Mathematics And Medicine: Does It All Add Up?

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The application of mathematics to solve medical problems has been made practical by the development of high speed and high capacity computers and the internet. A foundation in mathematics is now as important in physician training as a background in biochemistry and biology. Examples of the uses of mathematics in medicine include medical decision making, evaluating the efficacy of laboratory tests, and establishing guide lines for approaches to disease. All of these nowadays depend on the use of statistical techniques and the ability to mine data using the computer. Mathematical models of physiologic and pathologic processes are now employed to help validate hypothesis. Sophisticated mathematical analytical approaches are being used not just to test new ideas but as a non-invasive way to monitor the condition of patients and to prognosticate. The finding some thirty years ago in the United States that treatment for the same condition varied widely for no apparent reason in different regions of the country ignited a mission to make medical decision making more evidence based [1-2].. Best evidence comes from randomized control trials of therapeutic measures and of diagnostic procedures or the meta analysis of several such trials [3]. Evidence-based medicine has spread with amazing speed and has led to the development guidelines for the diagnosis and treatment of many illnesses. Its vitality and usefulness has depended on advances in applied mathematics. Data mining, now much easier with the internet, is an essential element in evidence based medicine. The use of mathematics in data analysis to determine receiver-operator characteristics, to determine the predictive power of a finding, and the odds ratio of an event occurring has allowed more thorough utilization of the findings of clinical studies. Mathematical models, besides helping to organize concepts and data are a powerful tool for the analysis of biological systems allowing the initial examination of the feasibility of ideas which ultimately may be tested by randomized controlled trials [4-5]. In addition these models allow the testing of extreme situations that are not susceptible to examination in clinical trials. They are particularly valuable in the analysis of pathological processes involved in syndromes which affect the operation of multiple organs like the metabolic syndrome. Numerous models of normal functioning and disease states have been developed which deal with processes both at the cellular e.g. transmembrane ion fluxes; the systems e.g. obstructive sleep apnea; and at the population level e.g. influenza epidemics. Another example of the use of mathematics in medicine is for the non-invasive analysis of data accumulated serially such as heart rate, breathing frequency, and gait to detect abnormalities in function and to make prognostications. Decreasing variability of heart rate for instance seems to signal greater stress and increased susceptibility to atrial fibrillation and heart attacks. Variability is an index of adaptability and the ability to accommodate. Variability can be studied mathematically in the time domain using the standard deviation; and the frequency domain to study variability in different frequency bands. The low /high frequency ratio is frequently used to detect abnormalities in autonomic nervous system balance .Using non-linear mathematical approaches indices of the chaotic nature of an output like approximate entropy can be obtained. Generally higher values are considered to be a good sign [6-7]. There is a caveat to all this. The success of mathematics however should not lead to the neglect of the intuitive non quantifiable part of medicine i.e. medicine as an art. Not everything in medicine so far can be measured and in our present ignorance there seems to be many exceptions to mathematical rules.

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