Case 3: IDSS based on Bayessian networks and Predictive models

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IDSS description

[Barbaros 2014]

Intelligent Decision Support System for Trauma Care

Decision supported:

Survival of traumatic patient

Multidisciplinar

Partners:

- School of Electronic Engineering and Computer Science (Queen Mery University of London, UK)
- Center for Trauma Science (Queen Mery University of London, UK)
- The Royal London Hospital UK

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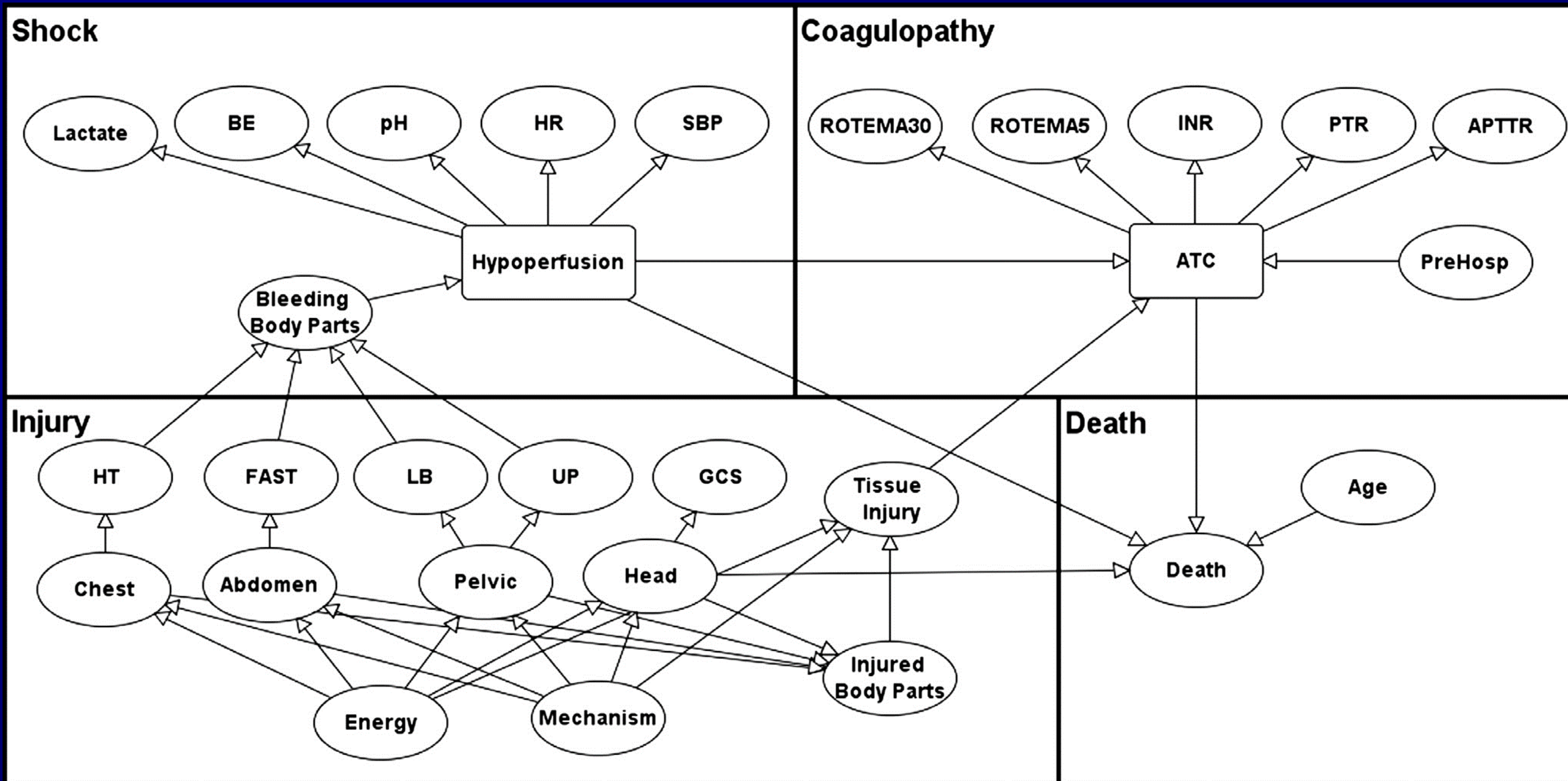
Actors

Building Bayesian Network

- Expert-based structure of BYN:
  - Consensus structure of common reasoning types
  - Causal coherence guaranteed
  - Combine expert knowledge and data when required

Bayessian network structure



- Expert-based Bayessian network structure

Domain knowledge is used to decide nodes and archs

Building Bayesian Network

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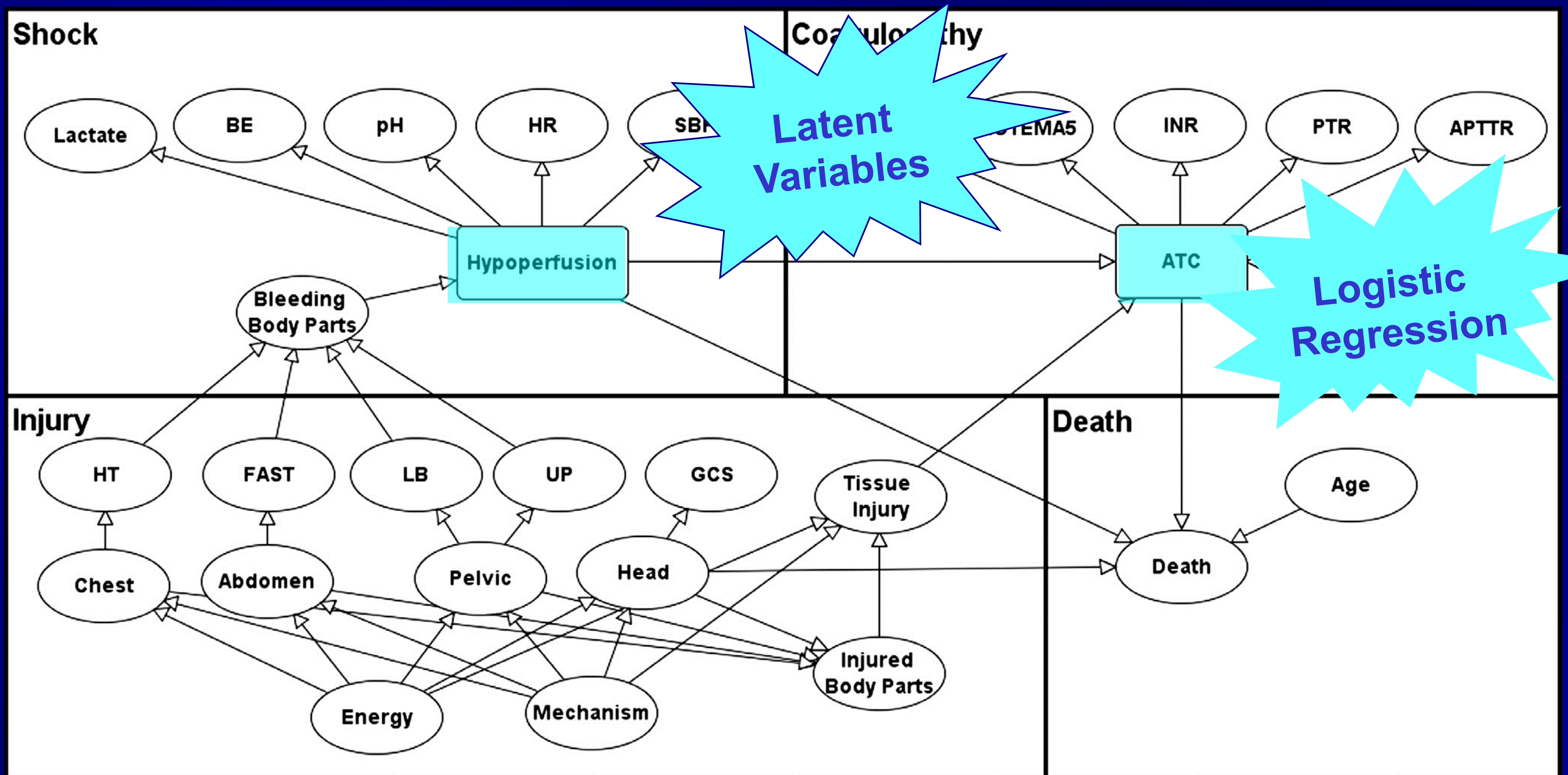
  - Consensus structure of common reasoning types
  - Causal coherence guaranteed
  - Combine expert knowledge and data when required
  - *Exclude variables out of the scope of the model*

- Identify latent variables and add to dataset
  - Label latent variables in training set:

Bayessian network structure



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BIC is considered outside of the scope of the current BYN
because BIC effects coagulation by a mechanism different to ATC

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    - from deterministic expert rules (mechanistic relationships, literature review...)

Predicting Coagulopathy

Usign BYN or a Predictive model

Predictive model *[Mitra 2014]*: COAST score:

entrapment, temperature <35 °C, systolic blood pressure <100 mm Hg, abdominal or pelvic content injury, chest decompression.

Logistic Regression

Learning: 1680 major trauma patients, 151 with coagulopathy

Pre-hospital variables independently associated with ATC:

- were entrapment (OR 1.85; 95% CI: 1.12–3.06)
- temperature (OR 0.60; 95% CI: 0.60–0.72)
- systolic blood pressure (OR 0.99; 95% CI: 0.98–0.99)
- abdominal or pelvic content injury (OR 2.0; 95% CI: 1.27–3.12)
- pre-hospital chest decompression (OR 4.99; 2.77–8.99).

Prospective Validation: 1225 major trauma patients, COAST ≥ 3

- Specificity= 96.4%, sensitivity= 60.0%,
- area under the ROC curve: 0.83 (0.78–0.88).

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  - Label latent variables in training set:
    - from deterministic expert rules (mechanistic relationships, literature review...)
    - using clustering (EM)
    - Consensus of final label (expert review in case of inconsistency)

Measurement threshold ATC labels changed by expert.

Measurements	After review		
	Yes	No	Unlabelled
ATC label review – measurements			
Yes	57	6	–
No	3	524	–
Unlabelled	1	5	4
			Total: 600

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- Learn BYN parameters with EM algorithm on extended dataset
  - Consider additional expert constraints on parameter orders if insufficient data is available

- Cross validate the performance of the BYN:

Specificity= 67%, sensitivity= 80.0%, AUROC: 0.81 (0.75–0.86)

Building Bayesian Network

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- Cross validate the performance of the BYN

- Expert-based model refinement

Expert based model refinement

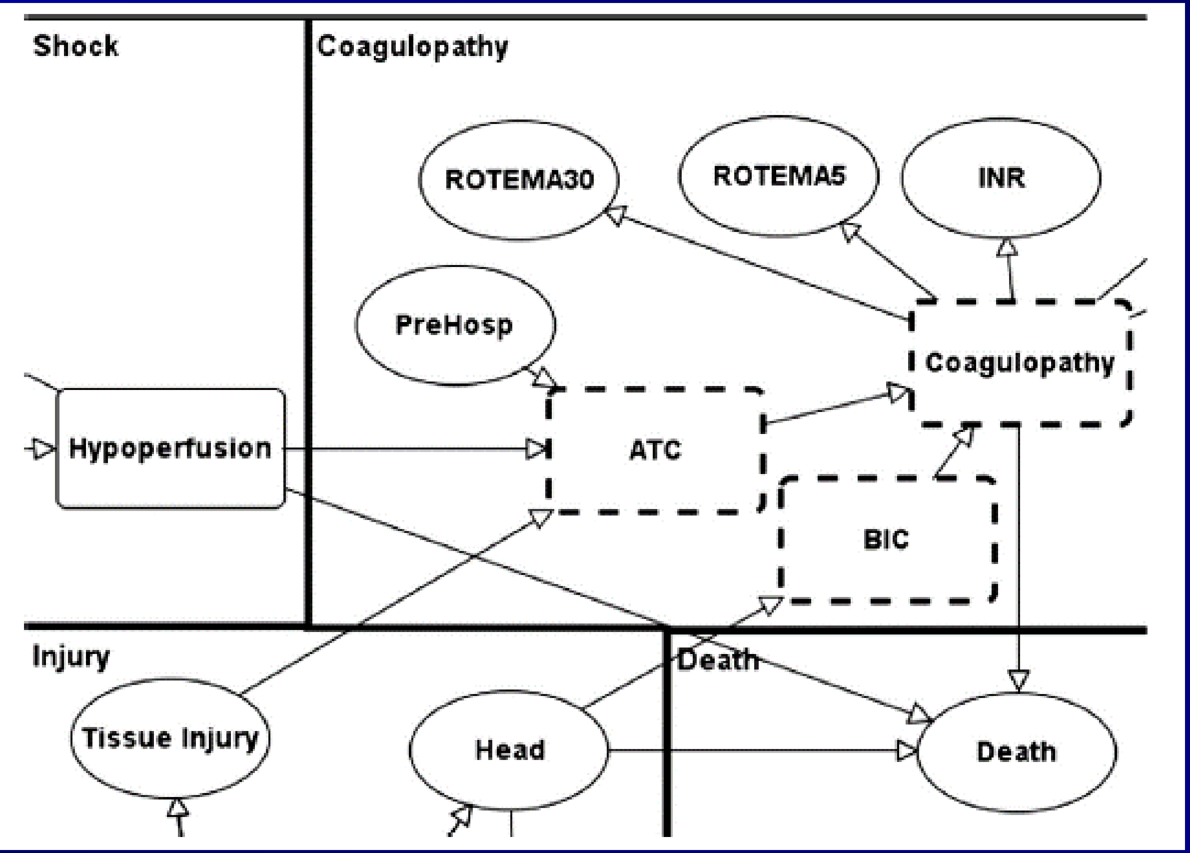
- Consider incipient coagulopathy
  - Relabel patients with incipient coagulopathy as ATC=True

  - Patients with initial measurements:
    Normal ATC values
    severe injury burden
    poor perfusion

  (they will show significant ATC values soon after)

- Retrain BYN and re-validate
  M0:
  Specificity= 67%, sensitivity= 80.0%, AUROC: 0.81 (0.75–0.86)
  M1:
  Specificity= 79%, sensitivity= 90.0%, AUROC: 0.92 (0.89–0.95)

Bayessian network structure



- Expert-based refinement of Coagulopathy in BIC patients