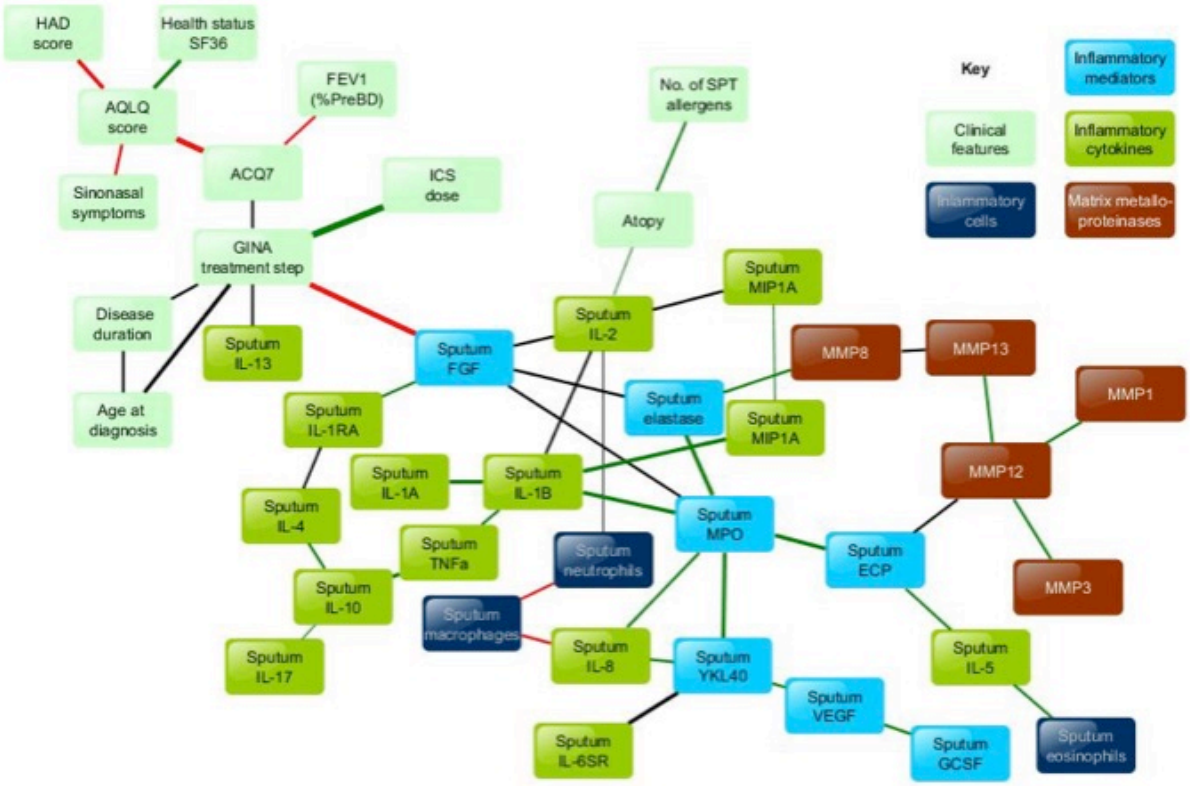
Understanding asthma using the maths of the stock markets

To unpack the wealth of results emerging from a massive seven-year study of several hundred people with severe asthma, researchers in Southampton and Portsmouth are turning to the mathematics of the financial trading markets.

Asthma is a common and disabling problem for many, particularly those with severe persistent disease that prevents them living a normal life. Standard asthma therapies aren't enough to control symptoms in these individuals and they live in fear of exacerbations that require emergency care and hospitalisation. There is an urgent need to find new treatment approaches that improve disease control and prevent disease exacerbation. To enable the more rapid conduct of trials with potential new treatments it is important to have well characterised patients, as it is recognised that severe asthma may arise from a range of causes and not all individuals are likely to benefit in the same way with specific interventions.



A Bayesian Belief Network showing how different aspects of asthma relate to each other. Closely related aspects are connected with the thickest lines. Features of asthma which are related in the

same way are shown in green, those which are related inversely in red. Abbreviations: ACQ7, 7-item asthma control questionnaire; ECP, eosinophil cationic protein; FEV1, forced expiratory volume in 1 second; FGF, fibroblast growth factor; GCSF, granulocyte colony stimulating factor; HAD, hospital anxiety and depression score, ICS, inhaled corticosteroids; IL, interleukin; MMP, matrix metalloproteinase; SPT, skin prick test, VEGF, vascular endothelial growth factor; YKL-40, chitinase-3-like protein 1.

Over the last 7 years researchers at the Southampton Biomedical Research Unit and at Queen Alexandra Hospital in Portsmouth have studied a group of over 300 volunteers who suffered from asthma or who were healthy by asking them to provide a sample of blood and of sputum (phlegm), in the largest study to date of this type. The volunteers breathed in a fine mist of salty water to help them cough up a sample which is invaluable to the researchers who were able to analyse 55 different types of inflammatory cells or molecules in each sample. Put together with a host of information from 57 other measurements in blood tests or from lung function tests and answers to questionnaires, this can provide a challenge to see the wood for the trees.

Stock market traders in the big financial centres have developed mathematical approaches to analyse large datasets made of different sorts of information. By applying their techniques, such as Bayesian Network Analysis and Topological Data Analysis, the research team have been able to identify 6 different types of asthma. More than that, because the study was performed in two separate cities, by comparing the results found in one centre with those in the other they were able to show that their findings were reproducible.

Using these analytical approaches they were able to let the data ‘speak for themselves’ and produce complex networks showing how different aspects of asthma interact to produce the symptoms that patients experience. This approach showed how different aspects of asthma related to each other, unpicking the complex interactions of inflammatory cells in the airways. A striking finding is that patient’s symptoms are often less closely related to these inflammatory pathways that drugs are designed to treat, and more related to other day-to-day parts of our experience such as anxiety and depression, sinus problems and our overall sense of wellbeing.

Put together, the findings in the first of several publications arising from this massive study show us in detail the existence of different forms of asthma in different people, they highlight different ‘pathways’ which might be targets for future drugs, but also underline the need for a whole-person approach to treating this complex and disabling disease.

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Multidimensional endotyping in patients with severe asthma reveals inflammatory heterogeneity in matrix metalloproteinases and chitinase 3-like protein 1
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