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Intelligent Alarm System-Based Devices Designed for People with Disabilities, Caused by Various Chronic Diseases

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Abstract

Context: Chronic diseases (CD) are defined as symptoms or disabilities, caused by diseases, genetic factors, and injury requiring long-term treatment. Intelligent alarm systems, which collect patient health data and transfer it to a medical server, help track and avoid future incidents.

Method: The search terms were "computer network" OR "information systems" OR "wireless technology" OR "decision support systems" AND "chronic disease" OR "chronic disease" in major electronic databases, including Pubmed/Medline, Scopus, Embase, ISI Web of Science, and Cochrane Central.

Results: The search resulted in 1275 articles with 11 specific to intelligence-based systems in chronic medical conditions until 08 June 2021. The creation of different access levels for care providers in the system and application customization according to CD conditions were the goals that can be achieved in future research. The human-computer interface (HCI) systems, smart home, and software, such as Fitbit using IoMT to monitor health metrics in people with different CDs, are introduced so far.

Conclusions: These systems, if provided on the web and mobile platform, can be accessed at any time and place and are more efficient. Finally, the combination of clinical decision support systems with artificial intelligence has beneficial effects on physician's systems, increases the accuracy in CD diagnosis, and improves the pain management. This intelligent system demonstrates factors influencing back to work and allows identifying high-risk patients and their potential to handle activities of daily living.

Keywords: Computer Network, Information Systems, Wireless Technology, Decision Support Systems, Chronic Disease

1. Context

Chronic diseases (CD) are defined as symptoms or disabilities caused by diseases, genetic factors, and injury, requiring long-term treatment (1). These permanent diseases are debilitating with irreversible pathology for which treatment is unlikely (2). CD now accounts for 40% of all deaths worldwide and 47% of the global disease burden in the USA (3). CD causes disability, dependence in daily activities, joblessness, increased risk of hospitalization, and mortality (4). Major CD is categorized into heart disease, cancer, and diabetes. Also, some risk factors, such as tobacco use and exposure to secondhand smoke, poor nutrition, lack of physical activity, and excessive alcohol use, were excluded (5).

The performance of people with disabilities usually differs depending on where their spine is damaged. For example, an individual with a wrist injury might not use a computer, while upper extremities, such as the elbow, can contract arbitrarily. It is difficult for people with severe CDs, such as multiple sclerosis (MS), amyotrophic lateral sclerosis (ALS), osteoarthritis, heart disease, and stroke, or any other movement disorders, to handle their daily life activities (6, 7). The condition is even worse for those with a disability or walking or movement impairments (8). The internet of medical things (IoMT) is a computing device system, mechanical and digital machines, objects, animals, or people identified by unique identifiers. It can transmit data over a network without the need for human-to-human or human-to-computer interactions. Disability today can no longer prevent people with disabilities from falling behind in their daily household chores (9-11). An intelligent home for an individual with a disability can bypass any disability and help maintain independence. Thus, intelligent alarm system-based devices may be helpful for people with disabilities caused by various CDs.

2. Methods

The search terms were "computer network" OR "information systems" OR "wireless technology" OR "decision support systems" AND "chronic disease" OR "chronic disease" in major electronic databases, including Pubmed/Medline, Scopus, Embase, ISI Web of Science, and Cochrane Central, and resulted in 1275 articles with 11 specific to intelligent systems in chronic medical conditions until 08 June 2021 (Table 1).

3. Results

3.1. Internet of Medical Things (IoMT)

The internet of things (IoMT) is a set of medical devices connected to the health systems network (23). Medical devices equipped with a wireless system (Wi-Fi) allow machine-to-Machine (M2M) communication, which forms the basis of the IoMT (24). IoMT devices connect to cloud platforms over the Internet, where the required data is recorded, analyzed, and stored (25). Like other evolving industries, the healthcare industry is adapted to new technologies, including the IoMT. Also, one of the most important applications of the IoMT in medicine is introduced and recognized. Most medical device companies show interest in operating and producing IoMT-based devices (26).

IoMT devices allow physicians and nurses to monitor their patients remotely. On the other hand, it can remote control patients with CD, such as high blood pressure or diabetes (27). Medical wearable devices can transmit information from a person's body to healthcare providers; injection pumps connect to analysis dashboards and operate according to schedule; hospital beds can measure patient blood pressure and other vital signs (28). Most mobile devices are now equipped with near-field communication (NFC) and radio frequency identification (RFID) technologies connected to computer systems, opening a lot of potential for the IoMT (29). The idea of using the IoMT to care for patients at home is called telemedicine, which eliminates the need for patients to see a doctor for questioning and changing the course of treatment (25).

3.2. Human-Computer Interface

The HCI system for physically disabled people receives the electrical signal from other muscles through electrodes and converts it into a mouse movement (17). People with cerebral palsy (CP), especially children, cannot control fine activities and have difficulties in working with tablets or existing computer interaction systems designed for regular people because the menu of these tools is small and their touch screen is susceptible (30). Thus, the solution is to provide tablets designed especially for individuals with physical disabilities, more prominent in hardware (31). Its sensitivity can be controlled according to the performance of the individual. At the same time, such tablets are adapted to individuals with disabilities in terms of the software environment application. They can work with the tablet, including a wide range of motions, and control their movements (32).

Individuals with spinal cord injuries are usually the young ones who had accidents and lost their function at working ages (33). As computer work and applications become more common in society, and individuals with spinal cord injuries cannot use their hands, the researchers designed a tool that uses electrical signals from muscles to build a healthy muscle (in any area of the body from the arm to the trapezius, shoulder muscles, etc.) and receives the electrical signal to move (34). This signal is eventually converted to motion after processing, and the individual can move the mouse arbitrarily on the shoulder or arm. Therefore, it allows the individual with limited mobility to do computer works and provides the chance of employment for mentally healthy ones with spinal cord injury caused by accident (35).

3.3. Smart Home

The space house is highly personal and essential. Individuals feel good when could do all the housework (36). But if they cannot do the housework or find it difficult, they usually feel helpless and think they have lost their independence. Before the intelligent home came into being, most individuals with disabilities experienced such events and feelings (37). But now everything has changed. The IoMT gives such individuals the opportunity to get rid of the thought of disability and regain control of everything at home. This concept refers to objects and devices, such as cars, watches, home appliances, etc., equipped with communication technology and connectivity (38). Such devices are commonly known as smart devices. Today, many common household appliances, such as lamps, keys, and door locks, are smart and can be easily controlled with a home computer, laptop, tablet, or smartphone, even if the individual is not home (39).

While each of these devices usually includes its custom program, an individual can have a system that puts all such intelligent devices together in a central hub if he wants to control multiple smart devices together. Finally, after connecting all the smart devices to a central system, an intelligent microphone can be added to the intelligent suite (40). This microphone is a voice assistant that can easily control and manage all the smart appliances in the house by receiving your voice commands. In this way, individuals with a

Table 1. Literature Available on Using Human-Computer Interface in Different Chronic Conditions

Study ID	Study Population	Platform	Target Group	Algorithm	Application	Advantage	Outcome
Roshanak Tirdad et al., 2021(12)	22 falling events	Intelligent alarm system	Physical disability	—	Sender and receiver application	The proposed model correctly and detect, track, and classify physically disabled people.	Helping to identify the patients who are most at risk for falls
Vera Anaya and Yuce, 2020 (13)	—	TENGs in hands-free HCI	People with disabilities	Threshold detection	Text input	It has low cost and is user-friendly	Improve their programming skills and job opportunities
Šumak et al., 2019 (14)	10 non-disabled adults and 8 with disability	A hands-free HCI with Emotiv EPOC+	People with motor disabilities	Machine learning	Using computers independently	It has low cost and is user-friendly	People with disabilities can be equally effective.
Bissoli et al., 2019 (15)	29 non-disabled adults and 1 with a disability	A hands-free HCI with gBo	People with disabilities	Machine learning	Smart home	It has low cost and is user-friendly	People with disabilities can be equally effective.
Meena et al., 2017 (16)	8 healthy participants	A hands-free HCI with eye-tracker	Healthy people	Machine learning	Wheelchair	It has low cost and is user-friendly	A practical and economical solution
Szczepaniak et al., 2017 (17)	Lost the possibility of a standard computer operation	Microsoft Kinect	People with disabilities	Artificial intelligence device	Using computer software	Ability to return to work	may be used as effective method
Ka et al., 2017 (18)	Spinal cord injury and cerebral palsy	The circling interface	People with disabilities	Artificial intelligence software	Dwell-clicking software	Achieve more effective mouse use	Computer access and augmentative communication software
Soltani et al., 2016 (19)	Severe motor disabilities (saccadic eye movements)	Electrooculogram	People with disabilities	Artificial intelligence software	—	Assuring a high level of comfort for the users	The average success rate in necessary eye movements was 61.5%.
Pauletto et al., 2013 (20)	—	Automatic speech recognition	—	Artificial voice subsystems	Text-to-speech	An emerging interdisciplinary ontology for artificial voices	HCI tools are proposed for future collaboration.
Kencana et al., 2008 (21)	—	existing tongue tracking	Severely disabled or quadriplegic person.	—	PC functions	—	This device helps individuals with severe disabilities to have some control over their environments.
Borghetti et al., 2007 (22)	20 healthy subjects	Electrooculography signal analysis	Healthy people	Artificial intelligence software	PC functions	Assisting the communication of patients with impaired movement	eye movement interface can be helpful to properly control computer functions

Abbreviations: TENGs, triboelectric nanogenerators; HCI, hands-free human-computer interaction; gBox, GlobalBox.

disability that cannot move properly can do all the housework only with the voice commands at home (41).

3.4. IoMT for Chorionic Disabilities

Software such as Fitbit employs IoMT to monitor personal health parameters; this information can be shared with a doctor to resolve recurring issues. HealthNet con-

nect recently developed a program to manage individuals with diabetes, improve clinical treatment, and reduce their medical costs, which achieved exciting results. Intelligent alarm systems, which collect patient's health data and transfer it to a medical server, help track and avoid future incidents. This machine may be implanted or used as an external device, such as a smartphone or computer (42).

For an individual with a disability, the current HCI device accomplished its goal and enabled him to return to work (17). The novel eye sensor recognizes the eyelash motion observed by the triboelectric reaction between human hair and silicone. It is shown that a basic python program can be written to view a message on a computer screen without using hands (13). Furthermore, individuals with profound motor disabilities perceive a modern HCI with fewer complexities than their existing machine usage solution, compared to non-disabled users using normal HCIs. By the employment of modern HCI technologies, users with disabilities are just as capable as non-disabled ones (14). Also, the findings suggest that diabetes and age play a role in diagnosing hypertension in the elderly (43). On the other hand, reliable laboratory trials and experiments developed the operating theory and set-up of a novel passive tongue HCI. Before the commercial provision of the technology, further clinical trials should be performed on individuals with disabilities (21).

All participants completed the system usability scale (SUS) questionnaire. The results revealed that healthy participants and those with extreme disabilities rated the assistive system with mean scores of 89.9 and 92.5, respectively (15).

Using the proposed model, injured people are accurately identified, tracked, and classified. This helps identify patients who are more prone to falls, as well as people with disabilities, and can enhance their programming skills and career prospects (13-15). In this regard, there are effective, efficient, practical, and cost-effective solutions such as computer software that increase their access to computers with functions such as essential eye movements (16, 17, 19). In general, future participatory approaches based on HCI are proposed (20), in which the system empowers the individual by allowing him to control the functions of the machine, and also helps patients with mobility disorders to communicate (21, 22).

4. Discussion

The present review study was performed on articles presented from 1990 to 2021 to understand the methodologies and applications of intelligent and expert systems. This article reviews knowledge of expert systems that can use different types of symbolic and comparative numerical data. Another characteristic of such systems was the use of innovative methods instead of algorithmic ones. This capability places a wide range of applications within the operating range of expert systems. The conclusion process in expert systems is based on inductive and deductive methods. These systems can explain their reasons for reaching a specific conclusion or the direction of their movement towards the goal. Due to the ability of such systems to work in the absence of complete information or different degrees of confidence in answering questions, expert systems are a good symbol to work in conditions of uncertainty or multifaceted environments. The degree to which an expert system is desirable depends primarily on its accessibility and ease of use.

4.1. Clinical Implications: Mobile Self-Care System for Tuberculosis Control

Infectious diseases have shaped human history, and the themes of this field are never repeated. In the modern era, tuberculosis (TB) is the leading cause of morbidity and mortality due to infectious diseases (44-46). Although the first anti-tuberculosis drugs were discovered 60 years ago, it is still a health issue, with 8.8 million cases and 1.7 million deaths annually (47). Advances in diagnosis, treatment, and control efforts worldwide over the past decade have led to the control of TB in many parts of the world, but the spread of VIH virus dramatically halted these advances. According to the Centers for Disease Control and Prevention (CDC), despite declining reports of cases of TB, the disease remains a serious threat, especially for people living with AIDS (48).

Of the 33 million people living with HIV and the millions of people infected each year, less than half now have access to treatment, which imposes the heaviest possible pressure on all nations around the world (49). Obviously, the traditional model of patient care for prevention and education appears hardly desirable. As a result, more effective technologies are now needed to help prevent and educate, reduce hospitalization, and ultimately replace critical situations. Recently, information and communication technologies are introduced and used in health care delivery systems, of which the most prominent ones are electronic health (E-health) and mobile health (m-Health) (50). The popularity of mobile phones is rapidly growing in developing countries. In particular, consumers in low- and middle-income countries use a wide range of mobile technologies because of the cost-effectiveness and benefits they add to healthcare systems.

Mobile devices play a key role throughout the chain of development, testing, treatment, care, and support. Medication adherence is very important, and many factors can affect it. Poor adherence to TB treatment remains a global

health challenge, and cell phone-based interventions have the potential to overcome such problems. Iribarren et al., conducted a comprehensive study on mobile apps created for TB. This study identified 24 TB-related mobile applications. Most apps have notification and storage features. Most apps also focus on providing information about TB diagnosis and treatment. According to a complete review of the apps, the lack of a self-care app for TB treatment is prominent (51). A study by Velayutham et al., studied the usefulness and feasibility of sending notifications via mobile phone by a voice-based system for TB. Audio messages are prepared to warn and inform patients, placed in different categories, and are sent according to different questions and issues of patients. The basis of this system is only to inform and increase the awareness of patients with TB, done after registering in the system. These messages are sent in English or French to remind or motivate patients to take prescribed anti-TB medications (52).

In a study by Narasimhan et al., the mHealth services (healthcare using mobile communication technologies) was designed to improve adherence to treatment and patient follow-up in deprived areas of South India using a voice message-based system. In this system, registration of patients with TB, maintenance of their information, sending reminder messages, checking adherence to drug use, and sending motivational and informational messages provide a route for the patient to communicate with caregivers. This system is mainly via voice or text messages (53).

Due to the long process of treatment in patients with TB, the need for treatment adherence especially when the initial signs of improvement appear, and information about the continued use and consequences of arbitrary discontinuation of the drug, customized messages are sent to patients according to the treatment schedule (54). In addition, to achieve better results and measure the actual effectiveness of the program, evaluation of the program by patients with TB is recommended, which requires short-term education of patients and the inclusion of the needs of such users. Also, different access levels should be created for care providers in the system, and customization of the application according to conditions of TB is another thing that can be done in future research.

4.2. Clinical Implications

Automated systems for gathering information and decision support for chronic pain management

In today's industrial world, pain is very common and has affected many people. Chronic pain has cost the community economy and the medical system dearly. In addition to personal and economic problems, the pain has also caused social dilemmas. In many medical conditions and CDs, pain is a major symptom, significantly associated with changes in the quality of life and overall performance (55). Pain is an unpleasant sensation and an emotional experience with tissue damage. Pain is a reaction caused by the perception of different nerves on the body surface to internal or external stimuli and is an emotional experience accompanied by severe tissue and psychological damage. Chronic pain management is an important issue in healthcare today. The clinical decision support system intelligently screens the information and knowledge of specialists to physicians, health professionals, patients, and others, and in the meantime conveys this knowledge to provide more efficient treatment and health care (56). Automated health information systems aggregate data and information to support integrated management decision-making processes (57). Nasr Heydarabadi et al., in a review study, shed light on various automated systems for data collection and decision support for pain management in patients with spinal cord injury. They showed that using clinical decision support systems based on the information and knowledge of experts makes the information available to the right person at the right time and place. They also showed the positive role of such systems in increasing accuracy and improving physicians' decisions. These systems, if provided on the web and mobile platform, can be accessed at any time and place and are more efficient. Finally, the combination of clinical decision support systems with artificial intelligence has beneficial effects on physician's systems, increases the accuracy in diagnosing the type of pain, and improves the treatment of patients' pain (58).

4.3. Conclusion

The IoMT may be beneficial to manage chorionic diseases due to the advantages and disadvantages of various available systems and processes. This intelligence demonstrates the causes that influence the ability to return to work, allowing for the identification of patients more at risk and the power of patients to handle their careers. More information about this method can be found when looking at a broader data set.

Footnotes

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