Chaos, complexity and nursing


Summary

Chaos and complexity theories have implications for nursing practice. Chaotic systems, potentially including health, the NHS and nursing, are governed by rules which should be understood in order to try to predict future behaviour. Complexity relates to the interconnectedness of things and fits neatly with the concept of holistic care. It can also make important contributions towards restructuring and reorganising nursing.

Introduction

Many conventional ideas about the world we live in have been shaken to their foundations by the emerging concepts of chaos and complexity. These new scientific theories are being applied with startling results in the social and natural sciences, particularly in the biological field.

Insights are now being gained from the application of complexity theory into phenomena varying in scale from ventricular fibrillation to the spread of epidemics. Nursing therefore needs to be aware of these new scientific ideas as they have significant implications for the theory and practice of nursing.

Chaos and complexity theory encompasses a large field. However, in this short article three key ideas will be introduced which are of relevance to nursing:

- Dynamic systems behave in an apparently unpredictable and chaotic fashion, making predictions of future behaviour impossible unless the rules governing chaotic systems are understood. Health can be argued to be a dynamic system.
- The whole is greater than the sum of the parts, therefore reductionism is severely limited in its use as a tool in health care.
- Boundaries between dynamic systems are naturally fragmented and fuzzy, consequently trying to draw sharp lines between nursing and medicine, for example, is fruitless.

Dynamic systems and chaos

One of the earliest and most accessible works which popularised chaos theory came from Gleick (1987). He points out that science had in the past assumed that the real world progressed in a predictable way, governed by laws and mathematical formulae which allowed accurate predictions to be made. The growth in computer power enabled scientists to push their equations further as more elaborate calculations became possible.

This led to the discovery by some scientists that, although they thought they understood some types of systems, when they tried to run them forward and predict future behaviour, very strange things happened. Predicting the weather with any accuracy beyond a few days, for example, defied the most powerful computers, despite a solid understanding of the laws governing the behaviour of the atmosphere.

It became apparent that in certain systems what happens next is heavily dependent on what happened last. These systems are very sensitive to feedback and even the slightest variation can become magnified to produce major disturbances.

This is known as sensitive dependence upon initial conditions or the ‘butterfly effect’ – so called because it has been said that a butterfly flapping its wings in the tropics can cause disturbances in air flow which become magnified so many times over by sensitive feedback mechanisms, that the result several weeks later is a tropical hurricane!

Such systems are known as dynamic systems and are distinct from linear systems which have the characteristic of proceeding in a straight line. An example of a linear system might be the catabolic processes occurring within the body after major infection or trauma. If nothing is done, body mass will decline at a steady and predictable rate due to a catabolic metabolism. However, dynamic systems can produce startling variability over short time-scales due to their sensitivity to feedback.

This variability can make the system appear chaotic and unpredictable, rather like the weather. However, computer analysis of such systems reveals that there is a deeper underlying order within the apparent chaos.

There are rules governing the behaviour of the system, hence it is referred to as deterministic chaos. The challenge is to discover the rules and determine how they operate so that we might gain insight into the apparently chaotic behaviour before us. Deterministic chaos should be distinguished from stochastic chaos which refers to random fluctuation or background noise, often distractingly superimposed upon the bigger picture.

An individual’s health behaviour is influenced by feedback from his or her actions. Small decisions...
made today can have major, unforeseen consequences tomorrow. A moment’s reflection also reveals that the NHS has the characteristics of a dynamic system in that what happens today affects what happens tomorrow, often in a very powerful and unexpected way. Sensitive dependence upon initial conditions frequently exists together with a feedback linkage between events. The basic ingredients are therefore present which allow us to view health, the NHS (and nursing) at least by analogy, as potentially chaotic systems.

The implications of this insight are simple and far-reaching; small changes today can have major and unforeseen consequences tomorrow. The corollary of which is that it is not possible to predict with any accuracy what may be all the effects of any healthcare reforms 10 or 20 years into the future, just as nobody can predict the weather, even a few days ahead. Health care is a potentially chaotic system and, until the rules governing that system have been uncovered, long-term predictions must be hedged with considerable uncertainty.

Pediani (1996) is one of the few British nurses to have drawn attention to the subject of chaos theory. He cites examples from the biological sciences, such as the observation that patient responses to medication are not as predictable as was once thought. Sensitive dependence upon initial conditions, coupled with feedback, might produce completely unpredicted abnormal responses.

We are all familiar with patients who defy the textbooks and conventional medical wisdom, to survive serious life-threatening illness for many years. Others present with a minor condition and end up critically ill on intensive care as one minor incident has a knock-on effect on something else, which affects something else and so on. Ford and Walsh (1994) illustrated this effect when they linked chaos theory to changes in nursing by referring to a well-known nursery rhyme written by Benjamin Franklin in 1758 (Box 1).

Benjamin Franklin could be said to be the first chaos theorist. His rhyme illustrates how minor incidents can have enormous consequences. You might like to complete a similar rhyme that starts ‘For want of a battery the laryngoscope did not work…’ or ‘For want of a few seconds the oxygen mask and tubing were not replaced in resus…’.

The examples do not scan particularly well, but you can see where they might lead and how such a rhyme might end ‘…and the patient was lost’.

Chaos theory therefore tells us always to expect the unexpected and never assume that because something is predicted to happen it automatically will.

When the UKCC published the Scope of Professional Practice (1992), did it foresee the changes it would lead to, not least the dramatic growth of the nurse practitioner movement? Nurses began to have a new and more liberated approach to expanding practice. This in turn opened the door to role expansion and practice development. Nurses, patients and doctors then began to realise what nurses could achieve. This feedback has led to further innovation and increasing degrees of autonomous practice unthinkable in the 1980s, including the nurse practitioner movement. Ironically, having let the genie out of the bottle, the UKCC has since seemed incapable of knowing what to do with it!

The implications are that if change is planned in health care, it should be put into practice cautiously. Those planning the change have to be prepared to live with uncertainty and expect the unexpected. Careful piloting and evaluation of new systems of working are essential so that evidence about what happens in practice can be gathered as it happens and used to influence practice as it develops. This action research approach is congruent with the basic idea of a dynamic system.

Theoretical predictions are unreliable unless you know the rules governing a chaotic system. The complete implementation of a new scheme such as the internal market is effectively done by learning from trial and error and the nation’s health is too precious to gamble with in this way. This raises questions about new initiatives such as NHS Direct, which is being rolled out without published evidence demonstrating the clinical effectiveness of pilot schemes.

Nurses might be reminded of the introduction of the nursing process 20 years ago without piloting or evaluation. Sensitive dependence upon initial conditions suggests that if a change like this has flaws in its initiation, these will become magnified as the change works through.

Nurses initially heard that the nursing process is difficult and time consuming, therefore they expected it to be so and so it turned out, leading them to tell others the same story, and so it went from bad to worse. It has been very unpopular ever since, consuming large amounts of time and producing documentation of poor quality. These consequences were not expected by those who pushed through its implementation in the late 1970s. Life is easy with the benefit of hindsight, but that is precisely the point about chaos and unpredictability – it is never possible to be sure how things will work out.
One of the key elements in chaos theory is the notion of interconnectedness and this leads into the emerging science of complexity. Put simply, this idea states that the whole is more than the sum of its parts. A more formal definition is that of Coveney and Highfield (1995) who state that: ‘Complexity is the study of macroscopic collections of such units that are endowed with the potential to evolve in time’.

The key idea in this new discipline is that systems consist of individual parts and that the effect of the parts in interacting with each other over a period of time in which they may change and evolve is far-reaching and often unpredictable. The relationships between things are more important than the things themselves, consequently it is the properties that emerge out of interactions between entities that really matter (Goodwin 1994). Reductionism is rejected in favour of understanding relationships. The concept of complexity has developed out of chaos theory (Ray 1998).

The system being discussed could be a single human body or the entire NHS. Ray (1998) has drawn attention to the relevance of this insight in nursing as it fits neatly with the concept of holism. The reductionist approach of conventional science seeks to break complicated entities down into their components which are simpler to study and understand.

Great advances in the natural sciences, including biomedicine, have been made as a result of this reductionist methodology. This has been at the cost of losing sight of the whole person as witnessed by the way medicine has fragmented into so many specialties. The tremendous growth in knowledge has meant that specialisation is perhaps inevitable, however, this has led to medicine often ignoring the question of what happens when the pieces are put back together again.

This reductionist approach leads some doctors into seeing patients as malfunctioning bits of anatomy and physiology rather than as whole persons. This problem was neatly summed up by a busy consultant hearder condemning his registrar in a hectic outpatient for wasting time talking about the patient’s problems and how they were affecting his life: ‘We’ve only got time to get on and deal with the bits we can fix,’ was his comment. A mixture of pressure of work and reductionist philosophy ensure that patients do not get treated as whole people, only as ‘bits we can fix’.

Complexity theory offers a new way of thinking about health, one which nursing has been working towards for the last decade or so. If nurses were to learn about complexity theory it could provide the scientific, theoretical underpinning to support a holistic philosophy of care.

The reductionist approach which has dominated science since the Renaissance is now being challenged by new ways of thinking based upon complexity. Studying the natural and social worlds by only looking at their component parts in isolation is missing the big picture. We have to put the pieces together again and see what emerges in the process to understand what really happens.

Complexity is a fundamental part of nature; we have to recognise that different entities will react with each other in strange and emerging ways, whether it be at the level of cellular biology or social structures such as how a hospital operates.

Not only does complexity have the potential to offer nursing a sound theoretical base and major insights into patient behaviour, it can also make important contributions towards restructuring and reorganising nursing.

This latter point is particularly relevant in view of our earlier discussions about predicting the effects of change. The lesson is that if we are planning some significant development in nursing practice, we have to look beyond nursing to begin to gauge its likely impact. Changing nursing practice affects doctors, porters, other ancillary staff, radiographers, the way stores are supplied, how care is documented and recorded, staff outside the hospital, patients, carers and a whole host of other people.

The effects of all these interactions can result in an outcome totally different to the original intended change and greater than the simple sum of the changes to the individuals involved. Chaos theory suggests that you will not be able to predict the outcome, complexity suggests you should not be surprised at all manner of unlikely outcomes. The whole is greater than the sum of its parts so the totality of change will always be greater than the individual changes that could be envisaged at the beginning.

This notion is captured in the phrase ‘It seems to have taken on a life of its own,’ which exasperated project managers are often heard muttering when a project refuses to go according to plan. This potential for dramatic change that exceeds any which was foreseen could explain the strong resistance encountered when an apparently simple change proposal is advanced. Staff soon to be moving into the next wave of new Private Finance Initiative (PFI) hospitals might ponder these ideas – plans might not transpire as intended and may indeed appear to have a life of their own.

**Boundaries: fractals, fuzz and fragmentation**

The term fractal simply means that a boundary retains the same complicated shape, no matter what scale it is viewed on. However much the boundary is enlarged, new details and new areas of overlap will always emerge. It seems impossible to resolve the boundary clearly so that all eventualities are neatly split either side of the boundary. In nursing and health care we spend a great deal of time arguing about boundaries,
hence the relevance of gaining new insights into boundaries.

Consider naturally occurring phenomena such as gender and life. Surely there is a simple boundary that can be drawn separating male from female, or alive from dead, as they are opposite conditions. For example, there will be no confusing a man and woman – one is male, the other female. However, this does not mean that it is possible to draw a simple line that delineates all males from all females. There is much complex detail and many grey areas at the male/female boundary, ranging from chromosomal abnormalities through a whole range of psychosexual problems such as transsexualism, transvestism and on to fashion trends involving one sex adopting the conventional dress characteristic of the other.

Even the boundary between alive and dead has the same problem. Although it is generally easy to distinguish between a person who is alive and one who is dead, it is impossible to draw a neat line that delineates all things dead from all things alive. On which side of the line does a virus or a prion sit? Where is the patient in a persistent vegetative state or in those crucial few minutes of cardiopulmonary arrest during a resuscitation attempt? Nature does not allow neat lines that divide all eventualities into different conditions. Instead there is a fractal fuzz – grey areas abound and there is a multiplicity of crossover conditions. There is not a simple clear-cut boundary.

However in health care we expect such boundaries. We draw lines and say this side of the line is nursing, that side is medicine. Nurse practitioners do not comply with that kind of professional apartheid, which is probably why the UKCC and some nursing leaders find them so difficult to understand. They have adopted parts of medicine and located these skills within a holistic nursing model.

The UKCC and nursing as a whole have also propagated this artificial view of boundaries into primary health care where we find no fewer than eight different types of community specialist nurses separated off by professional boundaries. Yet experience shows there are great areas of overlap between them, both in terms of educational preparation and practice. Nature does not produce clear-cut boundary conditions in complex situations, so why should nursing? Grey and blurred boundaries are the norm in nature. The lesson of chaos theory is that nursing is being unrealistic in demanding clear-cut dividing lines which cannot be crossed.

**Conclusion**

As a nurse reading about chaos and complexity, I have found rational explanations for many things that have puzzled me about nursing. These ideas explain why things never go according to plan, as development projects either get stalled early on or appear to take on a life of their own. We should not struggle to define boundaries so precisely that all possible conditions are separated off by them. Instead we should accept that boundaries in nature are fuzzy and fragmented areas of overlap and not waste time arguing about which professional group should do what; rather, it is about the best qualified person carrying out care for the patient’s benefit.

Complexity and its notions of interconnectedness gives nursing a theoretical and philosophical underpinning for practice that has much more to offer than the limited reductionist approach of traditional science. Modern scientific thinking can help nursing if we are prepared to accept the challenge of looking outside our traditional narrow field of theoretical endeavour.

The application of complexity theory to nursing would make an excellent topic for a conference which might indulge in some ‘over the horizon’ speculation, and explore the future foundations of nursing.

**REFERENCES**


