

# AI for Good

## Detecting Newborn Infant Hypoxic Ischemic Encephalopathy (HIE)

Building a decision aid tool to help emergency intensive care specialists to decide or not to start Hypothermia protocol

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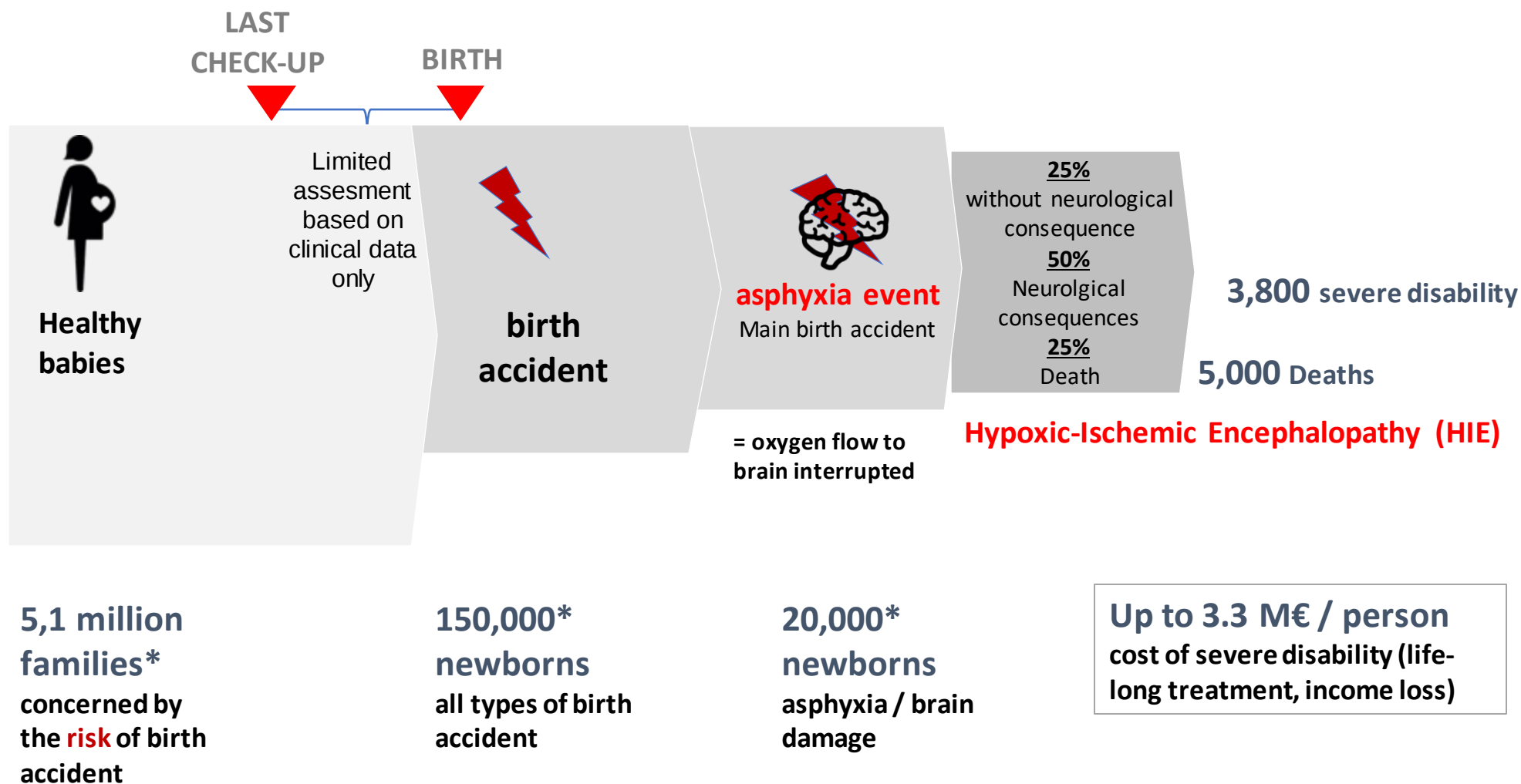
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# Tackling a severe disease in the shadow : newborn asphyxia

- «A storm in a sunny blue sky»
- Sudden, stressful, life-changing, life-long impact



# Tackling a severe disease in the shadow : asphyxia

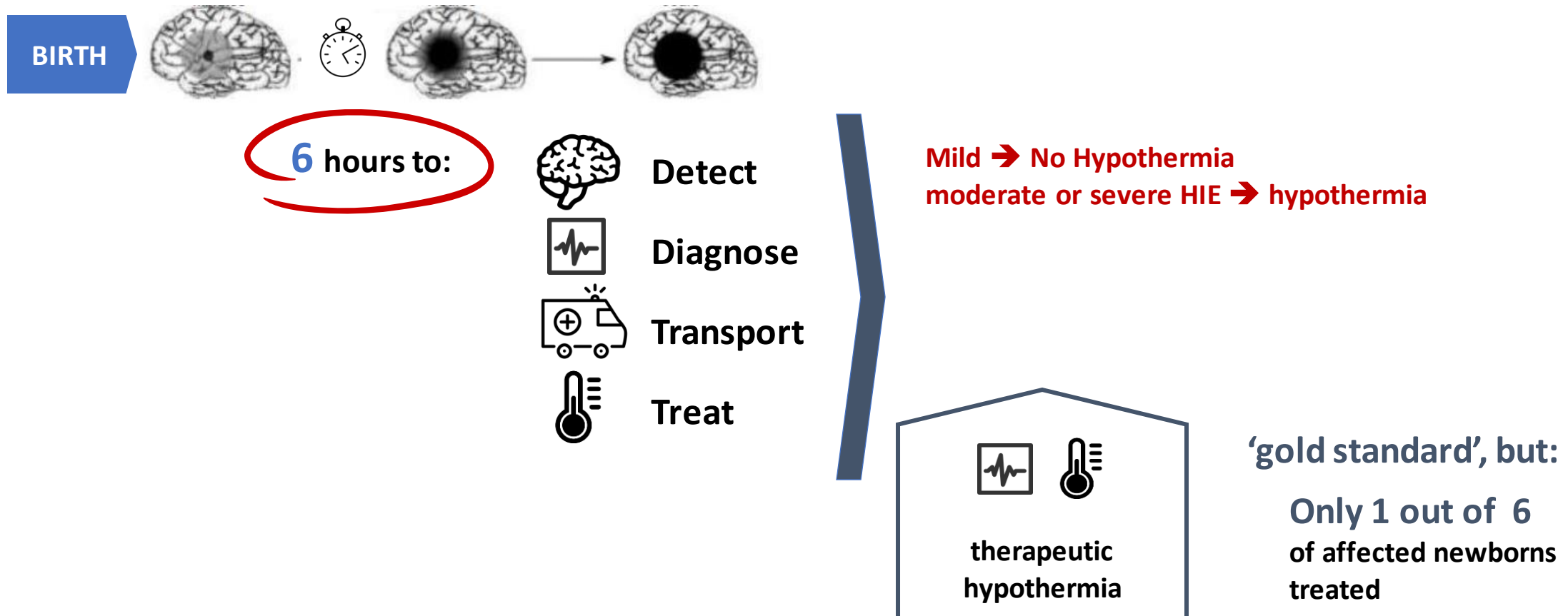


\*every year in EU (28)

# We can prevent damage from birth accidents!

Promoting hypothermia – the ‘gold standard’ intervention for asphyxia cases

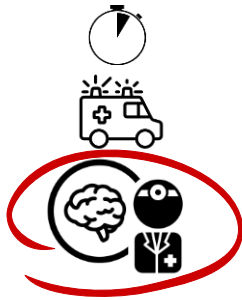
*« Time is Brain, Brain is Life »*



# A decision aid tool can close the gap of an imperfect existing process

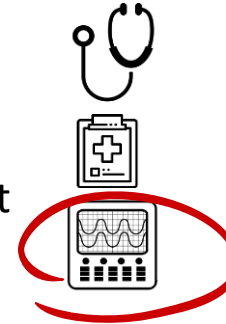
## Limited access to key care

Present  
situation



- Six-hour window
- Crucial decision : transfer or not
- Lack of qualified pediatric neurophysiologist

## Factors impacting hypothermia decision



- Clinic status of the newborn
- Biological markers
- EEG

### Conclusion 1 :

- Present sub-optimal post birth care

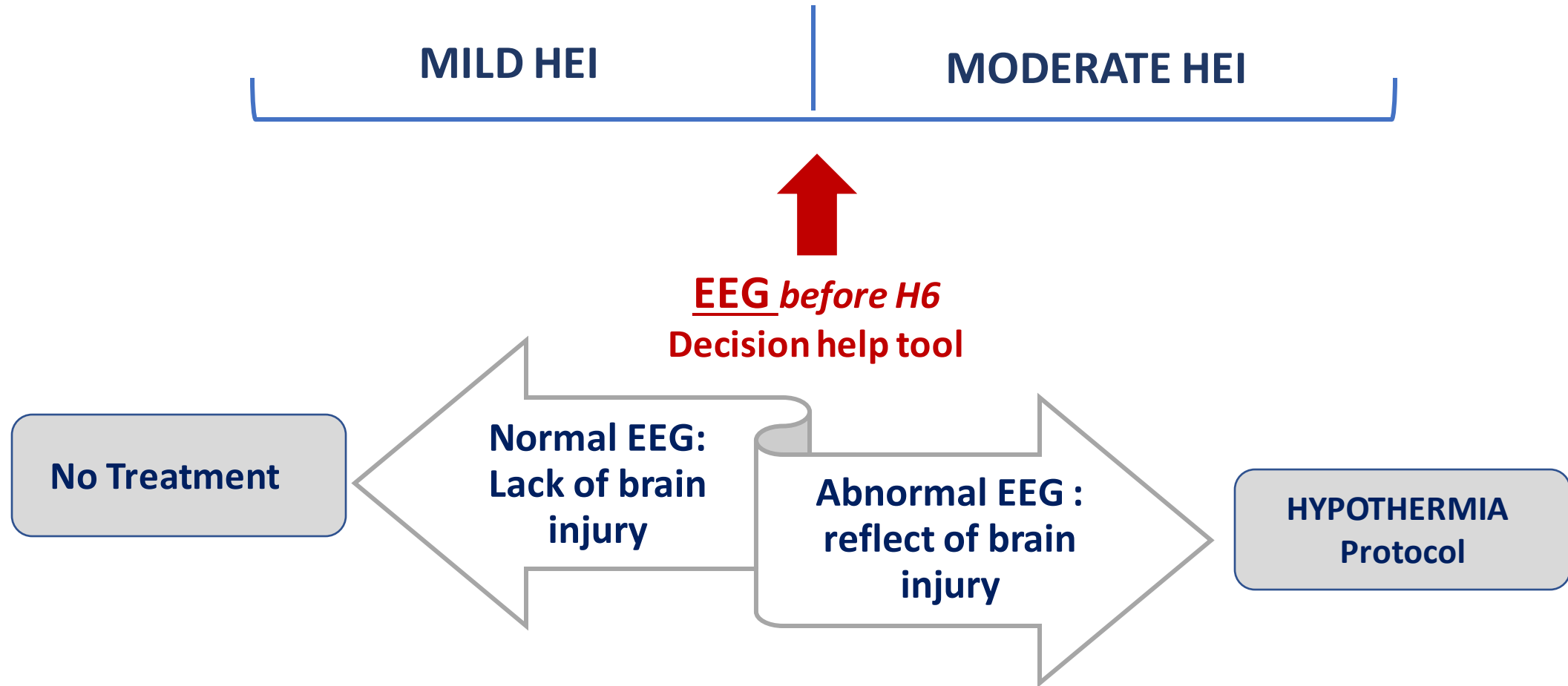
### Conclusion 2 :

- Techno and automation would help to clear up the lack of qualified Neuro-physiologist issue

Proposed  
improvement

**Solution : conceive, design and create a Neuro-Digital decision aid tool**

# Where our AI project really matters



# Medical Data Access

- Process varies per countries
  - Most countries require:
    - Parental approval
    - Hospital or equivalent organization Ethics panel
  - Some countries require:
    - Prior approval from governmental body (CNIL in France)
- Overall lengthy process
  - 3 years for a 104 EEG files in our case
  - Some data available in Open source but not always with necessary clinical data for study.
- De facto standards for publishing EEGs are CSVs and/or EDF+ (European Data Format).

# Typical AI techniques applied for grading

- Grading hypoxic–ischemic encephalopathy severity in neonatal EEG using GMM supervectors and the support vector machine
  - Rehan Ahmed, A. Temko, W. Marnane, G. Lightbody, G. Boylan
  - <https://doi.org/10.1016/j.clinph.2015.05.024>

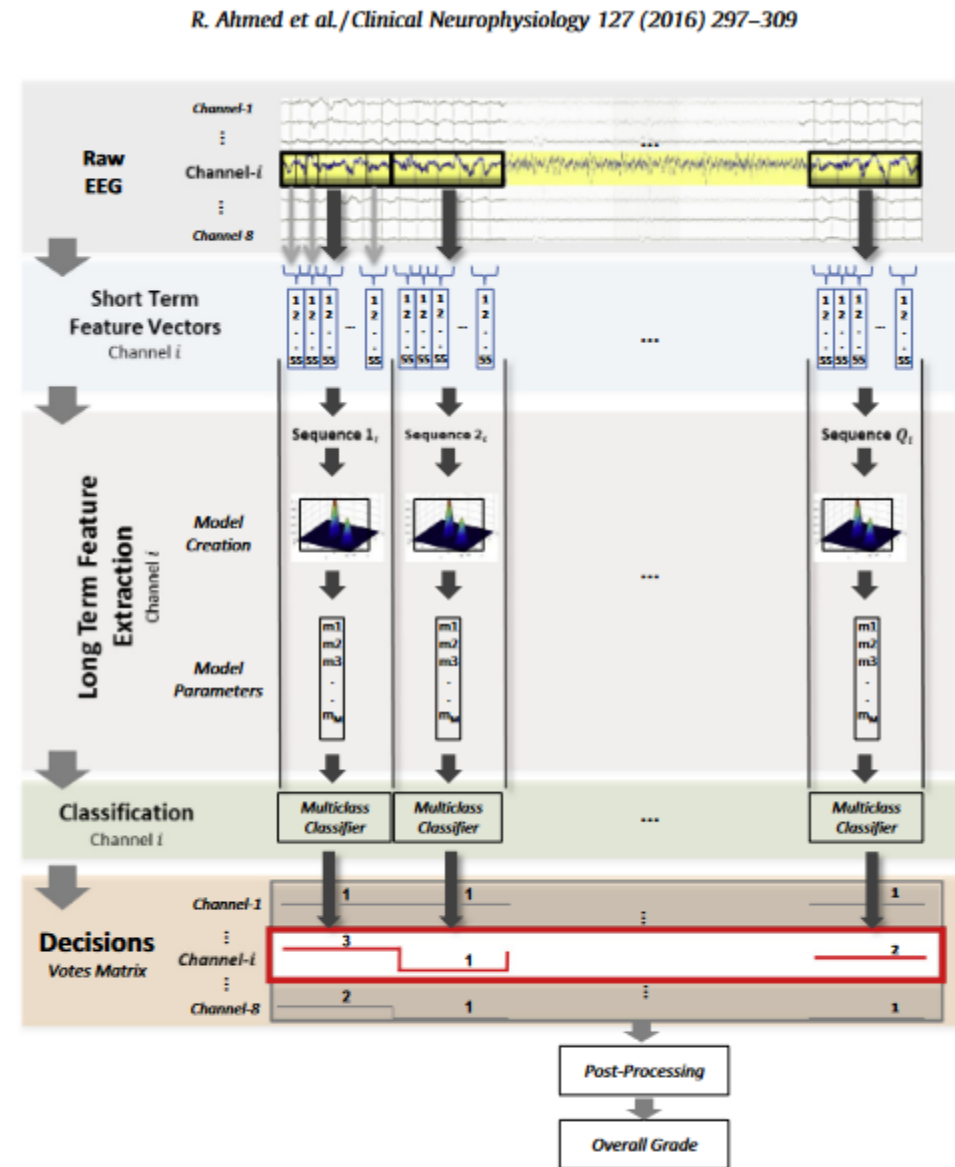


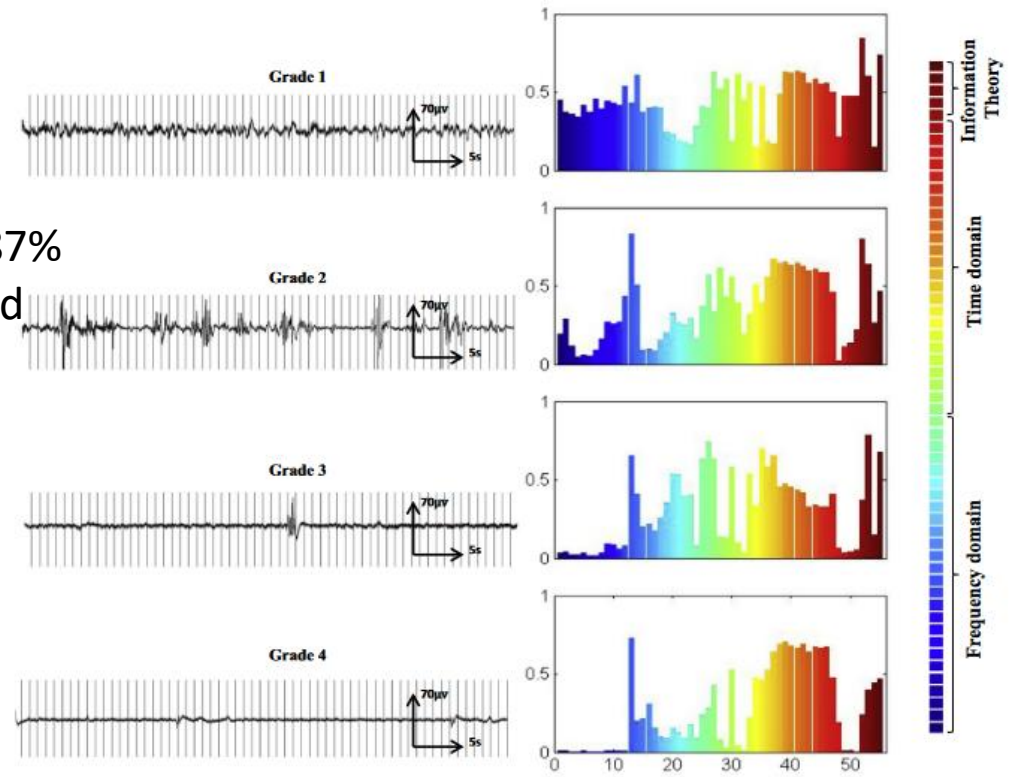
Fig. 2. Overview of the GMM-supervector based HIE-EEG grading system.

# Latest AI techniques applied for grading

- Grading hypoxic–ischemic encephalopathy severity in neonatal EEG using GMM supervectors and the support vector machine
  - Rehan Ahmed, A. Temko, W. Marnane, G. Lightbody, G. Boylan
  - <https://doi.org/10.1016/j.clinph.2015.05.024>

| Domains            | Feature list                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|--------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Frequency          | <ul style="list-style-type: none"><li>• Total power (0–12 Hz)<sup>1,2</sup></li><li>• Peak frequency of spectrum<sup>1</sup></li><li>• Spectral edge frequency (80%, 90%, 95%)<sup>1</sup></li><li>• Power in 2 Hz width sub-bands (0–2 Hz, 1–3 Hz, ...10–12 Hz)<sup>1</sup></li><li>• Normalized power in sub-bands<sup>1</sup></li><li>• Wavelet energy<sup>1</sup></li></ul>                                                                                                                                                                                                                          |
| Time               | <ul style="list-style-type: none"><li>• Non-linear line length<sup>1,2</sup></li><li>• Number of maxima and minima<sup>1</sup></li><li>• Root mean squared amplitude<sup>2</sup></li><li>• Hjorth parameters<sup>2</sup></li><li>• Zero crossings (raw epoch, <math>\Delta</math> and <math>\Delta\Delta</math>)<sup>1</sup></li><li>• Autoregressive modeling error (model order 1–9)<sup>3</sup></li><li>• Skewness<sup>3</sup></li><li>• Kurtosis<sup>3</sup></li><li>• Nonlinear energy<sup>1,2</sup></li><li>• Variance (<math>\Delta</math> and <math>\Delta\Delta</math>)<sup>1,2</sup></li></ul> |
| Information theory | <ul style="list-style-type: none"><li>• Shannon entropy<sup>3</sup></li><li>• Singular value decomposition entropy<sup>3</sup></li><li>• Fisher information<sup>3</sup></li><li>• Spectral entropy<sup>1,3</sup></li></ul>                                                                                                                                                                                                                                                                                                                                                                               |

Article states that 87% accuracy is achieved with these techniques.



# Lessons learned

- Long legal process to get access to medical data
  - There is no "Data donor" status equivalent to "Organ donor"
- Signal processing and symbolic AI can be better than machine learning.
  - Data scientists tend to be machine learning focused.
- Timelines in healthcare result validation processes are long.