HOW DATA SCIENCES TRANSFORM PATIENT MANAGEMENT: BEST PRACTICE SHARING

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The healthcare system as it stands misses the potential of technological breakthroughs

6.1 million new cases of CVD in the EU in 2015. Half of new CVD cases due to CHD, while around 10% of new CVD cases were due to stroke.

Structures and Incentives focused on unspecific reactive “Break & Fix”

Note: Europe refers to the 28 European Union (EU) member states. Data are based on latest available year for each European country. CV, cardiovascular.
• Individual 10-year risk
  - Always a high 10-year risk ≠ always a high benefit of medication
  - Always a low 10-year risk ≠ a low lifetime risk
• CV-risk categories
• SCORE not designed to be used in secondary prevention
• Other tools: ASCVD, SMART, ADVANCE, SMART-Reach, Life CVD Model, Elderly

ESC guidelines, 2019
The present and future steps

**Medical challenges:**

- Patients with acute coronary syndromes (ACS) are at increased risk of experiencing recurrent ACS.
- The predictive power of traditional risk scores remains relatively low, thus limiting the prediction of future events.
- Physicians adherence to guidelines remains suboptimal
- On the other hand, patient adherence and persistence on drugs and lifestyle changes remains a challenge
- Value of parameter analysis using machine learning algorithms in this field remains largely unexplored.

**Unmet medical needs:**

- Can you accurately predict the risk of your post-ACS patients?
- Can you define the best therapeutic approach in order to get the best outcome?
- Does each post-ACS patient achieve optimal risk reduction?
- Should every post-ACS patient receive the same therapy?
ESC recognizes the importance of risk prediction solutions for CV; report revealing the gap in secondary CV risk prediction

Most existing CV risk scores are developed for primary prevention; the few secondary prevention solutions focus on specific subgroups of CV patients.

Source: Risk prediction tools in cardiovascular disease prevention: A report from the ESC Prevention of CVD Programme led by the European Association of Preventive Cardiology (EAPC) in collaboration with the Acute Cardiovascular Care Association (ACCA) and the Association of Cardiovascular Nursing and Allied Professions (ACNAP); published Jun 24, 2019, European Journal of Preventive Cardiology.

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ProACS risk score: An early and simple score for risk stratification of patients with acute coronary syndromes

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Abstract

Introduction: There are barriers to proper implementation of risk stratification scores in patients with acute coronary syndromes (ACS). Including their complexity. Our objective was to develop a simple score for risk stratification of all-cause in-hospital mortality in a population of patients with ACS.

Methods: The score was developed from a nationwide ACS registry. The development and internal validation cohorts were obtained from the first 31,829 patients, randomly separated (60% and 40%, respectively). The external validation cohort consisted of the last 8586 patients included in the registry. This cohort is significantly different from the other cohorts in terms of baseline characteristics, treatment and mortality. Multivariable logistic regression analysis was used to select four variables with the highest predictive potential. A score was allocated to each parameter based on the regression coefficient of each variable in the logistic regression model: 1 point for systolic blood pressure ≤110 mmHg, Killip class 2 or 3, and 3-segment elevation; 2 points for age ≥75 years; and 3 points for Killip class 4.

Results: The new score had good discriminative ability in the development cohort (area under the curve [AUC] 0.79), and it was similar in the internal validation cohort (AUC 0.785, p=0.33). In the external validation cohort, there was also excellent discriminative ability (AUC 0.815), with an adequate fit.
Amgen led initiative investigating the role of machine learning presents a potential solution

➢ **DEEP™ is a platform** that harnesses the power of advanced data science to create solutions for predicting and preventing serious health conditions, helping patients live healthier lives, and unlocking value and efficiency for the healthcare system.

➢ **An AI-based clinical risk prediction model** that uses routine EHR data to identify individual patient’s risk and break down the risk drivers.

➢ **Trained and cross validated on multiple real-world datasets.**

➢ **Jointly developed with the healthcare community in a value-based partnership model.**

➢ **Detect**

➢ **Evaluate**

➢ **Engage**

➢ **Protect**

What?

How?
System uses AI and real world data to support a paradigm shift towards personalised and preventative healthcare

Predict at the individual patient level
- Risk of a subsequent event
- Drivers of event risks

Provide insights to
- Personalize treatment plans
- Optimize patient care management and improve health outcomes
- Allocate resources more efficiently to patients most at risk and in need
The DEEP™ algorithm today has already demonstrated superior risk prediction accuracy in primary care setting.

- Existing CV risk scores have been developed in clinical trial settings with almost perfect data. When applied to real-world primary care data, their prediction isn’t accurate enough to meaningfully differentiate patients.

- With the level of precise patient stratification possible with DEEP, physicians can create personalized treatment plans based on each patient’s risk profile.
Coimbra University Hospital
7,000 ACS Patients from UCU
Special interest on CV risk

Similar results were achieved on data from hospital setting

• As DEEP™ Cardiology focuses on **secondary prevention of CV events**, our target clinical setting is hospitals, where real-world post-MI/stroke patients’ data sit.
• In this setting, DEEP™ Machine Learning algorithm has similarly proven to be **powerful in differentiating high vs. low risk patients** compared to TIMI.
DEEP™ is a concrete step towards changing the healthcare landscape

AI and machine learning have the power to change the healthcare landscape
Our study is a long term, longitudinal, single center cohort study, where we collected data prospectively on 5977 ACS patients admitted for ACS and discharged alive.

Using machine learning algorithms involving data collected on 119 variables

Kaplan Meier event free survival curves were compared for parameters with highest ranked interaction with diabetes mellitus to predict readmission.
COIMBRA PATIENT POPULATION (N=5977)

**Sex**
- Women: 31%
- Men: 69%

**Age**
- Mean: 66 years old
- Median: 68 years old

**LDL**
- Mean: 125 mg/dL
- Median: 123 mg/dL
ADMISSION DIAGNOSIS

Most common diagnostics

- NSTEMI: 3214
- Unstable angina: 1783
- Anterior wall STEMI: 1103
- Postero-inferior wall STEMI: 1072
EVENT DISTRIBUTION

RESULTS

• 770 patients (13%) have at least a second cardiovascular event

• For the 5977 overall patients, re-event rates were 13% (771)

• Half of all recurrent events occur within (338 days) and the majority (90%) of recurrent events occur within 2000 days

• 42% of patients without readmission are observed under 2000 days (n=2186)
DEEP™ PREDICTION ACCURACY: SUBSEQUENT EVENTS

RESULTS

• The prediction accuracy for secondary CV events of existing scores is very limited with TIMI being the best among them (0.56)

• Combing the 17 features from all existing scores improves the accuracy to 0.6

• The DEEP algorithm using 273 features achieves delivers the highest prediction power with a C-index of 0.63
With 50 features we achieve almost the highest performance.

The marginal gain in prediction accuracy of more attributes is low.

For future use in clinical practice a “mini-max” approach should be applied.
PATIENT RISK SEGMENTATION – TIMI VS. DEEP™ SCORE

BASED ON TIMI SCORE

low: 0-1 (36%) -- medium: 2-3 (52%) -- high: 4+ (12%)

BASED ON DEEP SCORE

low: 36% -- medium: 52% -- high: 12%
PERSONALISED MANAGEMENT OF INDIVIDUAL CV RISKS - EXAMPLES

- Lipids
- DM
- HT
- Inflam

Lipids
LLT
- 2 pts
- 10%

DM
HT
Inflam

Lipids
LLT
- 2 pts
- 10%

DM
HT
Inflam

Lipids
LLT
- 6 pts
- 20%

DM
HT
Inflam

Lipids
LLT
- 6 pts
- 60%

- 15%
- 80%

Non Modifiable
Modifiable

12 pts 60%
10%
2 pts 10%
20%
6 pts 20%
60%
The present and future steps

• This algorithm is being trained and validated in different European databases
• And also applied in present and future clinical trial databases
• In Coimbra, the current algorithm is already used to predict outcomes and define the best secondary prevention strategy for each post-ACS patient
• For 2020 we envision:
  1. A further refinement of the algorithm (making it more accurate and more individualized)
  2. The publication of the first results of our combined databases
  3. Working on the setup of a user-friendly app for rapid assessment of risk and optimized risk management strategies
CONCLUSIONS

• Big data, Machine learning and Artificial intelligence are here to stay
• They are already everywhere and this trend will only become stronger
• There are lots of areas in Medicine that can benefit from these innovations
• As in other fields, this can lead to miracles or profound disasters
• If we own this process, we can influence its outcomes; if not...
• Clinicians and the Healthcare industry must thus cooperate on this issue to deliver better solutions for the patients and the society as a whole
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