Special Article

# Chaos Theory and Nursing

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**Abstract**

The Chaos Theory, which explains how a complex and unpredictable system behaves, shows that there exists a system within irregularly visible systems, it has affected all fields of science towards the end of the 20th century. In the Chaos Theory, it is impossible to understand and predict all of the dynamic system (non-linear systems), where small changes in a system lead to greater change in the process (sensitive to the initial state), similar to the smallest part of a whole (fractals). It is stated that behaviors occurring in systems are not random and that there is an atractor causing the behavior. The complex structure of biological systems studied in life sciences allows the use of the Chaos Theory in these areas. The focal point of all approaches to complex structures allows the application of Chaos Theory within the health sciences. In this review, the treatment and care initiatives for meeting the health needs of nurses, patients or healthy individuals who face most problems within the health care system are dealt with on the basis of Chaos Theory.

**Keywords:** Chaos Theory, health sciences, nursing, nursing care

## Introduction

Chaos Theory, a combination of conceptual, mathematical and geometric methods, deals with nonlinear, complex and dynamic systems characterized by its fractal structure (Gokmen, 2009; Tuna-Orhan, 2013). The concept of Chaos Theory dates back to ancient Greek and Chinese civilizations. Part of the important works that influenced Chaos Theory was carried out by the French mathematician , Jules Henri Poincare , in the 19th century. Poincare, in his study on the problem of 'three bodies', reported that multidimensional systems were too complex to be predicted and used the term 'chaos' for the first time in technical terms. Bertalanffy defined the system as a common and complex structure with a mutual interaction (Diker & Okten, 2009; Gokmen, 2009).

The beginning of Chaos Theory in the modern sense is based on the work of Meteorologist Edward Norton Lorenz. In 1963, Lorenz wrote an algorithm to model weather events through his computer to monitor the behavior of the weather. This program works on a system of three differential equations. Lorenz observed the behavior of this system and how the parameters changed relative to each other, and in this modeling he discovered the 'Atractor', which represented the order in complexity described in Chaos Theory. In addition, when entering data into the program, in order to save time, he ignored parts of the numbers after the comma (for example, 0.506 instead of 0.506127). However, he pointed out the important differences that arise in the outputs he obtained and showed a sensitive commitment to the initial situation **(Figure 1 )** (Gleick, 2005). Over time, the dynamic system in Chaos Theory is unlikely to be understood and predicted (non-linear systems). Small changes in a system, leading to larger changes in the progressive process. (sensitive commitment to the initial state), fractals-self similarity, the behavior occurring in the system is not random and it is declared that a hammer that causes behavior (Rickles, Hawe, & Shiell, 2007; Samur & İntepeler, 2017; Tuna-Orhan 2013).

**Basic Features of Chaos Theory - Sensitive to The Initial State**

In a system according to Chaos Theory, the small changes that occur in the beginning cause large changes in the process. ''Sensitive to the initial state'' It is possible to explain this property by the butterfly effect reported in literature. It is said that a butterfly flapping wings in Beijing will cause hurricanes in Washington. Of course, it does not lead to a butterfly hurricane flapping its wings, but it is important that a butterfly's wing flap is not neglected in the estimation of a hurricane (Gleick, 2005; Tuna-Orhan, 2013).

**Fractal Structure**

Fractal structure is an expression that refers to self-reflection or proportional break. A section of the Manldelbrot cluster found by Benoit Mandelbrot shows a cross-sectional view of a whole, similar to the smallest part of a whole **(Figure 2)**. Likewise, the Koch curve (Snowflake), defined by Helge von Koch in 1904 **(Figure 3)**, has the characteristic of being present in the fractal structure. To configure a Koch Curve, a triangle with a side length of one unit is drawn. A new triangle is added to the middle of each edge, one-third the size. Koch snowflakes are formed when additions are continued. When a close section of the Koch curve is observed, fractal structures, one of the main features of the chaotic structure, are observed (Chaffee & McNeill, 2007; Varela, Ruiz-Esteban & De Juan, 2010; Samur & İntepeler, 2017).

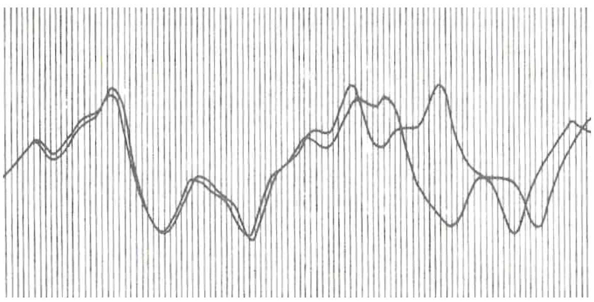

**Figure 1**. The diverging two numerical weather prediction graph **Reference:** Gleick, J. (2005). Kaos, Yeni Bir Bilim Teorisi. (F. Üçcan, Çev.). Ankara, Saner Basım Sanayi, 13. Baskı, 9-10.

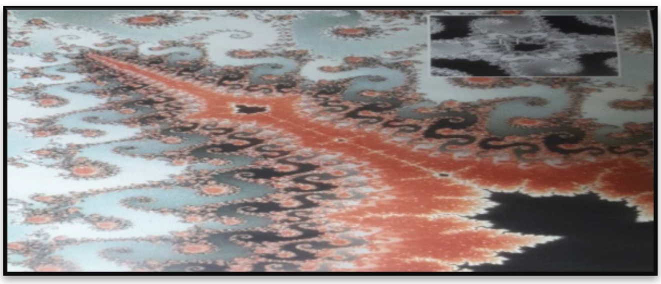

**Figure 2:** Mandelbrot Cluster **Reference:** Gleick, J. (2005). Kaos, Yeni Bir Bilim Teorisi. (F. Üçcan, Çev.). Ankara, Saner Basım Sanayi, 13. Baskı, 126-127.

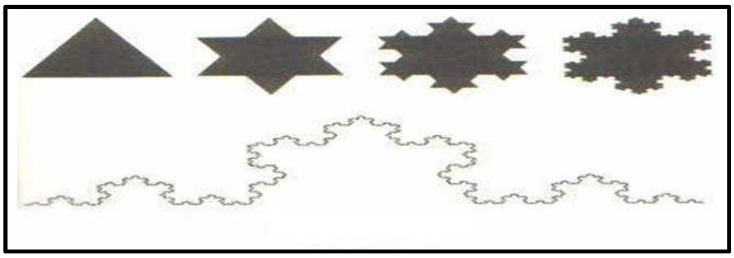

**Figure 3**. Development stages of Koch Curve (fractal) **Reference:** Gleick, J. (2005). Kaos, Yeni Bir Bilim Teorisi. (F. Üçcan, Çev.). Ankara, Saner Basım Sanayi, 13. Baskı, 114-115.

**Atractors**

One difference is the particularization of Caos Theory is the atractor. When the mathematical reflections are put on a graphic, the places which are intense are called attractors. It is pointed out that the behaviours seen in the caotic systems are not random and it is asserted there are some attractors that cause those behaviours. For example, the most intensive region in Turkey is Marmara Region. Because of its Economy, transportation and the service sectors are advanced it helps the region attract attention. In this context, Marmara region is the most prominent attractor of Turkey (Altun, 2001; Rickles, Hawe, & Shiell, 2007; Tekel, 2006; Tuna-Orhan, 2013).

**Nonlinear Systems**

The systems we see around can be described by some different features. Linearity or nonlinearity are some of its features. Linear systems are the ones who are easy to predict. For example, when we think of a machine which utilizes 10 raw materials and with those materials it produces 5 products, this machine would produce 10 products by using 20 raw materials. Hence the nonlinear systems are the ones who are unpredictable which depend first conditions. For example, when we think of a nonlinear machine, by using 10 raw materials it may produce 1,2,3 and 10 products or nothing which depend on its first conditions. Nonlinear sytems are the basic feautures of Chaotic sytems (Higgins, 2002; Yıldız, Fidancı, Konukbay & Suluhan, 2016).

**Chaos Theory –Human**

The biological, psychological, social and cultural aspects of human beings are complex and predictable up to a certain point, allowing us to implement Chaos Theory. The coincidental, irregular and irreversible distribution of useful energy in any physical or chemical event is defined as entropy. Entropy states that everything in the universe is moving towards disorder, and there is an irregularity in the order. For example, the emergence of a star, the continuous loss of heat over time and the path towards the disorder and its disappearance are typical examples of this situation. Typical examples include the release of glucose in the human body, of glucose in the mitochondria, of adenosine triphosphate, of death of millions of cells and of the formation of new cells. The fact that there is homeostasis (inner balance) against the existing entropy in the human body and that it continues until death shows the order that exists in our body. This situation is an express and open example of regularity inside irregularity as per this Chaos Theory (Janecka, 2007).

Looking at the human body, which is the cornerstone of complex structures, each organ has its own unique microstructure and unique chemistry. Examining the samples of chaos in the human body; In the heart of the ventricle fibrillation, electrocardiogram strips, lung bronchial branching, and the exchange of information are observed to follow the chaotic rules of information exchange. When the electroencephalography images are analyzed, it is seen that there is an order in the human brain in irregular pullers (chaotic properties). The condition of this disorder, which expresses chaotic structure, causes disease.

**Chaos Theory and Nursing**

The Chaos Theory, which explains how a complex and unpredictable system behaves, by the end of the twentieth century, it influenced all fields of science. The complex and unpredictable biological, psychological and socio-cultural structure of human beings, who have an important place among the basic concepts of nursing, allow the application of Chaos Theory in nursing science (Haigh, 2008; Samur & İntepeler, 2017).

As previously stated, Small changes in a system in Chaos Theory are known to lead to greater changes in the process. ‘‘Sensitive to the initial state(butterfly effect)’’ is expressed as, especially in the intensive care unit, bronchospasm due to endotracheal aspiration and a decrease in oxygen saturation, sample can be given. In cases where necessary nursing care interventions are not performed, impairment of general condition related to deterioration in all other hemodynamic parameters, described in the theory of chaos ‘‘Sensitive to the initial state (butterfly effect)’’ can be explained by. In this context, a decision on a patient or a healthy individual can lead to a large and unforeseeable outcome for the patient or healthy individual in the course of the process. With this approach, it can be determined by examining the onset of the disease development process and new approaches can be revealed in the early diagnosis of diseases (Janecka, 2007; Lett, 2001).

It is stated that behaviors occurring in chaotic systems are not random and that there is a attractor which causes this behavior. For example, the lack of water in the desert causes the desert ecosystem (plants and animals) to collect around water resources altogether. The serious importance of water in the desert ecosystem makes it attractive. The patient or healthy person in which the treatment and care interventions are applied and the focus of health care professionals can be given as examples of attractors expressed in Chaos Theory (Tuna-Orhan, 2013).

Another feature of Chaos Theory is the similarity of the parts that make up the whole and the parts that make it up, and the fractal structures that indicate that no part of a whole can be thought apart. Fractal structures are similar to the holistic approach that advocates the need to address all dimensions of the individual in the planning and implementation of nursing care (Haigh, 2008).

Non-linear systems are unpredictable systems depending on initial conditions. Despite the same treatment and care protocol for two individuals with the same clinical features, clinical course may vary. Different initiatives can be applied to individuals in the treatment and care process. Therefore, individuality is at the forefront in all stages of nursing care. This feature in Chaos Theory is in parallel with the individualized care understanding that is of importance in treatment and care (Janecka, 2007; Lett, 2001).

## Conclusion

The nurse, who seeks solutions to complex problems in the health care system, can meet the needs of the patient or healthy individual, taking into account the characteristics of complex events described in Chaos Theory.

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