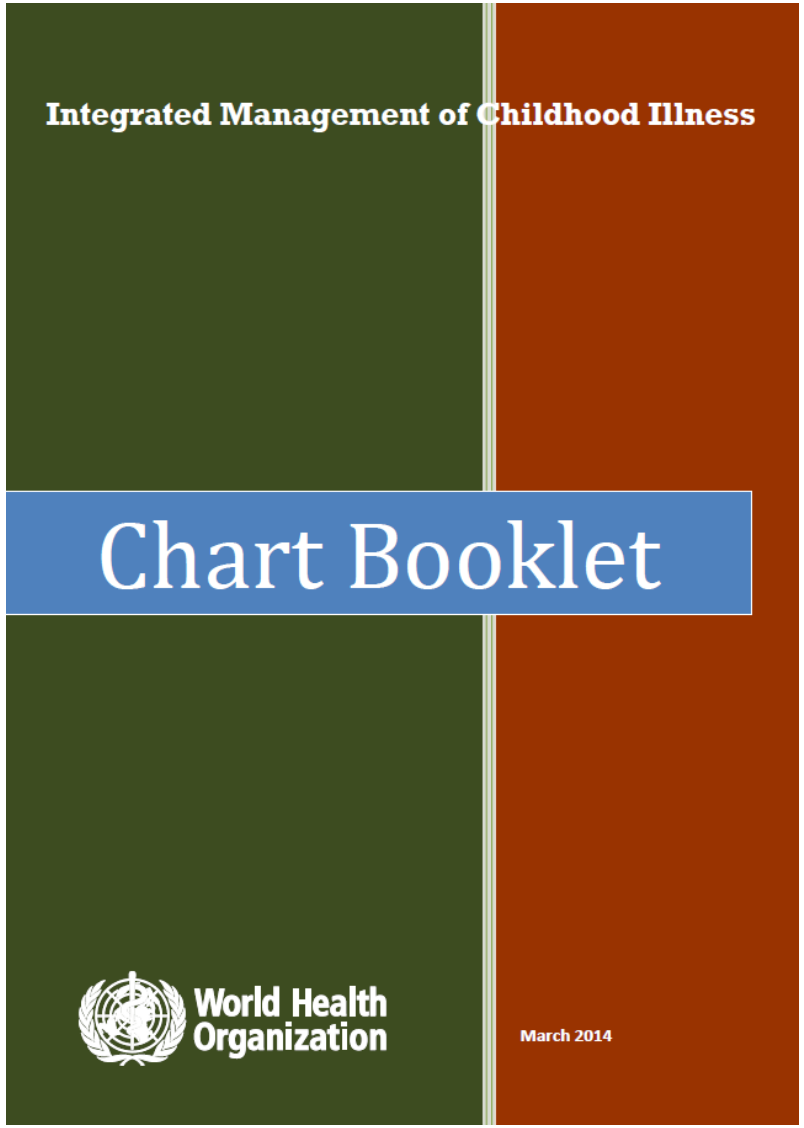
Poor Quality of Care[1-3]

High mortality & morbidity[4-5]

Ref: [1]Kruk, Bulletin WHO, 2017; [2]Das, J Econ Perspect, 2008; [3]Kruk, Health Services Research, 2018; [4]You, Lancet, 2015; [5]Hug, Lancet GH, 2019

Photo: Magali Rochat

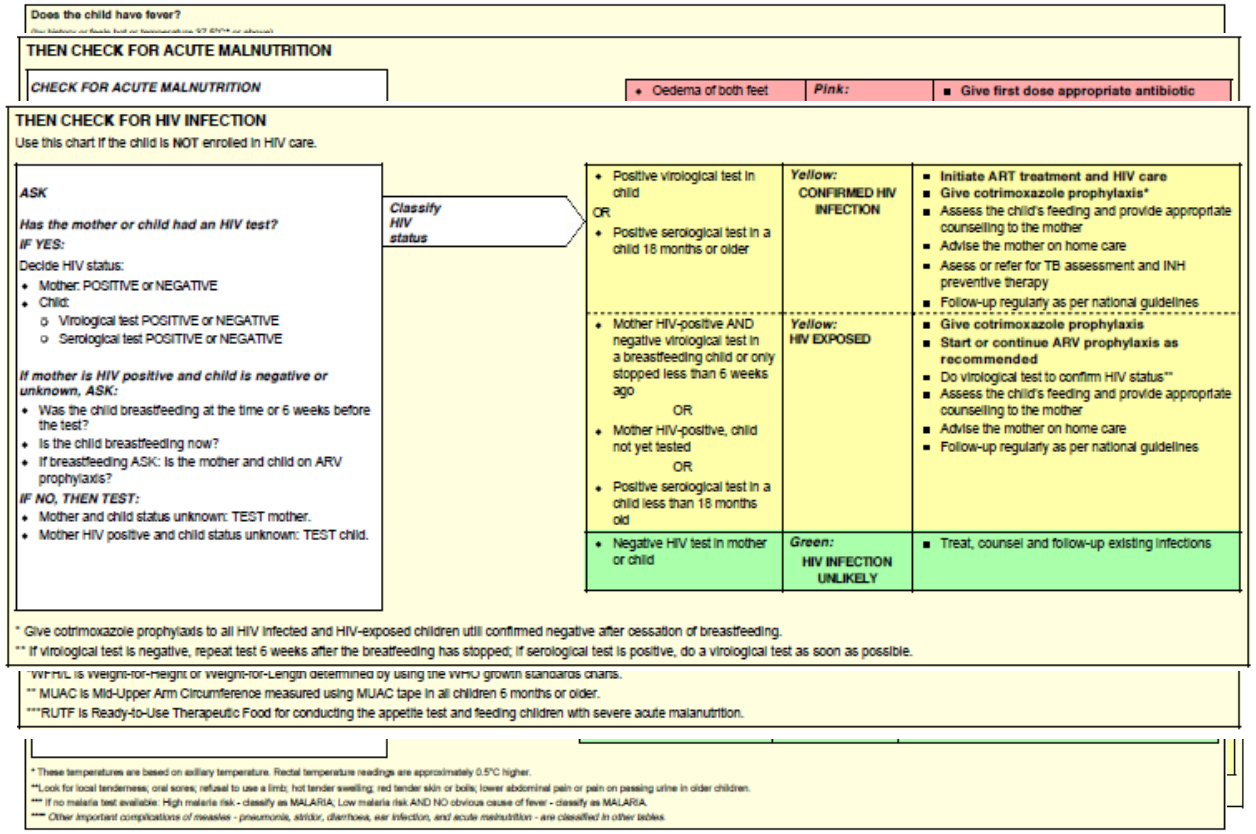
Guidelines to improve quality of care for children



- **Widespread support and implementation [1]**
- **Possible reduction in mortality [1]**
- **Challenges with implementation [2-5]:**
  - Adherence
  - Training
  - Monitoring

Ref: [1]Gera, Cochrane, 2016; [2]Renosa, Global Health Action, 2020; [3]Kruger, BMC Health Serv Res, 2017; [4]Kilov, BMJ Paediatr Open, 2021; [5]Kiplagat, BMC Public Health, 2014

Guidelines and CDSAs for antibiotic stewardship



Does the child have fever?

THEN CHECK FOR ACUTE MALNUTRITION

CHECK FOR ACUTE MALNUTRITION

• Oedema of both feet	*Pink:*	▪ **Give first dose appropriate antibiotic**

THEN CHECK FOR HIV INFECTION

Use this chart if the child is **NOT** enrolled in HIV care.

ASK

Has the mother or child had an HIV test?

IF YES:

Decide HIV status:

- Mother: POSITIVE or NEGATIVE
- Child:
  - Virological test POSITIVE or NEGATIVE
  - Serological test POSITIVE or NEGATIVE

If mother is HIV positive and child is negative or unknown, ASK:

- Was the child breastfeeding at the time or 6 weeks before the test?
- Is the child breastfeeding now?
- If breastfeeding ASK: Is the mother and child on ARV prophylaxis?

IF NO, THEN TEST:

- Mother and child status unknown: TEST mother.
- Mother HIV positive and child status unknown: TEST child.

Classify HIV status

• Positive virological test in child OR • Positive serological test in a child 18 months or older	*Yellow:* **CONFIRMED HIV INFECTION**	▪ **Initiate ART treatment and HIV care** ▪ **Give cotrimoxazole prophylaxis*** ▪ Assess the child's feeding and provide appropriate counselling to the mother ▪ Advise the mother on home care ▪ Asess or refer for TB assessment and INH preventive therapy ▪ Follow-up regularly as per national guidelines
• Mother HIV-positive AND negative virological test in a breastfeeding child or only stopped less than 6 weeks ago OR • Mother HIV-positive, child not yet tested OR • Positive serological test in a child less than 18 months old	*Yellow:* **HIV EXPOSED**	▪ **Give cotrimoxazole prophylaxis** ▪ **Start or continue ARV prophylaxis as recommended** ▪ Do virological test to confirm HIV status** ▪ Assess the child's feeding and provide appropriate counselling to the mother ▪ Advise the mother on home care ▪ Follow-up regularly as per national guidelines
• Negative HIV test in mother or child	*Green:* **HIV INFECTION UNLIKELY**	▪ Treat, counsel and follow-up existing infections

* Give cotrimoxazole prophylaxis to all HIV infected and HIV-exposed children until confirmed negative after cessation of breastfeeding.

** If virological test is negative, repeat test 6 weeks after the breastfeeding has stopped; if serological test is positive, do a virological test as soon as possible.

WFH/L is Weight-for-Height or Weight-for-Length determined by using the WHO growth standards charts.

** MUAC is Mid-Upper Arm Circumference measured using MUAC tape in all children 6 months or older.

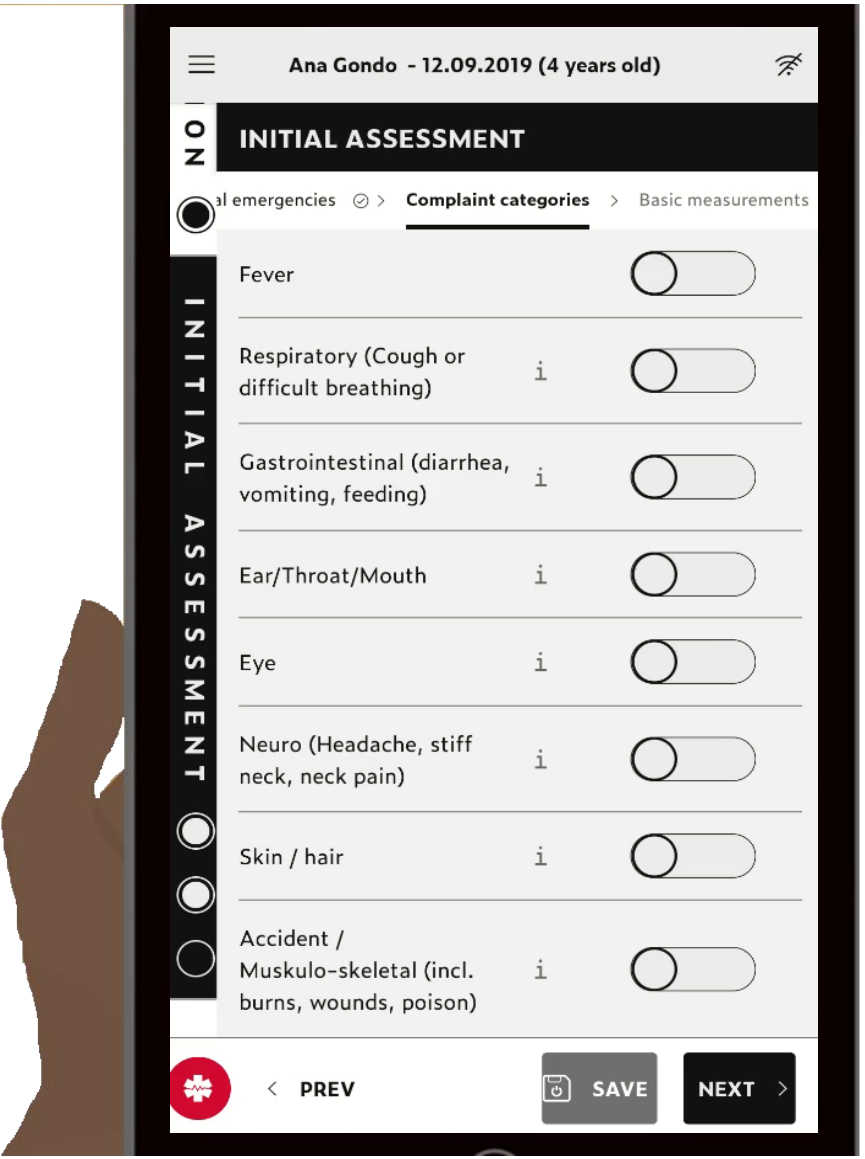
***RUTF is Ready-to-Use Therapeutic Food for conducting the appetite test and feeding children with severe acute malnutrition.

* These temperatures are based on axillary temperature. Rectal temperature readings are approximately 0.5°C higher.

**Look for local tenderness; oral sores; refusal to use a limb; hot tender swelling; red tender skin or boils; lower abdominal pain or pain on passing urine in older children.

*** If no malaria test available: High malaria risk - classify as MALARIA; Low malaria risk AND NO obvious cause of fever - classify as MALARIA.

**** *Other important complications of measles - pneumonia, stridor, diarrhoea, ear infection, and acute malnutrition - are classified in other tables.*



ePOCT+
Clinical Decision Support Algorithm

Dynamic

C-Reactive Protein &
Hemoglobin point-of-care tests

Pulse Oximeter

Dashboard on quality of care indicators

Mentorship support

Ref: Tan, PLOS Digital Health, 2023

Tanzania

20 Health Facilities

20 Health Facilities

Dynamic

- 1 Dec 2021 to 31 Oct 2022
- Sick children
- Age 1 day to 15 years

Ref: Tan et al., Nature Medicine 2024

20 Health Facilities

23,593 enrolled

17,985 using ePOCT+

76% Uptake

20 Health Facilities

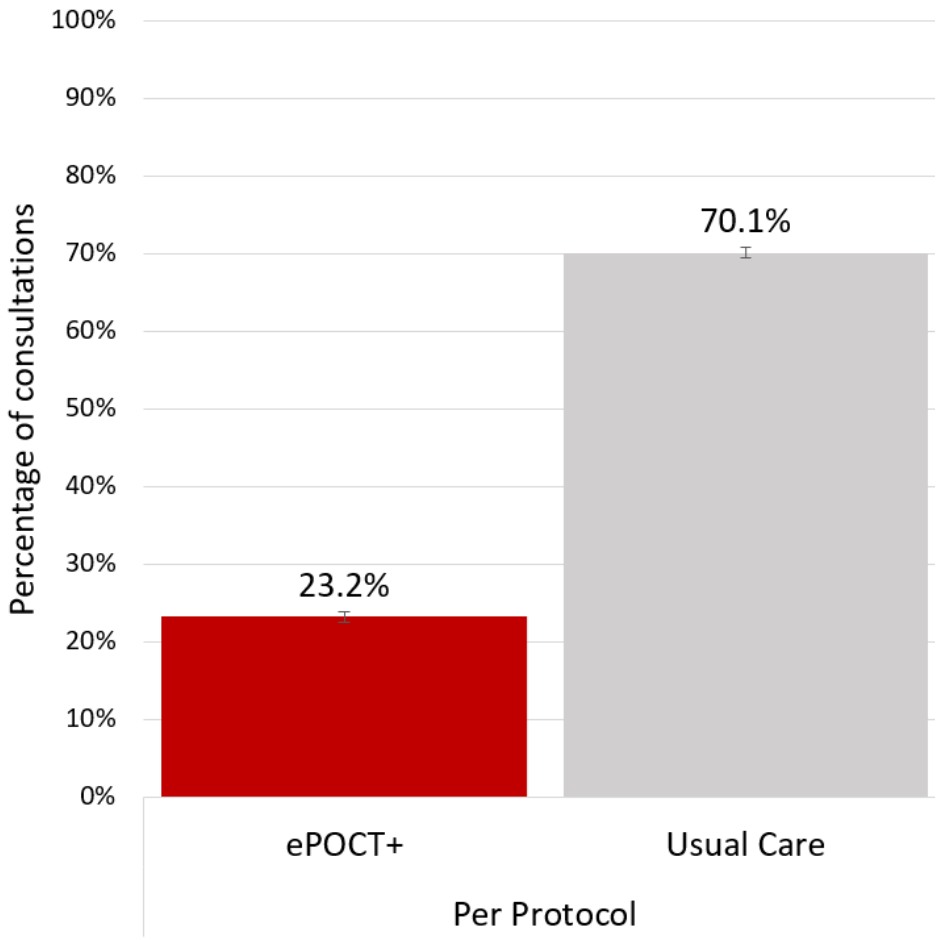
20,713 enrolled

18,937 using eCRF

91% Uptake

Ref: Tan et al., Nature Medicine 2024

Co-Primary Endpoint: Day 0 Antibiotic Prescription

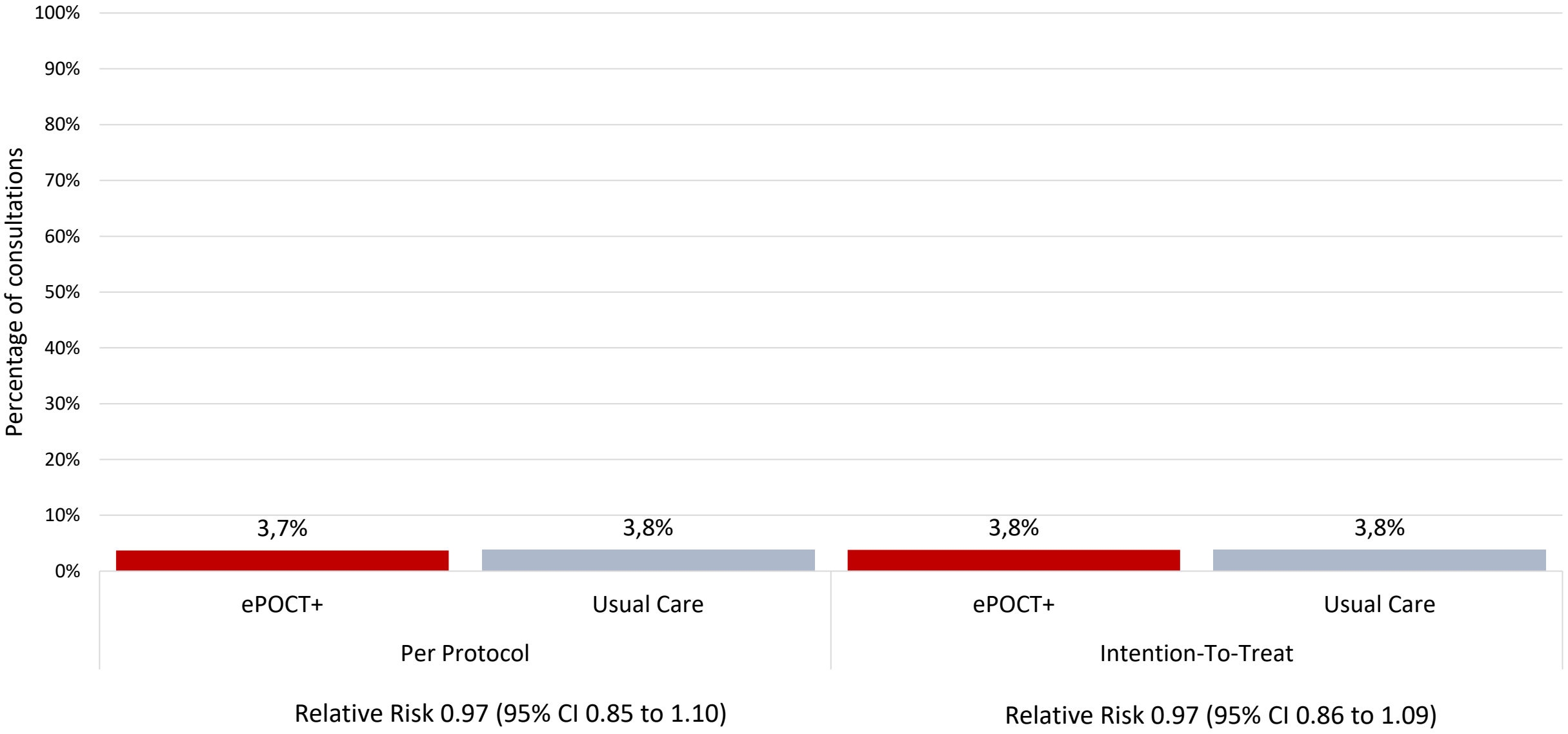


Difference -46.4% (95% CI, -57.6% to -35.2%)

Relative Risk 0.35 (95% CI 0.29 to 0.43)

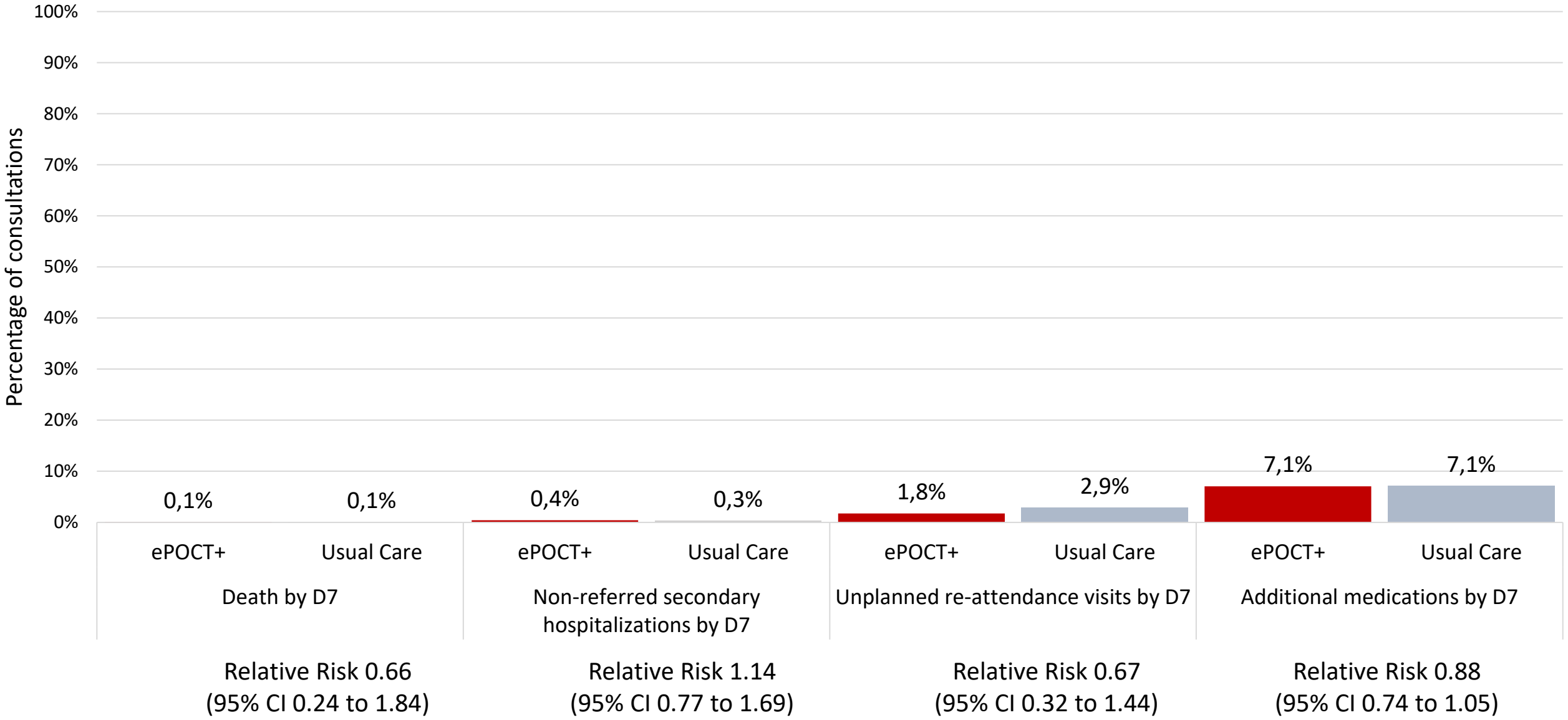
Ref: Tan et al., Nature Medicine 2024

Co-Primary Safety Endpoint: Day 7 Clinical Failure



Ref: Tan et al., Nature Medicine 2024

Secondary Endpoints



Relative Risk 0.66
(95% CI 0.24 to 1.84)

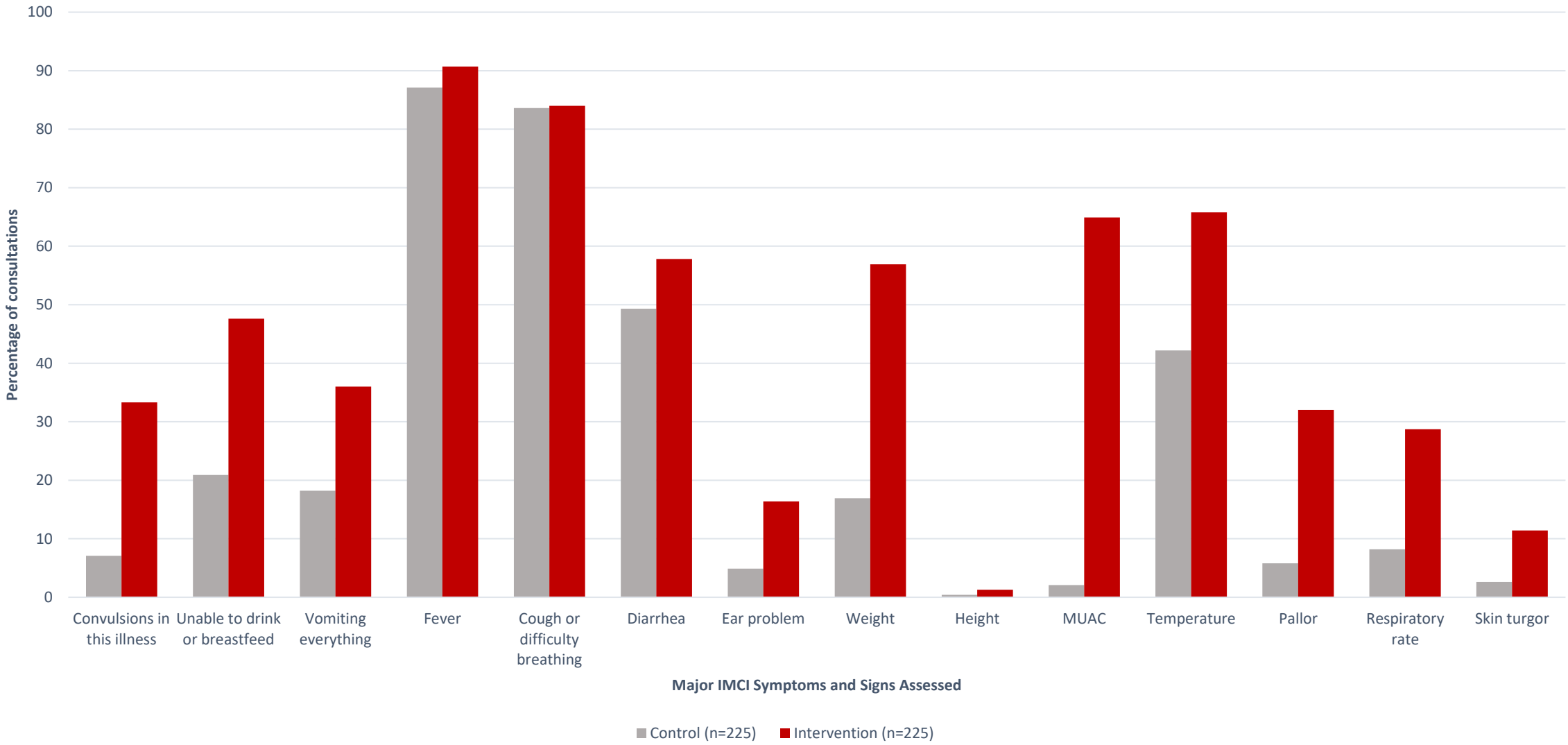
Relative Risk 1.14
(95% CI 0.77 to 1.69)

Relative Risk 0.67
(95% CI 0.32 to 1.44)

Relative Risk 0.88
(95% CI 0.74 to 1.05)

Ref: Tan et al., Nature Medicine 2024

Adherence to guidelines



Ref: Tan & Kavishe et al., PLOS DH *in press*

Qualitative and Mixed-method findings

- All 32 HCWs surveyed were satisfied with the ePOCT+ tools, and trusted the suggested diagnoses and treatment.

*"…It **helps in identifying the correct diagnosis** when the child presents with confusing symptoms/signs…"*
Experienced clinical officer

*"…It **makes us perform some measurements that we do not usually do** all the time, like measuring the temperature…"* *Registered nurse*


Photo: L Cobuccio

Ref: G Ashery et al. *in preparation*

Racism, xenophobia, and unconscious bias

- Xxxxxx xxxx
- Xxxxx xx
- Xxxx xxx xx
- Xx xxx

- Xxxxxx xxxx
- Xxxxx xx
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- Xx xxx

- Xxxxxx xxxx
- Xxxxx xx
- Xxxx xxx xx
- Xx xxx

353 Primary Care physicians evaluated the urgency of care for patients with back pain, chest pain or an injury based on clinical vignettes

Ref: Drewniak, Social Science & Medicine, 2016

Sexism and unconscious biases

Picture copyright: Freepik

672 patients at primary care in Switzerland with chest pain (women n=352; men n=320)

Referral to cardiologist: Men 2.5x > Women

Prevalence of chest pain of cardiovascular origin: 17.5% in men; 14.8% in women (p=0.4)

Ref: Liaudat, et al. Women's health 2018

Recognize the problem

Be conscious that we all have biases

Implicit biases have negative effects on the management of racialized patients

Question yourself

Before every clinical decision ask yourself: «Did I manage this patient like I would with others?»

Be systematic

Follow protocols, checklists or algorithms

Develop cultural humility

Recognize ones biases

Be curious, humble, and open

Ref: Adapted from Blandenier et al. Rev Med Suisse; *in press*

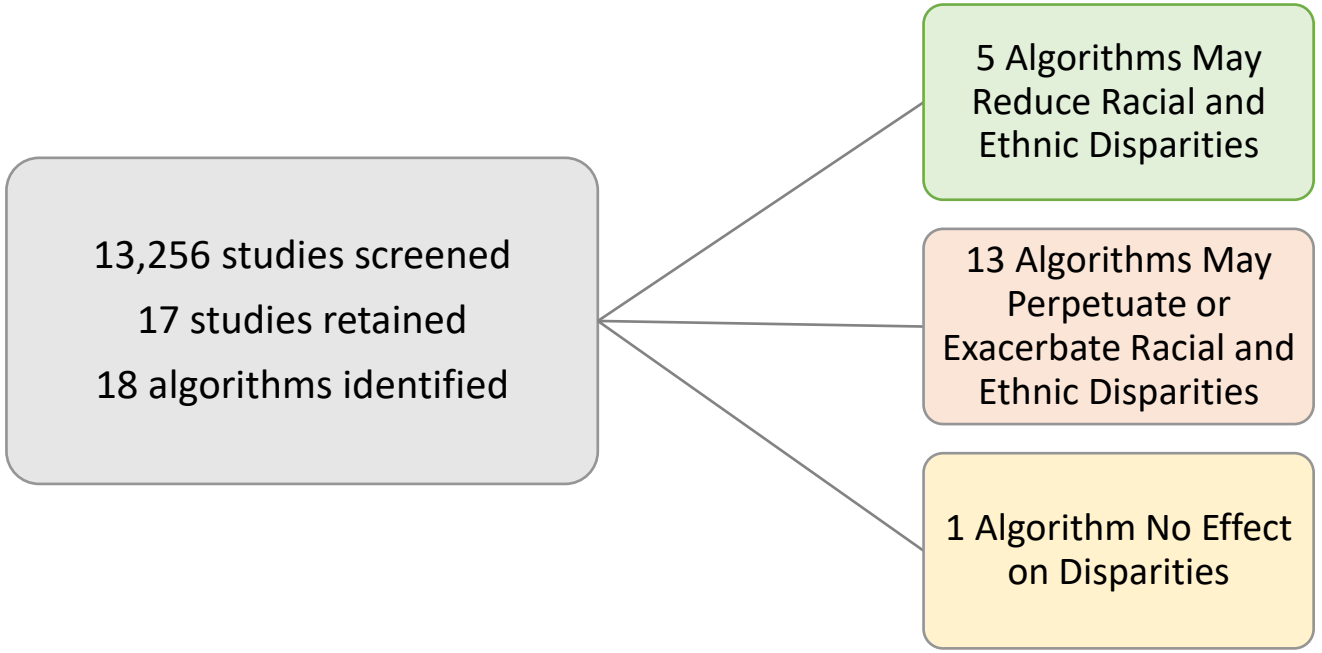
REVIEW

Annals of Internal Medicine

The Impact of Health Care Algorithms on Racial and Ethnic Disparities

A Systematic Review

Shazia Mehmood Siddique, MD, MSHP; Kelley Tipton, MPH; Brian Leas, MS; Christopher Jepson, PhD; Jaya Aysola, MD, MPH; Jordana B. Cohen, MD, MSCE; Emilia Flores, PhD; Michael O. Harhay, PhD; Harald Schmidt, PhD; Gary E. Weissman, MD, MSHP; Julie Fricke, PhD; Jonathan R. Treadwell, PhD; and Nikhil K. Mull, MD



Ref: Marcelin, J Inf Dis, 2019

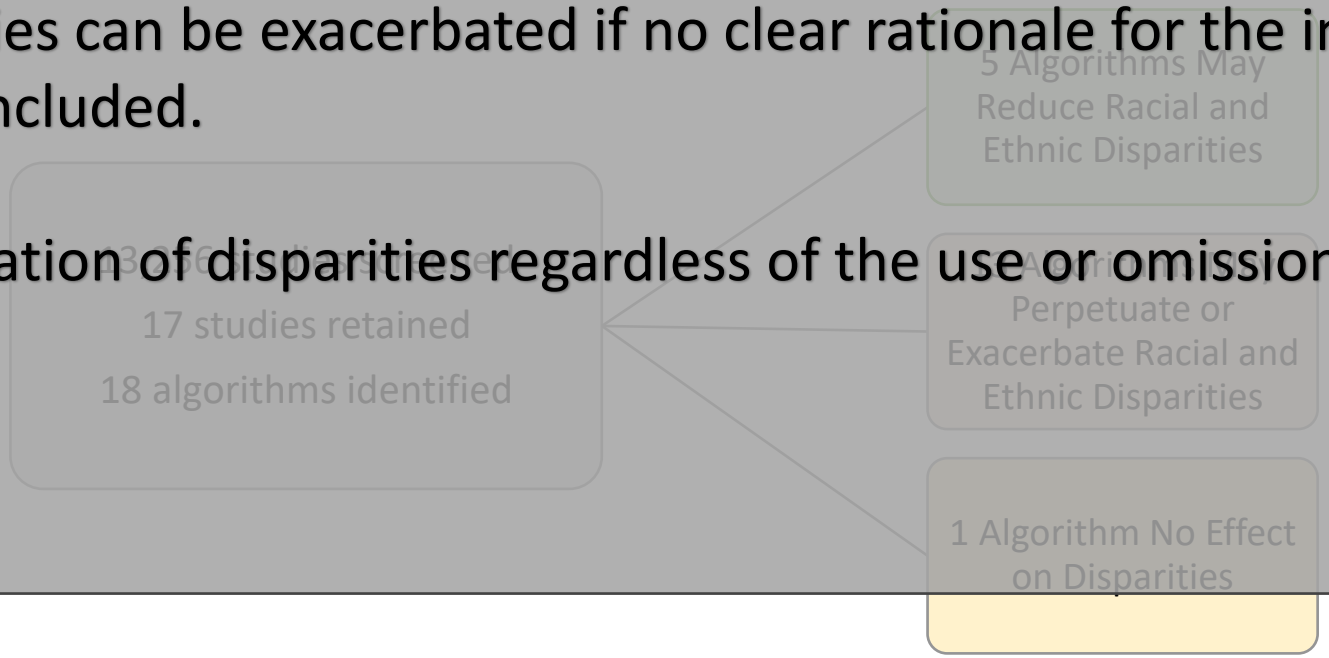
REVIEW

Annals of Internal Medicine

The Impact of Health Care Algorithms on Racial and Ethnic Disparities

A Systematic Review

- Disparities can be reduced if race/ethnicity incorporated intentionally to tackle known racial disparities (e.g kidney transplant allocation)
- Disparities can be exacerbated if no clear rationale for the inclusion of race is included.
- Exacerbation of disparities regardless of the use or omission of race as a variable



Ref: Marcelin, J Inf Dis, 2019

Mitigating biases in clinical algorithms

- Develop models using diverse patient cohorts (w/ patient characteristics)
- Engage patients and communities during all phases of algorithm development and evaluation
- Ensure algorithms are transparent and explainable
- Adjusting algorithms: bias correction, weighting methods, sampling methods
- Monitor and evaluate model performance across different subgroups
- Establish accountability for equity and fairness in outcomes from health care algorithms

Ref: Chin et al. *JAMA Netw Open* 2023*;* Schachar et al. *JAMA* 2023; Vokinger et al. *Communications Med* 2021

Take home messages

- Clinical algorithms have the potential to:
  - Improve care
  - Improve the appropriate use of antibiotics
  - Reduce health inequities
- Care and sustained efforts must be taken into account in order for clinical algorithms to not exacerbate inequities and disparities