Challenges for clinical applications of network science in neurology

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Since the ground-breaking work of, among others, Watts and Strogatz and Barabasi at the turn of the millennium, the science of complex networks has rapidly developed into a new framework for studying large systems of interacting components in many different fields of science. Applications of network science to the brain, one of the most complex networks of all, has shown that neural networks have characteristics of "small-world" and "scale-free" networks, display hierarchical modularity and rich club organization. Brain network organization, which is under strong genetic control and displays a characteristic pattern during development, is crucial for optimal functioning and information processing.[1] Increasingly, network science is applied to understanding psychiatric and neurological disease such as Alzheimer's disease, Parkinson's disease, epilepsy, brain tumors and multiple sclerosis.[2] One interesting pattern that emerges from network studies in neurological disorders is that many of these conditions, despite considerable differences in the pathology at the cellular and molecular level, show progressive involvement of highly connected and metabolically active hub nodes in the pathological process. Network aspects of neurological diseases are now also studied with large-scale computational models of the brain. This model work has suggested possible explanations for the characteristic involvement of hubs and typical spreading patterns of pathological proteins in Alzheimer's disease. An important challenge for future work will be the development of individual level models of brain networks, which would enable simulations to predict future disease course and response to treatment in a personalized medicine framework.[3]

References:

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