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The applicability of noncontact sensors in the field of rehabilitation medicine

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A noncontact sensor field is an innovative device that can detect, measure, or monitor physical properties or conditions without direct physical contact with the subject or object under examination. These sensors use a variety of methods, including electromagnetic, optical, and acoustic technique, to collect information about the target without physical interaction. Noncontact sensors find wide-ranging applications in various fields such as manufacturing, robotics, automobiles, security, environmental monitoring, space industry, agriculture, and entertainment. In particular, they are used in the medical field, where they provide continuous monitoring of patient conditions and offer opportunities in rehabilitation medicine. This article introduces the potential of noncontact sensors in the field of rehabilitation medicine.

Keywords: Brain injuries; Musculoskeletal diseases; Noncontact sensor; Rehabilitation; Spinal cord injuries

Introduction

A noncontact sensor, also known as a contactless sensor, is a device that can detect, measure, or monitor physical properties or conditions without requiring direct physical contact with the human or object being analyzed [1]. These sensors are designed to operate from a distance, often using electromagnetic, optical, or acoustic principles to obtain information about the target without physically touching it. This noncontact approach is often used to minimize contamination, reduce the wear and tear of equipment, and enable measurement when contact is impractical or undesirable. The representative types of noncontact sensors are as follows: (1) Infrared thermometer: This measures temperature by detecting the infrared radiation emitted by an object, facilitating contactless temperature measurement. (2) Radar sensors: Radio waves are used to detect the presence, motion, or position of targets without direct contact. (3) Optical sensors: Light or laser beams are used to measure attributes, such as distance, position, and object detection, without physical contact.

These noncontact sensors are used in several fields such as manufacturing, robotics, automobiles, security, environmental monitoring, space industry, agriculture, and entertainment [2-4]. The advantage of noncontact sensors, which can obtain information about the state or condition of a target without direct contact, is that they are being applied in the medical field. In addition, noncontact sensors have the advantage of enabling continuous longitudinal monitoring of a patient's condition throughout the day [5]. We believe that noncontact sensors are likely to be useful in reha-

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bilitation medicine. Here, we describe some scenarios or cases in which noncontact sensors can be applied in the field of rehabilitation medicine (Fig. 1).

The applicability of noncontact sensors in the field of rehabilitation medicine

First, patients with a stroke, traumatic brain injury, or spinal cord injury who undergo rehabilitation often experience unstable vital signs (e.g., autonomic dysfunction in patients with brain lesions and autonomic hyperreflexia or orthostatic hypotension in spinal cord injury) [6]. However, it is often difficult to detect and respond promptly to unstable patient vital signs with the current practice of only checking vital signs by contact, when direct checks by healthcare providers at set intervals make it difficult to detect and respond promptly. By using noncontact sensors, vital signs, such as heart rate, blood pressure, respiratory rate, inspiratory to expiratory ratios, and body temperature can be continuously monitored throughout the day [1]. This enables the immediate detection of unstable vital signs, enabling medical staff to respond quickly. Furthermore, these continuous measurements enable a comprehensive assessment of a patient's condition.

Second, the quantification of body movements plays a vital role in the assessment of individuals with brain lesions. Seizures are frequent manifestations in patients afflicted by conditions such as stroke or traumatic brain injury. However, due to the impracticality of sustained visual surveillance by healthcare providers, seizures are often underestimated. The utilization of noncontact sensors enables continuous monitoring of patient movements, allowing for the detection of even subtle movements. Therefore, healthcare providers can promptly identify seizures and take appropriate action in patients with brain lesions. Moreover, physiatrists often encounter challenges in accurately assessing motor function in patients with apraxia following brain lesions. Noncontact sensors en-

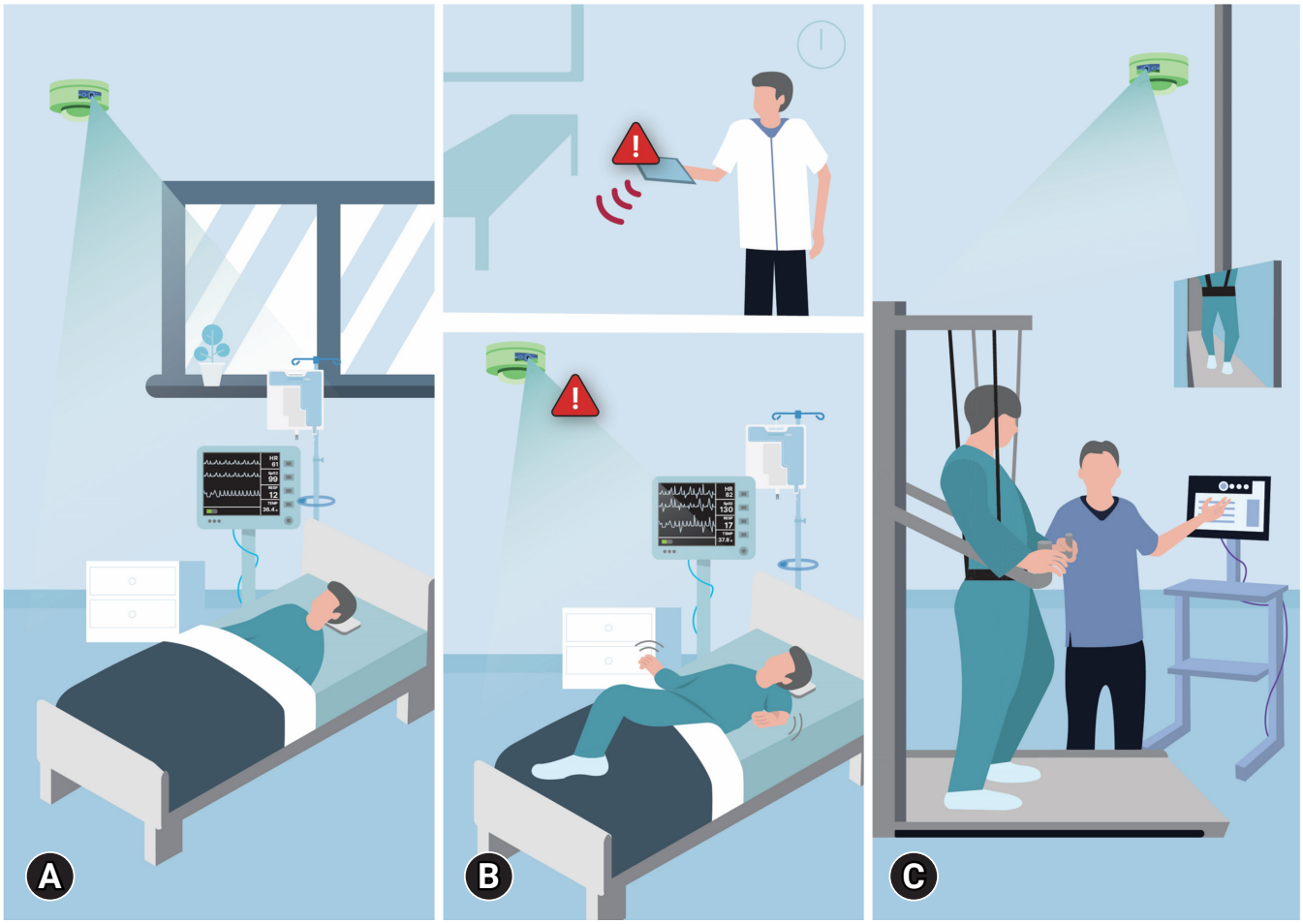

Fig. 1. Applications of noncontact sensors in the field of rehabilitation medicine. (A) Continuous vital sign monitoring. (B) Detection of patient movements such as seizures. (C) Posture analysis during exercise.

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able continuous monitoring of patient movements in everyday settings, enabling precise measurement of motor weakness.

Third, in patients with pain due to musculoskeletal disorders, exercise is important for pain management and the prevention of recurrence. However, exercising with poor posture not only compromises the effectiveness of exercise for the patients but can also worsen the severity of musculoskeletal disorders, potentially leading to pain even after recovery [7]. Noncontact sensors will provide accurate measurement and analysis of patients' motion during exercise. Through these measurements and analyses, physiatrists can measure patients' postures during exercise more accurately and in more detail, and patients can correct incorrect postures during exercise through feedback.

Conclusion

Noncontact sensors can be applied in many scenarios or cases in the field of rehabilitation medicine. Physiatrists can explore the potential of noncontact sensors, collaborate with engineering experts, and utilize these sensors for the rehabilitative management of patients. Thus, noncontact sensors can significantly assist in the care of patients in rehabilitation departments.

Article information

Conflicts of interest

Min Cheol Chang has been an associate editor of *Journal of Yeungnam Medical Science* since 2021. He was not involved in the review process of this manuscript. There are no other conflicts of interest to declare.

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Author contributions

Conceptualization, Methodology, Investigation: all authors; Formal analysis, Funding acquisition, Supervision, Validation: MCC; Visualization: YJC, MCC; Writing-original draft: all authors; Writing-review & editing: all authors.

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