# Bayesian Networks for low back pain masquerading conditions

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## BACKGROUND

**Back pain in the UK**

Lower back pain (LBP) is a very common problem in the UK and can sometimes be caused by very serious conditions that are masquerading as general LBP. Cauda equina syndrome and cancer are two examples. However, whilst associated risks and signs and symptoms are known, the prevalence rates are poorly understood[1].

**Bayesian Networks and machine learning**

Mathematically, a Bayesian Network (BN) is a representation (Fig. 1) of the joint probability $P(X_1, \ldots, X_n)$ in terms of conditional probabilities of the form $P(X_i|X_j)$. The probability of an output (e.g. Cancer) given inputs (e.g. age, weight loss) can then be calculated using Bayes Theorem.

BNs are very suitable for combining expert knowledge with data. They can be built without data first and modified as it becomes available.

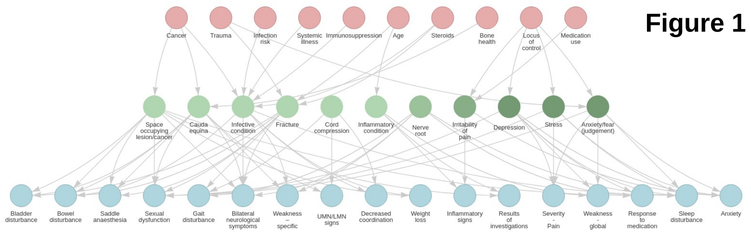


**Figure 1**

## METHODS

**Elicitation methods**

We have been conducting a Delphi/RAND process (see poster of A. Hill for details) to elicit the variables, relationships and probabilities associated with LBP and masquerading conditions in particular.

A custom website has been constructed that facilitates both online and workshop elicitations for forming consensus.

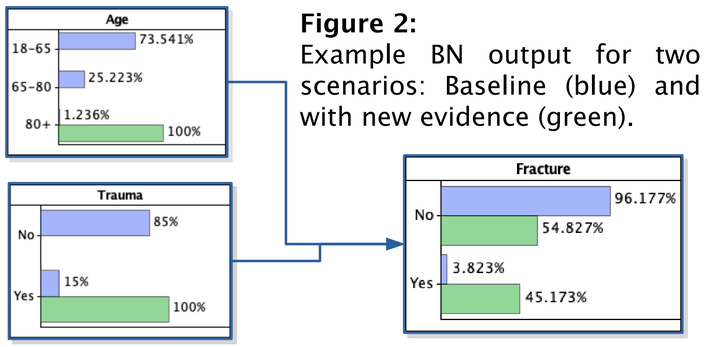


**Figure 2:** Example BN output for two scenarios: Baseline (blue) and with new evidence (green).

**Technical methods**

Various approximations such as NoisyOr[2] and Ranked Nodes[3] have been used to parametrise the BN's conditional probabilities. This helps to avoid overfitting and, more importantly, ease the elicitation burden on participants.

The elicitation results are analysed and combined using regression methods to estimate the parameters. A model is then subsequently generated that can be run in the AgenaRisk software.

## RESULTS

We have developed a BN that is awaiting the parameters for the conditional probabilities to be acquired from the final stage of the elicitation process.

The BN can display two (or more) scenarios: One that predicts the base rate prevalence of a condition and another that shows the prevalence in the presence of certain pieces of evidence (see e.g. Fig. 2).

## CONCLUSIONS

BNs are well suited for providing flexible modelling solutions based on expert knowledge and/or supplied data. We have used an elicitation process to construct a BN that will predict the rate of serious underlying LBP-related conditions. Future work will involve conducting a validation of the model based upon literature reviews and scenario testing with experts.

## REFERENCES

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2. Srinivas, Sampath. "A generalization of the noisy-or model." Uncertainty in artificial intelligence. Morgan Kaufmann, 1993.
3. Fenton, Norman E., Martin Neil, and Jose Galan Caballero. "Using ranked nodes to model qualitative judgments in Bayesian networks." IEEE Transactions on Knowledge and Data Engineering 19.10 (2007): 1420-1432.