Clinical decision support algorithms: how to ensure their safety and usefulness?

Prof. Valérie D’Acremont, MD, PhD
Centre for primary care and public health, UNIL (Unisanté)
Swiss Tropical and Public Health Institute, UNIBAS (SwissTPH)
CISTM16, 9 June 2019

Almost all areas of health are becoming e-health...

Are electronic clinical decision support algorithms really new?...

““The times have passed when a single human mind could even pretend to know all that might be useful in aiding patients.”

L.C. Payne, The role of the computer in refining diagnosis, The Lancet 1964

What is available on the market?

Play Store

Symptom checker

Isabel

Babylon ad

Babylon at the heart of controversies...

51% of actual diagnoses were among the top 3 diagnoses provided by the algorithm

Semigran et al, BMJ 2015

We Need an FDA For Algorithms

UK mathematician Hannah Fry on the promise and danger of an AI world.
**Ethics and challenges around digital health**

**Foreword**

“A key challenge is to ensure that all people enjoy the benefits of digital technologies for everyone. We must make sure that innovation and technology helps to reduce the inequities in our world, instead of becoming another reason people are left behind. Countries must be guided by evidence to establish sustainable harmonized digital systems, not seduced by every new gadget.

Ultimately, digital technologies are not ends in themselves; they are vital tools to promote health, keep the world safe, and serve the vulnerable.”

**First step: Define target user and patient**

- Community health worker
- Pharmacist
- Primary care clinician
- Physician at hospital

**2nd step: Structured review of the literature**

- 12'124 articles

**3rd step: studies to measure disease prevalence**

- Febrile adult travelers
- Febrile Tanzanian children

**4th step: CART analyses to best combine clinical predictors**

- Sensitivity: 46%
- Specificity: 93%
- LR+: 6.57
- LR-: 0.58

Kristina Keitel et al., Plos Medicine 2017

Buss et al., in preparation

D'Acremont et al., NEJM 2014

De Santis et al., Plos One 2017
5th step: novel host biomarkers that predict disease

- 28-day mortality in febrile Tanzanian adults
- Radiological pneumonia in febrile Tanzanian children

Richard Greenblatt et al., CID 2019
Etimain et al. PLoS One 2013

6th step: clinical decision support algorithm (CDSA)

Richard-Greenblatt et al., CID 2019
ALMANACH: Clotilde Rambaud et al., PLoS One 2013 (Adapted by Olga de Santis)

7th step: transform medical thinking into software coding

MedAl-C: a software to transform your algorithm into an App

Keitel & D’Acremont, Clin Microb & Infect 2018

The validation cycle of electronic clinical decision support algorithms

Regulatory framework

The new Regulations on medical devices

On 5 April 2017, 2 new Regulations on medical devices were adopted, and they entered into force on 25 May 2017. These replace the existing Directives.


The new rules will only apply after a transitional period. Namely, 3 years after entry into force for the Regulation on medical devices (2017/745) and 5 years after entry into force (spring 2022) for the Regulation on in vitro diagnostic medical devices.
Development of FeverTravel practice guidelines

- Literature review
- Construction of decision charts with documentation
  - quality of evidence
  - strength of recommendation
- Reviewed by 15 experts at the CISTM7 (Innsbruck, 2001)
- Publication in Journal of Travel Medicine 2003
- Update of guidelines in 2013 and in 2019 (new assessment by experts planned)

Online prospective study with 539 patient/clinician pairs

‘No death was recorded and all complications could be attributed to the underlying illness rather than to adherence to guidelines.’

Pilot study with GPs using FeverTravelApp on simulated patients

Online prospective study with 539 patient/clinician pairs

‘No death was recorded and all complications could be attributed to the underlying illness rather than to adherence to guidelines.’

Algorithm to manage febrile children at primary care level (ePOCT)

Recommendation for treatment and/or admission

Randomized control trial of e-POCT

3739 children 2 months - 5 years (9 facilities, Dar es Salaam)

- Routine
- ALMANACH
- e-POCT

Cure rate at D3 and D7; 2nd hospitalisations and deaths by D30

Impact of e-POCT implementation on cure rate

Potential impact of ePOCT in children in Tanzania:
1 million clinical failures averted per year
Impact of e-POCT implementation on antibiotic prescriptions

- **Routine**
  - 95% Other
  - 30% Pneumonia
  - 11% Severe disease
  - 0% ePOCT

**Potential impact of ePOCT in children in Tanzania:**
28 million unnecessary antibiotics saved per year

---

**The validation cycle of electronic clinical decision algorithms**

1. **Validation and user-friendliness of ePOCT in the IT lab**
2. Clinical safety and efficacy
3. Clinical and epidemiological context
4. Critical effectiveness

---

**The Tanzanian DYNAMIC project**

- **ePOCT**:
  - Extended medical content
  - New software
  - Full connection to biosensors and rapid tests

- **Validation**:
  - 70 health facilities
  - 2 semi-urban districts in Tanzania

- **Beneficiaries**:
  - 500,000 sick children per year attending primary care facilities

- **Dynamic algorithm**:
  - Through machine-learning and optimization

- **Health system**:
  - Enhanced M&E, disease surveillance, epidemic detection

- **Data sciences**:
  - High number and variability of data

---

**Ecology and durability of smartphones/tablets implementation**

- Use a FAIRPHONE!
- Don’t store useless data on long term!

---

**Impact of algorithms beyond health**

- *IeDA project from Terre des hommes in Burkina Faso*
<table>
<thead>
<tr>
<th>Name of CDSA</th>
<th>Author/developer</th>
<th>POCTs used</th>
<th>Algorithm content</th>
<th>Clinical efficacy</th>
<th>Clinical effectiveness</th>
<th>Impact study</th>
<th>Qualitative assessment</th>
<th>Implemented</th>
</tr>
</thead>
<tbody>
<tr>
<td>iCCM based tools</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e-ICCM</td>
<td>Imperial College London</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>eCCM</td>
<td>Imperial College London</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IMCI based tools</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>eIMCI</td>
<td>Tree, JHPIEGO, Harvard, Mariland</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ePOCT</td>
<td>Think MD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Digital IMCI</td>
<td>Tree, Boston Children Hospital</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neonatal IMNCI</td>
<td>None, then mRDT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>REC Terre des Hommes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bangladesh digital IMCI</td>
<td>MoH, ICDDRB</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Kristina Keitel et al., Clin Microb & Infect 2018