What Nurse Leaders Should Know About Complex Adaptive Systems Theory

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The purpose of this article is to provide an overview of key concepts in understanding complex adaptive systems theory (CAS) and its application to nursing management. CAS concerns altering management practice and revolutionizing how nurses think, behave, and problem solve. CAS discards former beliefs and embraces the concepts of self-organization and attractors (catalysts that allow new behaviors to emerge spontaneously) that enable order and creativity to emerge. Stressing that the most powerful processes begin at the micro level of an organization with the staff, complexity science offers nursing leadership new strategies for successfully navigating chaotic, complex times in health care management.

Nursing leaders are struggling to maintain a sense of control and predictability as hospital environments become increasingly more complex. Nurse leaders are key players in service redesign for health care improvements. Complex adaptive systems theory (CAS) is a new paradigm that is attracting nursing leaders and health care institutions to workshops and presentations within the United States. For example, in 1995, Voluntary Hospitals of America (VNA) began providing workshops on CAS to health care administrators. Originally an alliance of more than 2,200 nonprofit and community hospitals as well as physician practices, VNA became the Plexus Institute in 2000. Plexus's mission is to support an environment that fosters “the health of individuals, families, communities, organizations and our natural environment by helping people use concepts emerging from the new science of complexity” (About Plexus, 2004). In September 2004, the organization offered the first conference devoted entirely to nursing and complexity science.

CAS integrates easily with nursing values and beliefs. CAS challenges prescriptive management approaches that view organizations as biological processes that are nonlinear and adaptive in behavior, rather than inflexible and predictable machine-like behaviors with cause-and-effect relationships. CAS provides a different pathway for nurses to understand the meaningful interconnectedness of adaptation and behaviors. Embracing concepts of self-organization (the whole is greater than the sum of its parts) and attractors (catalysts in which new behaviors originate), CAS allows order and creativity to emerge. CAS moves away from the reductionist approach of examining the parts to a holistic approach of viewing the whole, recognizing the fundamental interdependence of all phenomena. CAS frees nurses leaders from previous prescribed behaviors that stressed prediction, forecasting, and control to behaviors that aim to build strong relationships with the freedom to produce creative outcomes. Doing so results in cost containment, increased production, and higher satisfaction (About Plexus, 2004; Santosus, 1998).

This article provides an overview of the key concepts inherent in understanding CAS. Basic management concepts that encourage development of an environment in which complex adaptive systems thrive are also discussed.

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(McEloy, 2000); thus behaviors emerge through adaptation and learning. Organizations learn from previous building blocks that allow them to adapt based on past knowledge and present environmental pressures.

Closely aligned with CAS is chaos theory. Both theories share several key elements. CAS and chaos theory describe complex systems that have patterns of behavior from which spontaneous self-organization emerges, behavior is nonlinear, and small changes can cause large effects. Chaos describes behavior as either orderly or random. All chaotic systems have behaviors that appear random and disorganized; order is hidden deep in this seemingly random behavior. CAS adds a third dimension, the edge of chaos, which lies between stability and chaos and where creativity thrives. Whereas chaos theory studies

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how change affects a system (organization) over time, however, CAS examines how complex adaptive systems (organizations) adapt to changing environments over time (Hayles, 1999).

One of the most significant attributes of CAS is emergence. Change is a result of the interactions or interconnections between different systems or people from which new behaviors emerge. CAS studies the processes of self-organization that are not imposed from external sources or traditional hierarchical control (Zimmerman, 1999). CAS examines emergent order in what is otherwise a very disorderly system that pushes life toward the edge of chaos. Emergent order is important to nurse leaders because it evolves from the staff as teams are spontaneously formed. Allowing teams to form on their own encourages a culture of care and connection in which staff are highly responsive to the needs of their units. Problems solved from those closest to them are much more effective than those imposed by higher authorities.

CAS stipulates that attractors, fitness landscapes, and feedback loops are key components to understanding and thriving at the edge of chaos. These key components will be further discussed to provide a clear view of CAS.

The Edge of Chaos

A unique key concept of CAS is the edge of chaos that lies between order and chaos, where behaviors or groups can undergo spontaneous self-organization, producing innovative and creative ideas. As nurse leaders, staff need to be pushed to the edge of chaos so that creativity and flexibility can thrive. New ideas are encouraged, supported, and implemented, as is risk taking. The edge of chaos is the region where change occurs; the environment is unpredictable but exciting, bursting with new ideas and innovations. At the edge of chaos, self-organization results from interactions between people. Nurse leaders need to create an environment in which relationships reflect trust, comfort, acceptance, respect, risk taking, and flexibility. The edge of chaos is unstable enough to push the environment to an infinite number of new behaviors and to allow new ideas to spontaneously emerge. Unlike more stable zones, however, the edge of chaos is not structured, so most behaviors and/or outcomes cannot be accurately predicted and instead new behaviors emerge based on learned past behaviors.

Penrs (2003) observed that nurse managers and nurse educators moved from the stable zone to the edge of chaos during the design and implementation of an educational program for a newly implemented clinical service. The education of staff and nurse managers was essential for the success of the new service. There was resistance to the program from nurse managers as well as from the nurse educators, which was significantly affecting its success. There was also distrust among nurse managers and nurse educators. The new clinical services redesigned patient flow and subsequently management of personnel was changed. This led to many nurse managers fearing losing patient volume, staff, and/or scope of management control. It was necessary to move the nurse managers and nursing educators into the edge of chaos, away from an environment that encouraged stability and remaining the same. Deliberate conflict was developed by threatening their environment: An outside consultant was to be hired to implement the services. With the realization that the nurse managers and educators would lose even more control, they immediately called a meeting that excluded upper management involvement. By the time the meeting took place, new groups had spontaneously emerged in which nurse managers and educators, who previously would not work with each other, developed a plan of action to deliver education to the involved nursing staff. The meeting took less than 2 hours, yet the educational program developed at that meeting was extremely successful, new, and creative. The consultant was never hired.

Fitness Landscapes

One of the more difficult concepts of CAS to grasp is that of fitness landscapes. The ability of an organization to adapt relies on its fitness landscape, which in turn is dependent upon its interactions with other organizations. Organizations are always competing and co-evolving. For example, within a community that has several hospitals, each hospital is competing for similar resources. Although all organizations have their own unique environment, they also share this environment with other organizations, especially related to cost, reimbursement, nursing staff, and patient populations. Thus, change at one hospital will affect all other hospitals that share the same environment, forcing some response or reaction (of course, doing nothing is one response). This is also true of a nursing unit; as one unit makes changes, other nursing units are positively or negatively affected depending upon how each unit elects to adapt to that change. Because change cannot occur without its effects rippling into other competing areas or units, both competition and co-evolution work together, as characterized by dynamic equilibrium and causing continuous changes in outcomes (Sed, 1999). Thus, each nursing unit is dependent on another nursing unit as each hospital is dependent on the actions of other hospitals and must adapt to change caused by internal and external factors in order to survive.
During change, either the organization adapts and continues to thrive, or it does not adapt and slowly becomes extinct. Interactions between different groups of people, different units, or different hospitals form webs of feedback loops that move the organization to its fitness landscape. For example, one hospital may be more successful at recruiting nurses than another hospital within its geographical location because it has recently added new benefits for nurses. As Figure 1 illustrates, this hospital is “fitter” and more successful than other hospitals, as reflected in the highest peak. Over time, due to competition and coevolution, the other hospitals in the environment also became “fitter” and develop their own unique benefit packages for nurses (see Figure 2). Because the environment is constantly in a state of fluctuation, the hospital that is the “fittest” (most appealing to the recruitment of nurses) changes over time depending upon which hospital best meets the needs for nurses within its environment.

If the competing hospitals are equally fit at attracting nurses (Figure 2), the landscape will appear to be flatter. If one hospital can recruit more nurses than the others, and becomes more fit than the others, the landscape will have a large projection (mountain peak) next to the relatively flat surrounding landscapes (Figure 2). If other hospitals develop and implement new, creative benefit packages, they become more competitive to the original “fittest” hospital and the landscape again changes. A hospital may also remain “stuck” at a certain fitness point, however, as a result of a sense of stability or resistance to change. Benchmarking offers an excellent method to compare one organization with others, allowing hospitals to adapt to the changing environment.

CAS asserts that all behaviors, including complex ones, evolve from simple basic rules that lead to countless possible outcomes of management actions that cannot be predicted. New outcomes are a product of such change. An excellent illustration of this concept is the human cell. As a single unit, the cell has little hope for survival. In the human body, the cell works together with billions of other cells, competing and coevolving to adapt and survive. This is similar to a nursing unit; one staff member or manager cannot be examined in isolation of all others to understand how the unit functions. Only through the interaction of staff, patients, physicians, and countless other people does the unit take on its own identity. How the staff responds to change from numerous internal and external stimuli determines adaptation and where their unit will be on the fitness landscape related to other units within the hospital.

Those units that are found on the highest peak are the fittest and strongest and will survive. Those that cling to old behaviors eventually will have to succumb to chaos and disorganization in order to move change forward or risk becoming extinct.

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Figure 1. “Fitter” Hospital #1.

Figure 2. “Fitter” Hospital #2.
Feedback Loops

Another fundamental principle of CAS is that local or individual behaviors can generate broad changes, accomplished through different interactions that form webs of feedback loops. Complex systems are not complicated; simple rules generate complex behaviors. Intricate feedback loops reshape the organization of work and, in turn, the architecture and structure of the organization. Both negative and positive feedback loops affect how an organization will behave in the future. Thus, the relationship or feedback loops that are formed between different groups or departments are much more important than the individuals themselves. Sufficient feedback from the surrounding environment is essential to adapt successfully to any change.

Interestingly, feedback loops do not have the same desired outcomes stipulated by leading management theorists, who emphasize that feedback loops serve to produce homeostasis. CAS emphasizes that feedback loops are critical for communication within an overall organization because they feed new, creative information to all its levels. CAS pays particular attention to the informal communication networks within an organization where tightly woven interconnectedness and feedback loops serve to rapidly but indirectly communicate information.

Understanding the importance of tightly interconnected feedback loops, one regional medical center in the Northeast redesigned a patient delivery system. It took almost a day for patients to be admitted to the hospital and begin antibiotic therapy. Using a CAS approach, small changes and a bottom-up approach, the Vice President of Nursing (VPN) brought together a diverse team (secretaries, doctors, nurses, and administrators) to determine how they could decrease waiting time. After several different approaches, within 5 months admission time was reduced to 1 hour (Santosus, 1998). The team served to develop feedback loops within the hospital at all levels and acted to communicate information continuously and indirectly to the rest of the staff.

Attractors

Attractors are something that an organization, group, or individual is naturally drawn toward. Attractors are the prerequisite to order (Kauffman, 1995) and govern behavior over time (Walls & McDaniel, 1999). Attractors emerge out of the organization as it tries to adapt to its environment. In CAS, attractors serve as excellent memory banks with the ability to retain information over long periods, yet they are vibrant enough to process the information. Attractors also serve as road maps for future behaviors that are composed of memories or past experiences. Behaviors mediated by attractors produce variations of responses dependent on past memories and present information that, in turn, produce new behaviors. Finally, attractors often function as feedback loops to behaviors.

Attractors serve to determine how change will happen. There are two types of attractors: stable and strange. Stable attractors hold behaviors to predictable patterns; the meaning is well defined and understood by the organization. The information carried by stable attractors leads to more predictable behaviors and outcomes, such as titles of administrators and work attire that can indicate power, reinforcing certain beliefs within the organization and encouraging prescribed behaviors. Stable attractors encourage the status quo and stability, returning the organization to its original position. Thus, stable attractors keep the environment in homeostasis, leading to more predictable behaviors that are less creative and innovative. For example, in a very stable hospital environment, the VPN has considerable positional power because the attractor of the title alone has a strong, developed network of meaning that reinforces power. Often directives by the VPN are followed even if staff believe that the decision is not in the best interest of their units.

There also are "strange attractors." Strange attractors are hidden within the environment and do not carry information laced with memory. Instead, strange attractors take on new meaning that is being defined at the edge of chaos. Strange attractors can be very powerful factors that significantly influence behaviors and outcomes. An example of a strange attractor is trust (Penprase, 2003), which can be continuously redefined within an organization. Although trust is constantly changing, it also carries significant memories and meaning (Baba, 1999).

Unstable attractors can lead either to more creative or to less desirable behaviors. Using the same example of "title," in an organization where the VPN position has turned over several times in as many years, the attractor of "title" has changed and has much less power than before. Staff also may be less respectful and responsive to this unstable position. A new VPN will have to prove her/his worth to staff before staff will begin to trust (old attractor) and follow the VPN's directives (Penprase, 2003). Unstable attractors can be positive as well. In the same scenario, a new VPN can introduce new ideas to nursing management and staff if they are more readily adapted because the environment is thriving at the edge of chaos. New ideas result in spontaneously regrouping of staff into positive energies and change (Penprase, 2003).

How CAS Works

CAS provides nurse leaders with a theoretical approach to deal with change in a novel way. It encourages staff to spontaneously regroup around attractors by communicating information and responding to change. CAS explains how complex organizations can adapt over time through patterns of relationships. These relationships are dependent upon attractors that act as catalysts to the formation of spontaneous self-organized groups where outcomes emerge (Burns, 2001). Knowing the history or past performance of an organization’s response provides insight into the building blocks of how it may progress in the future.

CAS describes organizations as learning environments where behaviors are always changing and responding to environmental
needs, leading to adaptation. Benchmarking with other organizations helps nursing leaders to understand their own fitness landscape. Striving to change and improve by competing and coevolving with other organizations leads nursing departments to the edge of chaos. Fundamental to CAS is that creativity and innovation abound at the edge of chaos; thus, nurses must strive to move their environment to the edge of chaos to successfully compete and create organizations conducive to change. Often this means introducing processes that cause disruption to a stable environment.

CAS does not imply that organizations forgo “ordinary management” (Stacey, 1993) that is responsible for carrying out day-to-day problem solving involving data analysis, goal setting, or evaluation. “Extraordinary management” (Rosenhead, 2004) is needed, however, to transform nursing departments and push nursing staff and their environment to the edge of chaos.

Application to Nursing Management

Unfortunately, behaviors that guide patient care by nursing staff are significantly different from those that guide nursing management. The need for power and control by nursing leaders has developed a culture of oppression (Ray, Turkel, & Marino, 2002). Many nurse leaders manage through control, thereby causing staff to lose trust in management while at the same time management becomes disillusioned with staff (Penprase, 2003).

An example of CAS through nursing leadership is illustrated by a VPN at a medical center in the Northeast (About Plexus, 2004). In 2002, when the VPN was attempting to implement a new community outreach program, she became frustrated with her staff’s lack of ability to move the nursing department forward to adopt a community outreach program that was needed within their hospital system. In response, she disbanded previous committees that had been formed to develop and implement strategies for the new community outreach program and instead implemented a CAS framework for institutional change. She promoted her vision of what she hoped for the new community outreach program, stressing its importance to the community and the hospital. In doing so, she gave the staff three basic and simple rules to follow: any nurse could take up to a half-day a week to undertake a community health interaction that s/he cared about; nothing could be done that was illegal; and nurses could take funds needed to support the initiative from the nursing department’s outreach budget. Within a short time, 27 projects had been initiated, some more successful than others, but all that helped create a very successful community outreach program. Through a clear vision, simple building blocks, and the freedom to spontaneously regroup into similar interests, results were quickly obtained.

A role of nurse leaders is to create and determine the purpose of nursing within their organization. According to CAS, strategies such as long-term planning over 3 to 5 years must give way to short-term goal setting and creating clear visions that will enable organizations to remain flexible and adaptive. The leader’s role is to decipher trends, assist staff to accept and adjust to changes, support coordination of the different elements of change, and help the nursing department to maintain its focus and identity as it moves through a turbulent health care environment. Kaufman (1995) claims that knowledge helps avoid obvious mistakes in management, such as trying to impose authoritarian leadership. Knowledge is the starting point, “but beyond that our best strategy is to get out of the way and let the system seek its own level” (Marion, 1999, p. 267). Nurse leaders need to anticipate and invite surprise rather than to fear it. Unpredictability needs to become acceptable, so nurse leaders no longer focus on long-term goals, but instead focus on current situations where adaptation to change is most acute.

Strengths and Limitations of CAS

CAS is an exciting theory that offers new, innovative ideas for nurse leaders to motivate staff toward change and adapt to the turbulent health care environment; however, it is a difficult and broad theory to understand. Defining key terms can vary. CAS evolved from the physical sciences of mathematics and physics, where behavior at all levels of an organization was conceptualized as being nonlinear. Here the understanding that behaviors spontaneously emerged without intervention became known. The transition to behavioral sciences such as nursing has been slower, with research predominantly focusing on management applications.

Research supporting nursing management practices has been primarily qualitative and is limited (Penprase, 2003; Ray et al., 2002; Turkel & Ray, 2000). Using a CAS theoretical framework, applying quantitative methodologies to observable data has been challenging because it is difficult to define and identify which variables could adequately represent the state of nursing practice. CAS has the capacity to broaden nurse managers’ understanding of chaos theory by thinking about nursing as a complex adaptive organization that is continuously interacting with its environment and other organizations.

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There is no research related to nurse leaders about the application of CAS and its indicators/outcomes in the nursing environment. Hunterdon (About Plexus, 2004) and Santosuos (1998) give examples of the application of CAS that are not research-based. There is no formal validation demonstrating that CAS supports management style, structure, and process (Rosenhead, 2004). CAS is a new paradigm and research has focused on the theoretical components rather than on application. Research application in CAS has been reserved for mathematics and physics. Research related to application of CAS to nursing management is needed to validate the assumptions of this theory.

Summary

As hospital environments remain challenging and unpredictable, CAS offers a new approach to managing complex health care systems that is attracting much attention in the United States (Burns, 2001; Walsh, 2002). CAS discards notions of control and predictability and allows creativity and innovation to guide
behaviors to the edge of chaos where staff can thrive and grow into future health care leaders. Organizations and management scholars have acknowledged the existence of complexity within organizations for decades. Before CAS, chaos theory dealt with the need to impose order and moved management away from believing organizations run like machines to nonlinear thinking where behaviors are unpredictable. CAS makes sense of chaos. Within all chaos there are patterns of stable behaviors that act as catalysts for change. Today, CAS is perceived as a natural evolution of behavior by organizations and encourages understanding that behavior is not predictable. It is a necessary state of survival in which order and new behaviors emerge spontaneously out of disorder and seemingly random behaviors.

A significant principle of CAS is that management cannot mandate institutional change. Change arises out of the spontaneous grouping and regrouping of individuals around attractors. CAS offers nursing leaders new strategies for shepherding nurses through these chaotic, complex times. Developing a clear vision, offering simple rules, and having the freedom to group around common interests are basic tools for managing within a CAS system. With each encounter between a nurse and a patient, nurses apply CAS at the bedside. The transition to management is only a short leap away, one that already has strong building blocks and feedback loops in place so that nursing can easily adapt to its changing landscape through a CAS framework.

References


Offprints

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