Chapter 4
Pervasive Healthcare Computing as a Scientific Care Discipline for Patients

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4.1 Introduction

Pervasive computing healthcare technologies have seen significant improvements in recent years, because of the significantly technical developments in modern electronic wireless devices and communication network architectures, electronic sensors instruments, men wearable technologies, and devices. The objective of modern pervasive healthcare facilities is to enable and provide distributed computing systems facilities that are available anytime and anywhere and also provide real-time management services through the use of high-speed communication and information technology [1–9]. Pervasive healthcare service plays an important significance healthcare service in our day-to-day life. It is a very useful treatment service because of the increasing recipient health risk parameters, various types of diseases, and insufficient available resources for expected early-required prevention and care in the many healthcare systems. Subsequently, the recent new developments in the systems serve the extensive use of anywhere real-time patient monitoring and care of health-related risk parameters with high-speed wireless electronic devices [10–13] (Fig. 4.1).

Modern pervasive healthcare treatment and healthcare are important patient's treatment techniques that promote systematic exchange of ideas in a coordinated

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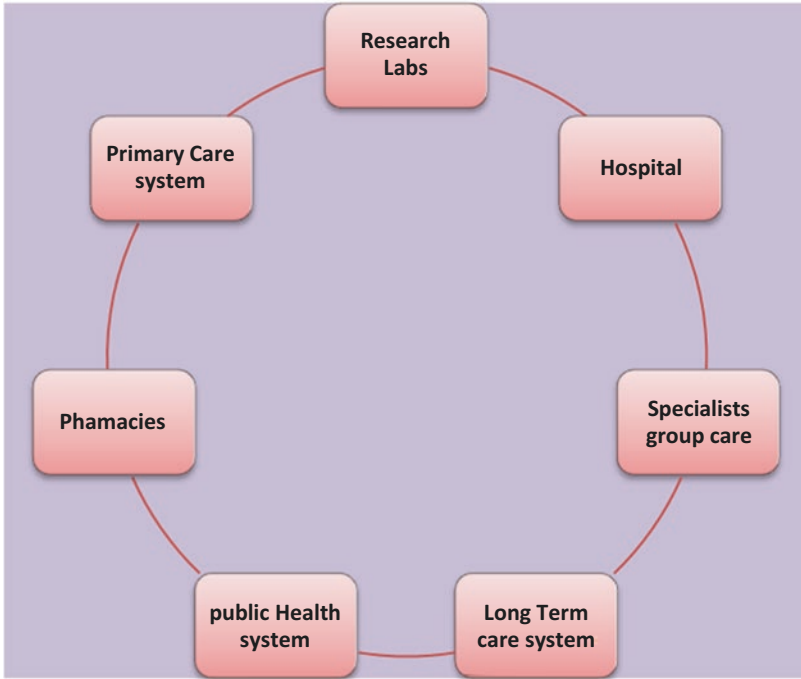
Fig. 4.1 Modern pervasive healthcare computing systems

way during the patients' cares and treatments. An effective care example of this kind of idea coordination has been demonstrated through the creation of pervasive healthcare treatment series as a platform for promoting discussions in this healthcare field. In the past, extended significance work from that platform was identified and available by this journal to provide a good understanding on relevant related work done in the healthcare field. Example of these types of works include a good research related to electronic sensing technologies, modern innovative applications, and visionary treatment roadmaps identifying trends and many opportunities in this healthcare area [14, 15].

4.2   Pervasive Healthcare Computing Systems

Pervasive healthcare computing offers both healthcare professionals and needy ill-patient services, including many new opportunities for better treatments and patient's care services. On one given side, medical healthcare doctors and other many healthcare professionals will get benefit from comprehensive diagnostic and therapeutic treatment opportunities far beyond expectation and what is possible with today's occasional health examinations. They all will have proper access to
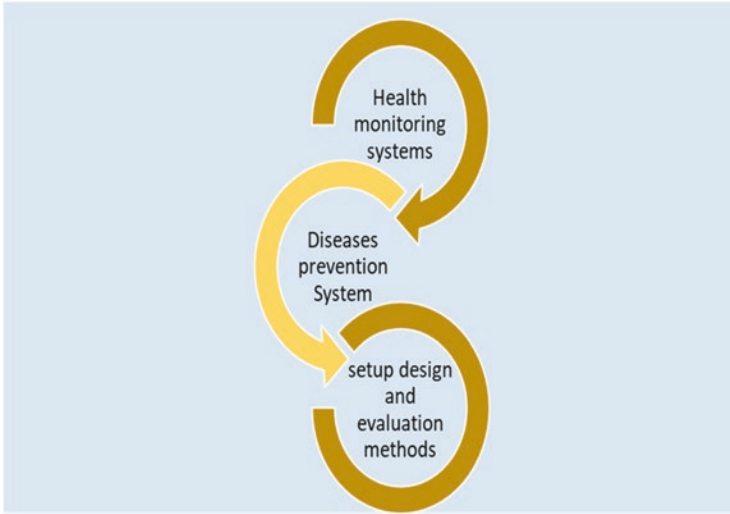
Fig. 4.2 Pervasive healthcare computing setup design and evaluation methods

long-term storage of physiological medical data measured including patient's daily activity and all the situations to which he has been diagnosed to. On the other side, needy patients are properly empowered to take significance and a more active role in their personal healthcare management and better prevention. For example, user feedback data or even personal monitoring and coaching might help a patient adjust his living style parameters to the requirement of his own health [5, 16–22] (Fig. 4.2).

In order to provide healthcare professionals and care seeker patients' services with these new medical opportunities, future research is needed in these health-care areas:

1. Pervasive treatments and reliable long-term health monitoring systems
2. Disease prevention as the primary element to maintain life-time care
3. A modern healthcare setup structure and comprehensive patients' care methods for pervasive care by the help of patient-centric care

The main element of the first area reflects to the improvement of pervasive electronic sensing. A relevant aspect in healthcare wearable electronic sensing systems is the setup between patients' care and the electronic sensor quality that must be clearly addressed and displayed in order to improve health pervasive electronic sensing treatments to the patients. This system trade-off relationship is further explained in the above healthcare monitoring. Regarding the second-stated issue, details will be provided in the disease prevention systems and evidences that there is a need for care monitoring, including multiple parameters and a need for developing adaptive healthcare systems to enable pervasive healthcare prevention to the patients. Regarding another issue, setup design and evaluation method highlight the

requirement for a new healthcare approaches for diagnosing and evaluating modern pervasive healthcare systems [9, 23–28].

4.3 Applications of Pervasive Healthcare System

Pervasive computing clinical systems can be also defined as patients' healthcare and treatment to the whole people at anytime and anywhere across the globe by removing another information, e.g., bounded time limit, locational information, and some other constraints, like needy people care coverage and service quality real care. Applications of pervasive healthcare system are clearly showing in the care system that it must be associated with the applications of pervasive healthcare facilities and healthcare computing systems to completely process significantly needed improvement for any needy people. We can explain significantly needed improvement in the healthcare system as insignificant treatment errors in the severe problem of any clinical healthcare and patients' care systems. For example, medication errors are a severe problem in healthcare systems. In the United States, medication errors are estimated in the treatments which are highly appreciated, due to the reason of 7000 (7 K) people deaths during treatment a year [29, 30]. Such medication errors in severe problem must be considered and tried to be eliminated. This could be possible through introducing pervasive clinical healthcare computing technology and treatment system. Subsequently, many features nowadays will be available, such as electromagnetic radio-frequency identification services that are doing great services in these regards. Eliminating medical type errors is one of the advantages of migrating pervasive computing technology in the healthcare systems and expertise care hospitals [31–35].

4.3.1 Modern Pathological Clinical Methods

Pathological clinical investigation concepts show availability of people's clinical historical data. It is assuring that the implemented methods and concepts of a new medication address the feasibility concept and that further research and disease care date investigation and treatment is reasonably approved by the clinical care authority.

Furthermore, in the pathological clinical methods, the drug approval and commercialization provided required validation data with respect to new indices. The methods used during this clinical proof of concept should be targeted at collecting medical evidence, which clearly demonstrate about adopted treatment technology. It may be relevant to collect initial clinical data evidence for the medical benefit of the adopted technology [36–40].

Pervasive healthcare modern pathological clinical methods for any types of clinical investigation concept are trying to measure some best clinical effects that are essential during the pathological clinical proof of concept. For example, in order to

start establishing any pathological clinical effect in the monitoring of hypertension symptoms, blood pressure dataset may be compared over the time span of the clinical proof of concept, and set of questionnaires regarding the target patients' awareness and handling of their blood pressure record may be issued and properly analyzed. The clinical set of evidence may be influenced by different factors and hence not as powerful as would be required in evidence-based medicine treatment [9, 41–44].

4.3.2   Smart Blood Pressure Monitoring System

Hypertension symptom is the most general preventable cause of cardiovascular problem. Home blood pressure monitoring electronic device is a self-monitoring and blood pressure checking tool that can be incorporated into the healthcare service for patients with hypertension disease and is greatly recommended by major guidelines. Hypertension symptom increases the risk of severe heart attack, increasing kidney problems, stroke, and some vital organs failure [45]. Smart blood pressure monitoring system is the leading preventable risk prevention device for global cardiovascular disease problem worldwide. However, the impact of blood pressure on cardiovascular risk has been devoted to the issue of blood pressure measurement and its accuracy [22, 46–49] (Fig. 4.3).

A plane surfaced smart blood pressure patients' details that would automatically measure a patients' blood pressure chart. Pervasive healthcare system aims to discuss the many below-given advantages of home blood pressure monitoring and also examines medical data, aimed at improving its accuracy:

- Can take multiple reading records over a given period of time.
- Predicts cardiovascular disease better than office blood pressure systems.

Fig. 4.3 Smart blood pressure monitoring system chart

- Home blood pressure monitoring electronic device allows patients to better understand hypertension and do better management for it.
- It can detect increased blood pressure variability.

According to National Institute for Clinical Excellence's guidelines [50–52] for Home blood pressure monitoring electronic device, recommend that when using Home blood pressure to confirm a diagnosis of hypertension symptom and it is necessary and it is recommended for the use of home blood pressure monitoring to ensure that:

- Blood pressure is recorded two times, morning and evening, on a daily pattern.
- For each blood pressure recording, there is two consecutive measurements that must be taken, at least 60 s apart with the person in a seated position.
- Keep blood pressure recording records continuous for at least 7 days [53–55].

4.3.3   The Future of Pervasive Healthcare

During the last one decade, computers were normally used for high-resolution image cutting-age technologies and field maturing to use as the reasonable parameters of being easily able to implement modern care facilities with the number of patients for estimated and required significant treatment time. The modern pervasive computing health investigators and research experts are doing great efforts on technologies that are often very hard for very large real-time implementation. According to the health experts regarding the extension of deployment in this field, the clinical researchers can identify four important improvement areas for research to allow fast and real-time prototype development, including novel pervasive healthcare technologies and error-free disease diagnosis. The modern pervasive care facilities are doing significant support on patient's personalization and great disease diagnosis to ensuring that they can meet the needs of different kinds of patients: treatment. According to the definition of international treatment and patients' care analogy and healthcare guidelines. It will be facilitated by incorporating these needed aspects into patients' care systems, as pervasive healthcare system research supports, significantly doing positive impact on current and existed patients' care practices. In the clinical care scenarios, the healthcare experts need to do the proper consideration on the real-time diagnosis and treatment transition demands. Subsequently, it is also important and needed because it carries standard dataset to assess and diagnose the values of a healthcare technology in real-world and everywhere settings and it must provide such valuable care information and support to all the people [3, 56, 57].

4.3.4 Adoption and Acceptance

As pervasive healthcare computing technologies fulfil the way for real-time diagnosis and estimating traditional healthcare facilities into a rigorous on time patient's oriented preventive treatment model. The treatment record of patient's illness needs to be further extended and evaluated to make proper consideration an acceptable and significance use of the healthcare systems. The selected or limited use of electronical sensor machines or body fitness devices could lead to the ambiguous results and incorrect inferences, and it finally shows unpredictable effects of the latest technology in the healthcare industry. Considering this, the biased and inappropriate use of healthcare facilities can result in inappropriate input illness information. This information can affect the patents' health and quality of the healthcare service. Finally, it could degrade the perceived clinical care system significances, adoption, and utilization of the pervasive technology. However, it is unethical to always expect real-time perfect data collections and device's dedication from all types of the users. Considering this, the future pervasive clinical care applications must overcome all types of challenges. Nowadays treatment strategies and methods include the care treatment using context-based sensor devices to tag and detect abnormal results during self-monitoring process, considering users' behavior and operational algorithms that get information from incomplete estimated data from diagnosis and always trying to encourage professionalism of users through various operational algorithms and treatment strategies [58–60].

The adoption and acceptance ability to get important task as creating and measuring more reliable digital sensors, modern medical devices, or healthcare systems for patient-care settings. Moreover, to exploit healthcare advancements and facilities for providing real-time required healthcare treatments, a parallel healthcare must be allocated on improving mechanisms on finding the dataset that facilitate the patient's compliance with the suggested and recommended healthcare treatment. Subsequently, tracking and tagging user activities and behaviors in real time can be helpful in the diagnosis and understanding the significance of the collected patients' data sample. Furthermore, eliminating the impairments and issues in the dataset and informing the service through prescribed models [61–63] could validate the input datasets.

All previous research studies and experiments have shown that many factors and inputs such as demographic characteristics and available resources for human populations, lifestyle, and personality along with culture represent strong predictors and patterns, which can be automatically dragged and captured to develop individual care models and diagnosis framework. In addition, future research in healthcare is needed for better and clear understanding of the reasons for special models in specific use of patients' cases. This will certainly help many patients, also it can clearly explain patients' needs and symptoms, and it will further eliminate many obstacles and issues to greater compliance.

It will further explain with example, by defining the latest healthcare strategies for treatment models, such as designing and incorporating fewer complex devices,

including automation, comparison with the past, and analysis. Subsequently, most of the existing and available patients' healthcare systems have been developed and designed on targeting and assuming specific patients and diseases without considering valuable features for personalization, and this could be one of the key reasons for the limited acceptability of the care systems. Although many healthcare communities and healthcare centers have been proposing and introducing different concepts of personalization in terms of specific patients and diseases, in practice, there is still a need of individualized technologies and models that would be personalized on specific interaction. To the user's routines, check-up must be appreciated [64].

4.4 Open Data Research in Pervasive Healthcare System

Clinically diagnosed large datasets and inputs and combining all datasets with required information with the needed pattern from other heterogeneous data sources could help research developments in general healthcare by creating new applications and strategies in modern pervasive health systems and making new strategic and treatment policies. Subsequently, progression of computational applications and many techniques in pervasive clinical care computing is the sign of medical data sharing, diagnosing, and the broad availability of healthcare datasets. The need for making healthcare broad availability of healthcare datasets has been strongly recommended by the group of health organizational bodies.

Healthcare models and frameworks that are being invented and used to characterize many types of their data correlation and pattern mapping with symptoms and their pattern symbol within pervasive healthcare frames have a basic requirement, and it must be developed, evaluated, tested, and validated based on test datasets. Validation test datasets can be collected from heterogenous types of patients' covering ranges based on gender, cultural, and social behaviors. Many clinical patients' care research takes the characteristics and features of the digital sensor node index values in the operation and treatments. Furthermore, geographical locations within the organizational bodies, social atmosphere, and the context limitations should be imposed in different environments and experiments [5, 20–22].

Making medical research dataset groups, that are available to the original research team and research groups where they have been diagnosed and generated and experiments, in a responsible within prescribed time frame. Furthermore, considering approved and international trial standards including safeguard criteria will show several significant advantages. From medical research dataset's perspective, collecting and storing such dataset results are critical, expensive, and time-consuming process, leading to the following questions:

- How can dataset be collected ethically with the best practice context?
- How can medical research group ensure that selected standards for dataset management are entrenched and developed and reused effectively?

- Is there any prescribed format or parameter that ensure issues and challenges around dataset are the high-quality empirically validated data in the research?
- What type of research frameworks and models should be designed so that it can support online dataset sharing in real-time repository?

We must address these selected issues in making research dataset repositories for pervasive healthcare systems.

4.5   Conclusions and Future

Pervasive clinical care systems have been proved and defined as modern healthcare to the whole people at anytime and anywhere across the globe by removing constraints such as time limit, locational information, and other constraints including significantly increase in both its service quality and large-scale coverage. Our rigorous work clearly shows that significant and high-level potential mapping in the applications of pervasive healthcare computing systems increases the care process with significant consideration. Pervasive healthcare computing technologies fulfil the way and requirement for transforming currently applicable healthcare systems into a never-ending on-time, large-scale patient's or users' oriented preventive healthcare treatment system. The record of patients' illness needs to be diagnosed and extended and evaluated to consider the significant use of the healthcare systems. The significant and on-going advancement in healthcare treatment systems leads to support and facilitate the acceptability of pervasive healthcare systems. Improving the quality of healthcare services and eliminating medical-type errors are some of the advantages of migrating pervasive computing technology in the healthcare systems and expertise care hospitals. This chapter also shows significantly and approved access to pervasive clinical and healthcare system, including lower cost and real-time health monitoring services to a more generalized level and heterogenous environments. In this chapter, we also highlighted pervasive clinical computing and associated valuable data information systems and their future perspective and uses.

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