



Application of Roy Adaptation Model: Using Artificial Intelligence-driven Immersive Virtual Reality As a Novel Technology for Cancer Pain Management among Patients with Advanced Breast Cancer

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ABSTRACT

Background: Patients with advanced breast cancer often experience severe physical and psychological symptoms, including pain. Poor pain management is still prevalent despite the widespread availability of opioids as well as guidelines from the World Health Organization, professional training, and the availability of pain management alternatives. Consequently, researchers and healthcare practitioners have directed their efforts towards non-pharmacological approaches, such as artificial intelligence and virtual reality. Recently, AI technology has been used to develop advanced virtual reality systems that adapt and respond to human behavior in a highly intelligent and interactive manner. **Purpose:** This study aimed to structure a conceptual framework guided by the Roy Adaptation Model (RAM) for implementing AI-driven immersive VR in managing pain among patients with advanced breast cancer. **Methods:** A conceptual study framework was structured to use artificial intelligence-driven immersive virtual reality as a novel technology for pain management among patients with advanced breast cancer guided by the (RAM). **Results:** According to the proposed conceptual framework, it has been determined that healthcare providers can use the structured conceptual framework guided by the Roy Adaptation Model to adapt a nursing-based intervention, such as AI-driven Immersive VR for pain management among patients with advanced breast cancer. Adopting this intervention will help patients achieve a state of adaptation by addressing various modes of adaptation to manage pain, including physiological-physical mode, self-concept mode, role function mode, and independence mode. **Conclusion:** Roy Adaptation Model (RAM) is a highly valuable conceptual framework that plays a crucial role in guiding the use of artificial intelligence-driven immersive virtual reality as a novel technology for pain management among patients with advanced breast cancer. **Implications for Nursing:** By utilizing RAM, nurses can enhance their abilities to facilitate effective innovative nursing interventions such as artificial intelligence-driven immersive virtual reality for cancer pain management and to identify all of the related stimuli that directly lead to an increase in the intensity of cancer pain and have a significant influence on the effectiveness of the nursing intervention.

Keywords: Breast cancer, Chronic cancer pain, Roy adaptation model, Artificial intelligence-driven immersive virtual reality.

What does this paper add?

1. Despite the widespread availability of opioids,

updated WHO standards, professional training, and the availability of alternative pain management

approaches, patients with cancer still have insufficient pain management. Thus, this paper discusses the effectiveness of using innovative technologies as a complementary therapy for pain management.

2. In recent years, there has been a significant shift towards exploring alternative methods for pain relief. This has led researchers and healthcare professionals to focus on the potential benefits of non-pharmacological interventions, including the use of artificial intelligence and virtual reality. Thus, this paper added new knowledge regarding the adaptation of artificial intelligence and virtual reality within nursing practice based on the existing robust framework (RAM).
3. The Roy Adaptation Model serves as an invaluable conceptual framework that guides nursing practice and assists nursing professionals in adopting an innovative non-pharmacological intervention to decrease chronic cancer pain among patients with advanced breast cancer.

Introduction

The Prevalence of Cancer Worldwide

Cancer has become recognized as a significant and prevalent health issue on a global scale, as well as constantly ranking as one of the most commonly diagnosed diseases worldwide. Moreover, cancer incidence has steadily risen during the past decades. To illustrate, according to World Health Organization (WHO) statistics in 2020, cancer is the second leading cause of death before the age of 70 in more than 112 countries around the world (Bray et al., 2021; World Health Organization, 2020). Moreover, according to recent global cancer statistics, by 2040, the number of cancer cases is predicted to increase by 47% from 2020 to 28.4 million cases in 2040, with a significant rise in transitioning (from 64% to 95%) than transitioned (from 32% to 56%) countries (Sung et al., 2021).

Breast cancer has recently surpassed lung cancer as the most widely diagnosed type of cancer. In consistence, the prevalence of breast cancer has increased over the past few years, as it is the most frequent cancer diagnosed globally (Sung et al., 2021). Based on the World Health Organization cancer statistics in 2021, there were 685,000 breast cancer deaths as well as more than 2.3 million newly diagnosed

cases (World Health Organization, 2021). Moreover, breast cancer incidence rates range from less than 40 per 100,000 females in certain Asian and African regions to over 80 per 100,000 in Australia, Northern America, New Zealand, and some regions of Europe, with a significant geographic range among nations and globe regions. However, the geographical variation in mortality was less significant, but the proportion of breast cancer deaths in transitioning nations remains higher than in transitioned countries. Breast cancer continues to play a significant role in the overall number of cancer deaths, since it is the most prevalent cancer on the globe. In addition, population growth and aging are expected to produce over 3 million new cases of breast cancer and 1 million deaths per year (Arnold et al., 2022; Rao & Mishra, 2021; Sung et al., 2021; World Health Organization, 2021).

Chronic and Breakthrough Cancer Pain

Pain is one of the most debilitating and burden symptoms among patients with cancer (Broemer et al., 2021). According to the International Association for the Study of Pain, pain is defined as “an unpleasant sensory and emotional experience associated with or resembling actual or potential tissue damage.” Furthermore, pain is a prevalent complaint among patients with cancer despite a noticeably higher emphasis on diagnosis and therapy, particularly among patients with metastatic stage, which has an impact on several aspects of the patient’s life (Gress et al., 2020 & Haumann et al., 2017).

Multiple research studies have been carried out in the past to determine the prevalence of cancer pain across various populations with different types of cancer, since the prevalence of experiencing cancer pain is statistically significant. For instance, van den Beuken et al. completed a comprehensive review of the literature by using numerous online databases to conduct a systematic search of the literature published between September 2005 and January 2014, where 122 research studies were selected for the meta-analyses on pain prevalence and intensity. The review's findings revealed that the prevalence of pain was 66.4% among patients with advanced, metastatic, or terminal disease, followed by 39.3% after curative treatment and 55.0% during anti-cancer therapy. Moreover, using a numerical rating scale, 38.0% of patients reported experiencing moderate to severe pain, and the participants scored their level of

pain at five or above (van den Beuken et al., 2016). In accordance with this finding, a recent study was carried out by Broemer et al. (2021) to determine the prevalence and severity of pain in a large representative sample of patients with cancer. A total of 3,745 cancer patients were enrolled in this study, and the study findings indicated that up to 37% of patients with cancer experienced moderate to severe pain (Broemer et al., 2021).

Despite the widespread availability of opioids, updated WHO standards, professional training, and the availability of alternative pain management approaches, patients with cancer still have insufficient pain management; approximately 30% of cancer patients continue to report inadequate pain management. Furthermore, despite the presence of scientifically validated standards, the prevalence of uncontrolled cancer pain is much greater in Asia, where it is roughly 59%, compared to 40% in Europe and 39% in the United States (Javier et al., 2016)

Breakthrough cancer pain is a prevalent and distinctive aspect of cancer pain; however, it was initially highlighted in 1990 by Portenoy & Hagen, who stated that "a transient increase in pain in a cancer patient who has stable persistent pain treated with opioids can be defined as breakthrough pain" (Portenoy & Hagen, 1990). Moreover, breakthrough pain is a brief escalation of pain that happens whether spontaneously or in response to a certain predictable or unpredictable trigger. Despite the nature of each breakthrough pain episode, recurrent episodes may have a substantial impact on patients' quality of life (Ferrero et al., 2019; Zeppetella, 2011).

The prevalence of breakthrough cancer pain significantly increases among patients with advanced cancer. In concordance, there was a recent study on the prevalence of breakthrough cancer (Canal-Sotelo, 2018). It aimed to assess the prevalence of breakthrough cancer pain in a sample of advanced cancer patients treated at an outpatient clinic. It recruited 277 patients from one outpatient clinic in Lleida, Spain, and the results revealed that more than 39% of patients with advanced cancer experienced breakthrough cancer pain (Canal-Sotelo et al., 2018). In consistence, another study was conducted by (Perez-Hernández et al., 2019) to estimate the prevalence and characterize of breakthrough pain among patients with cancer. In that study, a large sample size of patients with cancer (3,765)

was recruited, and the prevalence of cancer breakthrough pain was approximately 30%. In addition, the findings indicated that the prevalence of cancer-related pain is higher among patients at advanced and terminal stages of cancer.

Virtual Reality and Cancer Pain Management

Advanced innovations of new technology for pain management have been rendered feasible by technological advancements to promote pain management. Thus, several health technologies use cognition distraction. Therefore, virtual reality (VR) technologies have acquired prominence in the last few years as non-pharmacological pain management approaches. Virtual reality (VR) can serve as an advanced alternative suggestion for traditional psychological techniques by distracting patients from unpleasant sensory stimuli and shifting their attention to the virtual world. Moreover, virtual reality technology is increasingly becoming accessible, affordable, and effective in achieving higher degrees of realism attributable to rapid technology advancements. In addition, the nature of VR technology allows for a powerful diversion of focus away from the source of the pain, which helps alleviate it (Haisley et al., 2020; Li et al., 2018; Rodrigues et al., 2016).

A perception of immersion in a virtual world that is similar to the actual world is being achieved through virtual reality technology. Thus, in various therapeutic applications, virtual reality (VR) has recently come to be recognized as an effective non-pharmacological adjuvant treatment. Users of virtual reality (VR) can interact and immerse themselves in a three-dimensional computer-generated world. To interact with or modify the virtual environment, a VR setup typically consists of VR software, head-mounted displays (HMDs), headsets, different sensory input equipment, activity monitoring systems, and accessories like a computer mouse or videogame controller. Due to significant technical advancements and lowering costs, VR interventions are gradually becoming more accessible as pain management techniques (Grassini, 2022; Indovina et al., 2018).

The last ten years have witnessed a movement in medicine toward the adoption of new technologies, including virtual reality. Moreover, the usage of VR technology has spread from the entertainment field to clinical practice and has been demonstrated to be both

proficient and cost-effective, and the implications of VR technology are currently being investigated in a variety of medical settings, from medical training to pain management. However, VR has implications for both acute and chronic pain management (Goudman et al., 2022).

The effectiveness of virtual reality in treating acute pain has gained considerable attention and investigation. Therefore, to emphasize the effectiveness of virtual reality as complementary pain management in reducing acute pain, a comprehensive literature review was provided through a recent systematic review in order to discuss previous clinical trials of virtual reality therapy.

Virtual reality intervention has the potential to transform the way that pain is controlled by using computer-generated, realistic virtual environments. To emphasize this fact, a previous systematic review study was completed to describe and discuss the novel applications of VR as a distraction therapy in pain management, and other therapeutic clinical procedures. The review study was conducted by including 45 research articles that met the study criteria, and this review's findings gave evidence that is consistent with the hypothesis stating that VR simulations can improve pain management by lowering patient perception of pain (Pourmand et al., 2017).

Virtual reality can also serve as an effective distraction strategy for cancer patients who are experiencing burden symptoms throughout their terminal phase of life. For instance, a prospective, multi-center, single-arm study was conducted in order to determine whether virtual reality is effective in alleviating symptoms among patients with terminal cancer, where twenty participants were selected to be enrolled in this study and attended one virtual reality traveling session that lasted an average of 30 minutes. However, the session duration times were adjusted based on the preferences of the participants. The HTC VIVE VR headset and the free Google Earth VR were used to complete the session. According to the study findings, the participants who "traveled to memorable places" claimed that their pain, weariness, drowsiness, lack of appetite, breathlessness, depression, anxiety, well-being, enjoyment, and happiness had significantly improved. Additionally, there were no significant side effects during the application of virtual reality sessions (Niki et al., 2019).

Roy Adaptation Model (RAM)

Nursing theories play a crucial role in guiding, explaining, discussing, and defining the delivery of nursing care in an effective approach. In 1976, Sister Callista Roy introduced the Adaptation Model of Nursing, which has become one of the prominent theories in the field among nurses. Roy's adaptation model views individuals as complex and open systems consisting of biological, psychological, and social systems. These systems are interconnected, and individuals constantly try to maintain a balance between them and the external environment. However, it is important to note that achieving a perfect equilibrium is not always possible. The Roy Adaptation Model serves as an invaluable conceptual framework that guides nursing practice. Essentially, this model focuses on understanding and assessing individuals' ability to adapt to a dynamic environment. In addition, by enhancing nurses' understanding of the ways of individual adaptation, the model empowers nurses to facilitate effective adaptation by improving the individual's interaction with their surrounding environment. Additionally, the Adaptation Model offers a consistent nursing process that guides healthcare professionals in providing holistic care to their patients (Tomey & Alligood, 2006).

Roy's Adaptation Model (RAM) is a highly beneficial conceptual framework that significantly guides nursing practice and research studies. (Tomey & Alligood, 2006). This model specifically focuses on the way individuals adapt to their ever-changing environment and serves as a guiding tool for assessing and understanding the adaptation process. By using RAM, nurses are able to enhance their abilities to facilitate effective interactions between individuals and their surrounding environments by employing effective intervention, ultimately leading to improved adaptation outcomes. Moreover, RAM provides a consistent nursing process that directs practitioners toward delivering holistic care to their patients and ensuring that all aspects of their well-being are addressed (Tomey & Alligood, 2006).

RAM consists of four key components: person, health, environment, and nursing (Roy & Andrews, 1999). The person is viewed as a bio-psycho-social being who is in constant interaction with a changing environment. Health is defined as a state of being that is characterized by wholeness, integrity, and optimal

functioning (Roy & Andrews, 1999). The environment is seen as a complex system that includes physical, social, and cultural factors that influence the individual's adaptation (Roy & Andrews, 1999). Nursing is defined as a profession that focuses on promoting adaptation and health through the use of nursing interventions (Roy & Andrews, 1999).

According to the Roy Adaptation Model (RAM), the individual is considered to be an open system that constantly interacts with both internal and external influences. This interaction, or adaptation, occurs when

the person responds to stimuli that promote his/her overall well-being. However, if the response to these stimuli is ineffective, this can lead to negative health consequences. This system can be broken down into various components, including input (the stimuli received), control processes (the mechanisms responsible for regulating and processing the stimuli), effector modes (how the individual responds), and output (adaptive or maladaptive response (see Figure (1)).

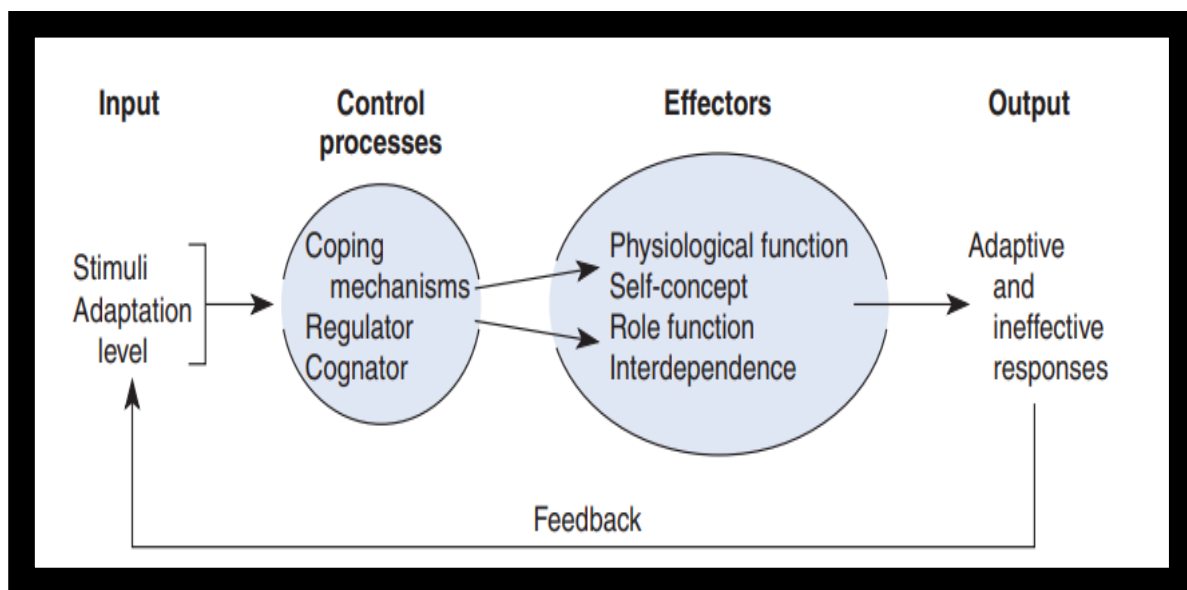


Figure 1. The Roy adaptation model

Adaptation is a central concept in RAM. It is defined as the process and outcome of individuals and groups who use conscious awareness, self-reflection, and choice to create human and environmental integration (Roy & Andrews, 1999). Adaptation occurs when individuals respond positively to environmental changes, and it is influenced by various factors, including the individual's coping mechanisms, social support, and environmental stimuli (Roy & Andrews, 1999).

RAM has been widely applied in various healthcare settings, including acute care, community health, and mental health (Roy & Andrews, 1999). The model provides a framework for nursing assessment, diagnosis, planning, implementation, and evaluation (Roy & Andrews, 1999). Nurses use the RAM to identify the individual's adaptation level, assess his/her coping mechanisms, and develop nursing interventions that

promote adaptation and health (Roy & Andrews, 1999).

Assumptions of the Roy Adaptation Model

The Roy Adaptation Model is based on several assumptions that underlie its theoretical framework. These assumptions include:

- **The person is a holistic being:** The person is viewed as a bio-psycho-social being who is composed of interrelated systems that function as a whole.
- **The person is in constant interaction with the environment:** The person is in continuous interaction with the environment, which includes physical, social, and cultural factors that influence the individual's adaptation.
- **Adaptation is a continuous process:** Adaptation is a continuous process that occurs throughout the person's life, as people respond to changing environmental stimuli.

- **The person has the capacity for self-awareness and self-reflection:** The person has the ability to be aware of his/her own thoughts, feelings, and behaviors, and to reflect on his/her experiences.
- **The person has the capacity for choice and decision-making:** The person has the ability to make choices and take decisions that influence his/her adaptation and health.
- **The environment is constantly changing:** The environment is constantly changing, and the person must adapt to these changes in order to maintain his/her health and well-being.
- **Nursing interventions can influence adaptation:** Nursing interventions can influence the person's adaptation by promoting healthy coping mechanisms, providing support, and modifying environmental stimuli.
- **Health is a dynamic state:** Health is a dynamic state that is characterized by wholeness, integrity, and optimal functioning.
- **The person's adaptation level can be influenced by various factors:** The person's adaptation level can be influenced by various factors, including coping mechanisms, social support, and environmental stimuli.

Purpose

The purpose of this study was to structure a conceptual framework based on the Roy Adaptation Model (RAM) for the implementation of artificial intelligence-driven immersive virtual reality as an innovative technology in managing cancer pain among patients with advanced breast cancer.

Conceptual Framework

The guiding conceptual framework for this paper was developed based on the principles and concepts of the Roy Adaptation Model. This theoretical framework provides a comprehensive approach to understanding and analyzing the adaptation processes of individuals in response to various stimuli and stressors. Furthermore, the Roy Adaptation Model offers a comprehensive framework that encompasses physiological, psychological, and social dimensions, allowing for a thorough examination of the complex dynamics involved in the adaptive process (Roy & Andrews, 1999). Through the application of this conceptual framework, this paper intended to gain

insights into the mechanisms and strategies employed by healthcare providers caring for patients with advanced cancer in order to assist patients in adapting to challenging situations such as cancer-related pain. This study is a significant contribution to the existing body of knowledge in the field of adaptation and health by using a novel technological approach to pain management.

The use of artificial intelligence-driven virtual reality technology-assisted guided imagery has been proposed as a valuable nursing intervention to ease patients' adaptation by alleviating the effects of pain. This innovative approach aims to enhance patient healthcare outcomes. By employing virtual reality tools, healthcare providers can create a simulated environment that transports patients into a different realm, allowing them to escape from their physical and emotional discomfort. In specific, adaptive virtual reality (VR) environments, assisted by artificial intelligence (AI), represent a groundbreaking advancement in personalized pain management. This innovative approach utilizes artificial intelligence technology's advanced capabilities to analyze patient feedback and emotional responses, allowing the VR environment to be dynamically customized to meet each individual's unique needs and preferences. Thus, by leveraging these AI-driven insights, the VR system can adjust various elements, such as the level of immersion, interactive components, and sensory stimuli, to optimize the effectiveness of pain relief and improve patient engagement. One of the key strengths of AI-enhanced VR systems is their ability to process and respond to real-time feedback from patients. As individuals interact with the VR environment, AI algorithms continuously assess their reactions and emotional states, making immediate adjustments to the VR experience. These modifications might include altering the intensity of the virtual environment, changing interactive features, or adjusting sensory inputs, such as sound and visuals. This adaptability ensures that the VR experience remains closely aligned with the patient's current state and needs, providing a more responsive and effective form of pain management.

This immersive experience reduces pain intensity; therefore, that will ultimately facilitate the patients' ability to adapt and cope with their health conditions more effectively.

Relationship between Research Variables and RAM Concepts

Input

A stimulus can originate from either the external environment or internal sources within an individual. These stimuli play a crucial role in shaping a person's capacity. According to RAM, there are three types of stimulus.

Focal Stimulus

The focal stimulus is “the internal or external stimulus most immediately confronting the human system” (Roy & Andrews, 1999: 31). In this study, the focal stimuli include patient’s age, gender, disease stage, and metastatic area of disease.

Contextual Stimuli

Contextual stimuli “are all other stimuli present in the situation that contribute to the effect of the focal stimulus” (Roy & Andrews, 1999: 31). In this study, the contextual stimuli include unrelieved cancer pain.

Residual Stimuli

Residual stimuli “are environmental factors within or outside the human system with effects in the current situation that are unclear” (Roy & Andrews, 1999: 32). In this study, the residual stimuli include experience with unrelieved cancer pain and a knowledge deficit about the artificial intelligence-driven virtual reality approach for pain management.

Control Processes

Artificial intelligence-driven virtual reality will be employed as a coping mechanism to relieve patients’ cancer pain. In this framework, artificial intelligence-driven virtual reality will be employed as a coping mechanism to relieve pain among patients with cancer. In this framework, the nursing-based intervention depends on using advanced virtual reality (VR) technologies that can adapt and respond to human behavior in a high level of immersion and interactive manner through the integration of artificial intelligence.

Specifically, artificial intelligence (AI) will play a crucial role in enhancing virtual reality (VR) to decrease pain, since the AI algorithms can analyze data from various sources, such as facial expressions, physiological signals, and patient reports, to accurately assess pain levels. Consequently, this data can then be

used to tailor VR experiences to individual patients, providing a more effective distraction from pain. Therefore, AI-powered VR systems will adapt to a patient's preferences and responses, and adjust the intensity and type of stimuli to optimize pain relief. Thus, AI technology will enable the creation of realistic and dynamic virtual environments that can transport individuals to a new virtual environment.

Adaptive Models

The Roy Adaptation Model provides a comprehensive understanding of coping processes, both innate and acquired. Within this model, there are four distinct modes of adaptation: physiologic, self-concept, role function, and interdependence. These modes encompass various aspects of an individual's life and help identify the specific areas in which adaptation may occur (Figure 2).

Distinct Modes of Adaptation

1) Physiological - Physical Mode

Changes in the body's neuro-transmitter level, such as the level of serotonin as evidenced by the reduction in pain.

2) Self-concept Mode

- Decrease in psychological distress level induced due to severe cancer pain.
- Increase in patients’ decision-making ability as a response to pain reduction.

3) Role-function Mode

- Increase in patients’ ability to perform roles, and activities of daily living.

4) Independence Mode

- Increase in the patients’ independence level to perform daily tasks.

Output

The output refers to the final result or consequence that is produced by the system. In the context of patients with advanced breast cancer, this output encompasses both adaptive and maladaptive responses:

Adaptive Response

1. Physiological Mode

The use of virtual reality (VR) driven artificial intelligence (AI) for cancer pain management can be highly adaptive by positively influencing the physiological aspects of pain perception. By immersing

patients in engaging virtual environments, VR-based interventions can help modulate neuro-transmitter levels, such as serotonin, leading to a reduction in pain. This reduction in pain signals results in an overall enhancement of the patient's physiological state. With decreased pain, patients experience improved comfort and well-being.

2. *Self-concept Mode*

In the self-concept mode, VR-driven AI contributes adaptively by significantly reducing psychological distress associated with severe cancer pain. Specifically, immersive VR experiences offer patients a distraction from their pain, which can alleviate the emotional burden and improve their mental state. This reduction in distress not only enhances patients' self-concept, but also strengthens their decision-making abilities. Feeling more in control and less overwhelmed by pain enables patients to make more informed decisions about their care and daily activities, ultimately leading to a more positive self-perception and increased empowerment.

3. *Role-function Mode*

From a role function perspective, VR-driven AI facilitates adaptive responses by enhancing patients' ability to engage in daily activities and fulfill their roles. Specifically, by alleviating pain through immersive distraction, patients can perform essential tasks and participate in social and familial roles more effectively. This improved functionality allows them to maintain their roles within their personal and social environments, contributing to a sense of normalcy and improved quality of life. Thus, the increased ability to manage daily responsibilities supports a more active and fulfilling lifestyle.

4. *Independence Mode*

In terms of independence, VR-driven AI supports adaptive responses by increasing patients' ability to perform daily tasks autonomously. The reduction in pain and psychological distress enables patients to engage more effectively in self-care and other routine activities. Therefore, the increase in independence allows patients to manage their needs and navigate daily life with greater confidence and self-sufficiency. Consequently, enhanced independence fosters a sense of control and dignity, which is crucial for maintaining an improved quality of life.

Maladaptive Response

1. *Physiological Mode*

In a maladaptive response, where VR-driven AI fails to decrease pain, patients may experience persistent or even exacerbated discomfort. If VR technology does not effectively modulate pain perception or neuro-transmitter levels, patients might not achieve the intended reduction in pain. This lack of pain relief can lead to continued physical distress, negatively impacting the patients' overall physiological state. Persistent pain can exacerbate existing symptoms, leading to increased discomfort.

2. *Self-concept Mode*

In the context of the self-concept adaptation mode, when VR-driven AI does not decrease pain, this can adversely affect the self-concept of patients. Specifically, persistent pain despite the use of advanced technology may lead to increased psychological distress and a diminished sense of self-efficacy. Patients might feel frustrated, helpless, or disheartened if their expectations of pain relief are not met. This ongoing struggle with pain can weaken their self-concept, as they may perceive themselves as less capable of managing their condition.

3. *Role-function Mode*

If VR-driven AI does not alleviate pain, the negative impact on role function can be significant. Patients may find it increasingly difficult to engage in daily activities and fulfill their roles due to ongoing pain. The persistent discomfort can hinder their ability to perform essential tasks, reducing their participation in social, familial, and personal responsibilities. This lack of pain relief can lead to diminished functional capacity and decreased involvement in daily life, negatively affecting the patients' overall role function and quality of life.

4. *Independence Mode*

In the context of independence mode, if virtual reality (VR) driven artificial intelligence (AI) fails to effectively manage pain, patients may experience a reduction in their ability to perform daily activities independently. Persistent pain despite the use of VR technology can impede their capacity to carry out routine tasks without assistance. As a result, patients might become increasingly dependent on caregivers or

support systems for help with everyday functions. This reliance on external support can undermine their sense

of self-sufficiency and autonomy, ultimately affecting their overall independence and quality of life.

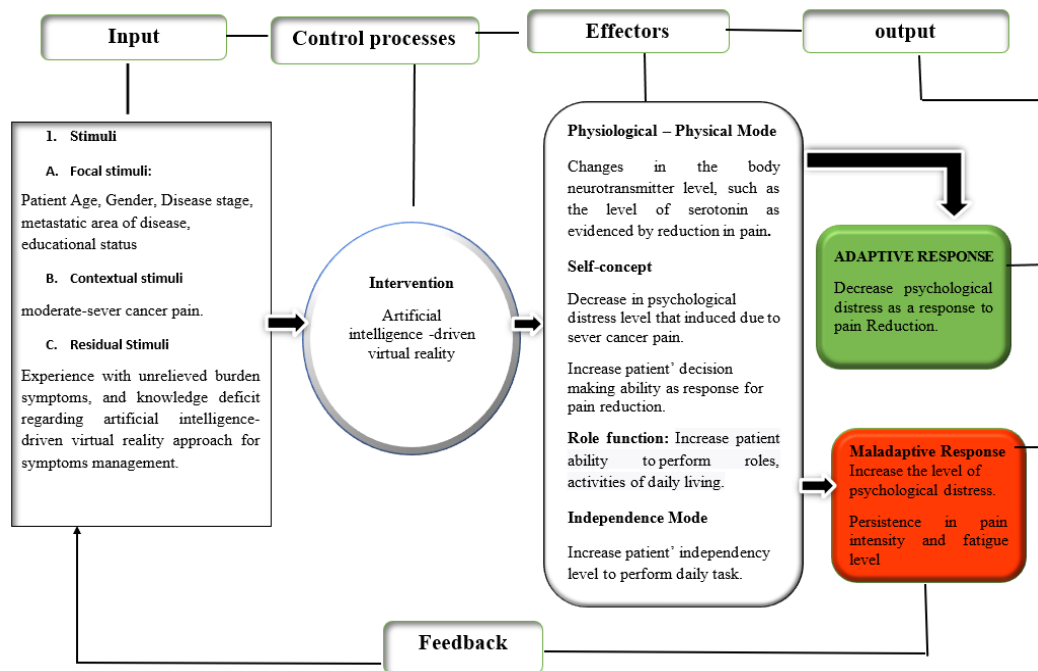


Figure 2. Conceptual framework based on the Roy adaptation model (RAM)

Implications for Nursing

In the scope of nursing practice, providing comprehensive care for patients with breast cancer and addressing their physical, emotional, social, and spiritual needs are essential in managing the burden symptoms associated with cancer. Thus, the adoption of nursing models such as the Roy Adaptation Model could significantly assist nurses in addressing the holistic and comprehensive needs of their patients. Furthermore, by using this model, nurses ensure that patients receive the necessary care and support needed to improve their overall well-being. Furthermore, according to this model, nurses will have the ability to recognize multiple stimuli that impact the human system and lead to maladaptation. According to the RAM, these stimuli include the focal stimulus, which is the immediate internal or external stimulus that the individual is facing. Additionally, there are contextual stimuli, which encompass all other stimuli present in the situation that contribute to the effect of the focal stimulus. Lastly, there are residual stimuli, which refer to environmental factors both within and outside of the human system that have uncertain effects in the current situation.

Furthermore, this model provides valuable assistance to nurses in promoting a more comprehensive

and holistic approach to patient care for patients with breast cancer. Therefore, by utilizing various nursing interventions, nurses can help patients adapt to their current situation. Moreover, it is important to note that this approach not only focuses on treating the disease itself, but also takes into consideration the patient's overall quality of life. Thus, the ultimate goal is to improve the patient's overall health and well-being. As a result, nurses play a crucial role in ensuring that their patients receive the holistic care necessary for their optimal recovery and overall well-being by using a novel nursing intervention and employing it effectively based on the Roy Adaptation Model.

In the scope of nursing education and training, it is highly recommended to educate nurses about the existing nursing theory, philosophy, and framework to adapt novel and innovative nursing-based interventions based on a theoretical basis to provide high-quality care, and it is recommended to include continuous educational courses about how to use artificial intelligence to create a virtual reality within nursing training and educational courses to demonstrate the adaptation of health technologies in healthcare based on structuring a robust and comprehensive framework to manage patients' burden symptoms. Thus, the findings

of this article could be used as a reference point for learning aspects about how to adapt a RAM model by nurses among patients' with breast cancer to relieve pain. Furthermore, the model could be restructured to manage several cancer burden symptoms.

Conclusion

Chronic cancer pain is one of the most debilitating and burden symptoms among patients with cancer. In addition, poor pain management is still prevalent despite the widespread availability of opioids as well as revised guidelines from the World Health Organization, professional training, and the availability of pain management alternatives. Thus, several patient-centered technologies have been developed and employed recently to promote the present shifts in healthcare paradigms by optimizing and integrating various effective interventions as required in accordance with patient needs. Innovative interventions such as virtual reality have been utilized to alleviate chronic cancer pain.

According to the Roy Adaptation Model (RAM), the individual is considered to be an open system that constantly interacts with both internal and external influences. Thus, by utilizing RAM, nurses are able to enhance their abilities to facilitate effective interactions between individuals and their surrounding environments by employing effective intervention, ultimately leading to improved adaptation outcomes, such as decreased pain intensity among patients with cancer. Furthermore, healthcare providers can adopt the Roy Adaptation Model to employ artificial intelligence-

driven virtual reality technology to reduce cancer-related pain among patients. This approach allows for the identification of various stimuli that contribute to ineffective pain management in cancer patients. These stimuli can be categorized into focal stimuli, which include factors like the patient's age, gender, disease stage, metastatic area of disease, and educational background. Further, contextual stimuli, such as the presence of moderate to severe cancer pain, are also taken into consideration. Additionally, residual stimuli, like the patients' experience with unrelieved burden symptoms and their lack of knowledge regarding the use of artificial intelligence-driven virtual reality for symptom management, are identified. By understanding and addressing these stimuli, healthcare providers can improve pain management strategies for patients with breast cancer.

The findings of this research paper contribute significantly to the field of nursing by expanding our knowledge on how RAM can be effectively utilized in nursing practice for patients with breast cancer and those suffering from chronic cancer pain. Consequently, it is imperative for nurses to gain a comprehensive understanding of the underlying principles of the RAM, the intricacies of chronic pain, and the stages of the coping process. This understanding will enable nurses to enhance their coping-based intervention techniques, aligning them with the RAM framework, ultimately leading to a reduction in the severity of chronic pain experienced by patients with breast cancer.

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