Applying network science to better understand anesthetic drugs

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Video Abstract

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Abstract

For an anesthesiologist, medically induced transitions between conscious and unconscious brain states are just part of the daily routine. But precisely how general anesthetics produce a state of unconsciousness isn't all that clear. That's because researchers are missing a key piece to the puzzle: no one has been able to definitively pinpoint exactly where consciousness comes from. The prevailing idea is that there's no single "seat" of consciousness – it's more the product of multiple interactions occurring throughout the brain. A recent review article published in the journal *Anesthesiology* argues that, because of this global network property, the field of network science could provide the framework needed to more comprehensively understand the biological basis of consciousness...and by extension the principles underlying anesthetic-induced unconsciousness. Network science takes highly complex systems and breaks them down into their most fundamental parts: nodes, which represent the distinct actors within a system, and edges, which form the connections between nodes. Taking the US airline system as an example, nodes can be used to denote each major airport, while edges represent the connecting air routes. Looking at these elements in the form of a two-dimensional map reveals key properties such as how nodes cluster together or the average number of edges needed to connect any two nodes. These relationships shed light on the linkages that exist between a system's parts and help reveal how dynamic interactions among these links generate emergent behaviors. Anesthetics clearly act on the brain at multiple scales, affecting neurons, circuits, systems, and the global brain network. Applying the principles of network science to integrate these varied levels of organization could offer a new glimpse at how anesthesia disrupts the brain's capacity to generate and assimilate conscious thought. Such insight has the potential to enhance scientific understanding of anesthetic drug actions. It's possible that loss of consciousness, recovery of consciousness, and specific altered cognitive functions could be predicted by looking at network architectures and their dynamic responses to anesthetic interventions. These predictions, in turn, could contribute to new ways of controlling neurologic function in the operating room.