

# Implementing Monitoring System for Alzheimer in Nigeria: Wireless Sensor Network (WSN) Knowledge Based Perspective

Apena W. O.<sup>1</sup>, Popoola O. R.<sup>2</sup>, Ogunti E. O.<sup>3</sup>, Akingbade K. F.<sup>4</sup>

<sup>1,2,3,4</sup> Department of Electrical and Electronics Engineering, Federal University of technology, Akure, Ondo State Nigeria  
(<sup>1</sup>waliuapena@yahoo.com, <sup>2</sup>opopson@yahoo.com)

**Abstract-** The study review healthcare knowledge management (KM) concept and wireless sensor network (WSN) technologies to propose community-based healthcare service for Alzheimer (Dementia) in Nigeria. Its proposition incorporates an intelligent electronic based system for analysis and monitoring so as to provide the caregiver or community based health care service with relevant information promptly. Community-based healthcare service could address issue facing aging disease patients (dementia) such as mobility monitoring (alerts and falls), infections control and cardiovascular diseases risk factors (hypertension and diabetes). This paper proposed a robust Alzheimer monitoring system (RAMS) in Nigeria to enhanced community-based healthcare activities.

**Keywords-** Alzheimer, monitoring, knowledge management (KM), and Nigeria

## I. INTRODUCTION

Alzheimer disease - AD (dementia) is one of the common human-age brain disorder (neurodegenerative) and is clinically identified as memory associated disease (Avvenuti *et al*, 2009). Patients struggled to access available health service due to lack of proper monitoring and clinical follow-up. The paper viewed possibility of moving healthcare from hospital to individuals' home by providing technological-based monitoring in knowledge management (KM) concept. Bali *et al.*, (2011) described KM as an organisational knowledge with meaningful interaction of people, processes, activities and technologies that enable the sharing, creation and communication of knowledge. Olaniyi and Nadine (2014) described World dementia prevalence for those aged 60 year and above to be in range of 5% - 7%, while Sub-Sahara Africa data on current prevalence is 2.29 % to 21.60%.

According to WHO (2003) "mental disorders have profound effect on public health service". AD patients are prone to falls, this could cause severe injuries such as fractures and internal bleeding (heads). Beside falls, wandering behaviour in directionless manner is another severe stage of AD. Hence, dementia patients require a remote technological-based process and care supports that will provide freedom rather than disease stigmatization. This study focus on deployment of knowledge management (KM) concept and

wireless sensor network (WSN) technologies to enhance real-time activities in community-based dementia patients' monitoring in Nigeria. Monitoring system for critical dementia episode parameters such as mobility behavior, infection control and cardiovascular diseases risk factors (hypertension and diabetes) could be adopted in Nigeria public health system.

Monitoring starts from surveillance camera, sensing patch to a closed network interface. The basic limitation of surveillance camera is out coverage challenge, when the subject(s) moved out or away from marked covered area. Another fundamental challenge is privacy and dignity, where subject(s) related-illness involves striping of cloth. Here involve decision strategy on appropriate technological deployment. Sound could be used to monitor or tracks body movement along with other fall parameters in dementia (Avvenuti *et al*, 2009). Deployment of sound in monitoring AD patients depends on the availability equipment to interpret acquired data. Though, this approach could be efficient and may address issue of patients' privacy and dignity over surveillance camera.

The signal acquired during monitoring could be linked to the portion of the brain responsible for body movement and alert. These signals could be used for triage parameter such as temperature, blood pressure and pulse. Avvenuti *et al*, (2009) proposed a unique approach using biomarkers that derived from multi-threshold indices responsible brain-activity and the body movement. The general concept of monitoring involve active capture of signal brain-body movement signal, signal analysis, data communication and computational intelligence decision strategy for medical inference(s) and predictions. This review aimed to propose a KM-based conceptual technique to monitor community-based AD patients in other to enhance freedom and address dementia stigmatization in Nigeria.

## II. SENSORS AND KNOWLEDGE CREATION

Data mining is the non-trivial process of identifying valid, novel, potentially useful and ultimately understandable pattern from data and knowledge creation (Krysztof, 2001) cited in Wickramasinghe *et al.*, (2009). Knowledge creation starts from data acquisition and progress to decision making strategies. Deployments of sensor require an initial knowledge of parameters such as fall-movement, alert, temperature and

cardiovascular risk factors. Sensing Health with Intelligence, Modularity, Mobility and Experimental Reusability (SHIMMER) wireless sensor platform comprises of knowledge-based monitoring healthcare system adopted in developed world (Ojetola *et al.*, 2011). Sensor(s) could be interfaced with networks (wired and wireless) to monitor triage physiological data. Personal biomarker such as EEG/REM, EMG could be captured and assigned for each purpose of triage design.

#### A. Types of Sensors

Sensor based AD Patient monitoring is an integral part of the knowledge creation process, it involves all processes carried out to ensure the relevant information regarding the patient is available to the care giver at any point in time. The knowledge base will fundamentally provide a two sided intelligence information. This two sided intelligence is to ensure the care giver at every point in time has a robust knowledge about the patient. First is information on absolute or personal conditions of the AD patient which include the medical profile of the patient such as patients cardiovascular RF, patient temperature, etc. Relative intelligence on the patient is also provided. This deals with information of the patient with respect to his immediate surroundings. Categories of sensors used to provide these information are listed in the following subsection.

**Medical profile:** The medical profile of the patient is monitored by specialized sensors which keep track of the patient electrocardiogram synopsis and body temperature. Sensors for this monitoring can either be done by contact or noncontact. Contact based measurements include bio-impedance measurements as reported in Landeata *et al.*, (2006) and by the use of wearable technologies as seen in Binkley (2003). Non-contact based measurements has been investigated by D'Souza *et al.*, (2012) specifically for cases of AD patients and it is a more appropriate means of medical activity monitoring.

**Movement:** AD patients' movement occurs either indoors or outdoors. Knowledge by Indoor monitoring of the patient is gathered by use of indoor position trackers. The use of Relative Signal Strength Indicators (RSSI) will suffice for this. The

RSSI is implemented by placing a low frequency transmitter (which is medically harmless) on the patient and monitoring the strength of received signal from the transmitter to a receiver. The stronger the signal received, the closer the patient is to the receiver. Adib *et al.*, (2015) proposed a vital radio which uses a wireless network to monitor vital signs. This radio can also be used to determine sources of radiation by the same signal strength monitoring process. The AD patient's movement is hence tracked and if the patient moves outside the area of reception, the care giver is informed. Outdoor tracking is achieved by a hybrid of a Ground Positioning System (GPS) and General Packet Radio Service (GPRS). The GPS/GPRS hybrid provides information about the outdoor location of the AD patient. The hybridized system regularly tracks the location of the patient and maps the location via the GPS module to a particular geographical boundary as specified by set of coordinates. At any point in time, when the patient leaves the mapped region, the hybrid system sends the GPS coordinates of the patient to the caregiver via the GPRS module on board. The GPRS module is preferred to other forms of messaging due to the wide availability of radio packet services amongst all the major network carriers in Nigeria, besides, the GPRS is cost effective in use and also in the deployment.

**Alert:** An alert system is setup by a Real Time Operating System (RTOS) controller which observes all sensors and monitors their real time outputs. If any of the sensors give an output above or below a stipulated range, the alert system sends a trigger signal which informs the caregiver of the particular violation that has occurred by the sensor.

#### B. Body Sensor Network (BSN) and System Architecture

Ojetola *et al.*, (2011) described conventional system architecture as 3-tier interface of body sensor network (BSN), gateway server (GS) and wireless access point. The BSN create knowledge by mining personal biomarkers and acquisition of data through the community gateway server through middleware to hospital information system. Middleware is a healthcare communication intelligent system which prioritize the vulnerability of the monitored patient through the captured data and releases a warning signal in real-time. The block diagram below figure 1, illustrates basic concept of BSN-System architecture.

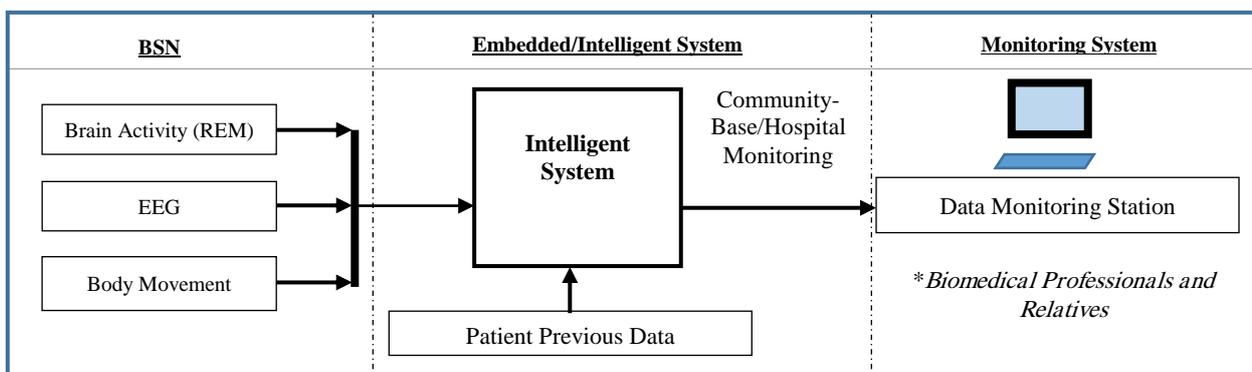


Figure 1. BSN-System Architectures

The interface of BSN with designed system architecture could base on the availability of resources in Nigeria and this could determine the efficacy of patients' monitoring system. Although, Nigeria are yet to attain electronic-based hospital information system to access real time patients' healthcare details in synchronization with community-based public health activities. Family and concerned friend could deploy this initiative to monitor their dementia relative(s).

### III. HEALTHCARE KNOWLEDGE MANAGEMENT (KM) CONCEPT

Healthcare knowledge management (KM) is emerging knowledge approach that is aimed at solving healthcare challenge and increase efficiency of the biomedical professional working as team. Quality of healthcare depends on the available workforce (people), process and technology in the context of knowledge management (KM). Figure 2, illustrate KM concept.

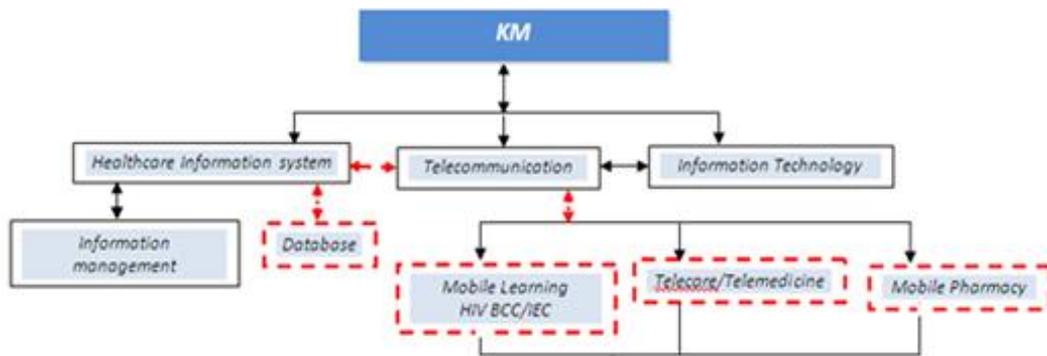


Figure 2. Knowledge Management (KM) Concept (Apena *et al.*, 2014)

The power of conceptual KM concept lies in the fact that it can realize the transformation of knowledge in the knowledge spiral (Wickramasinghe, 2009).

Successful healthcare KM requires operational research tools in the evaluation of activities, effective communication and forecast (prediction). KM limitation is organizational problem such as system failure and managerial issue. These two factors could militate against effectiveness of WSN application in the concept of healthcare KM. Qualitative measures can be recorded to ensure quality healthcare service and promote patients dignity. Wireless sensors network (WSN) can be seen as a KM tool for systematic organization, planning, scheduling and monitoring of people, processes and technology in effective communication (feedback).

### IV. ROBUST ALZHEIMER MONITORING SYSTEM (RAMS)

Robust patients monitoring system require a computing infrastructure (Section 2.0) that can comparatively sense and

Bali *et al.*, (2009) described the advent of electronic healthcare and data warehouse as source of knowledge sharing. Quality care requires an intelligence real-time considerable at the point of care through use of KM tools such as electronic health (e-Health) and telemedicine (Apena *et al.*, 2014). KM architecture is always designed to capture data through acquired knowledge to produce meaningful healthcare information for decision strategy and prediction. Hence, wireless sensors network (WSN) can be regarded as a KM tool for knowledge sharing to support medical decision strategy.

WSN can be deployed to manage healthcare knowledge sharing such as post-surgery monitoring and community-based service(s). Monitoring patients using WSN can reduce risk of infection transmission in the hospitals and provide job opportunity to the public health professionals. Antenatal patients could be monitored after discharge from the hospital rather than been kept as in-patients.

make a real-time intelligence data communications to the closed network interface. In the context of knowledge management, non-intrusive patients monitoring system could be deployed to sense psychological parameter and make timely intelligence computing decision with nursing station or wearable devices and sensor. Figure 3 is proposed RAMS concept in Nigeria.

RAMS can support sharing of knowledge among the biomedical professional and the concerned relative electronically to enhance adequate community-based caring.

#### A. WSN Challenges and Limitations

Avvenuti *et al.*, (2014) described possible challenges and limitation in deployment of WSN for monitoring as follow: energy management distributed processing, reliability, technology, data integration and privacy-security issue.

- (i) *Energy management* – Operations of WSN has always been determining by energy management constrained. For efficient activity, the data acquisition is expected not to be truncated by providing constant energy supply to

the sensor, as a result energy management remains concern.

- (ii) Distributed data processing – Data trafficking and intelligence analysis system to determine height of vulnerability of patient(s). It will be helpful not to congest the system with data acquisition, limit the computing power and availability of human resources.
- (iii) Reliability and Adaptability – The system should be reliable and available at all time to acquire data and signal. The concern of WSN is to communicate reliable message in the true picture of data acquisition, and also

with the aim of adapting to any changes in both patient’s physical and environmental conditions.

- (iv) Technology – Component(s) selection and availability of technology such as healthcare intelligent data analysis tool(s). System could be cumbersome with wrong choice WSN interface and limit efficacy of the system performance.
- (v) Privacy-security issue – Privacy and dignity pose an issue in community-based patient’s monitoring due to remote data handling and processing.

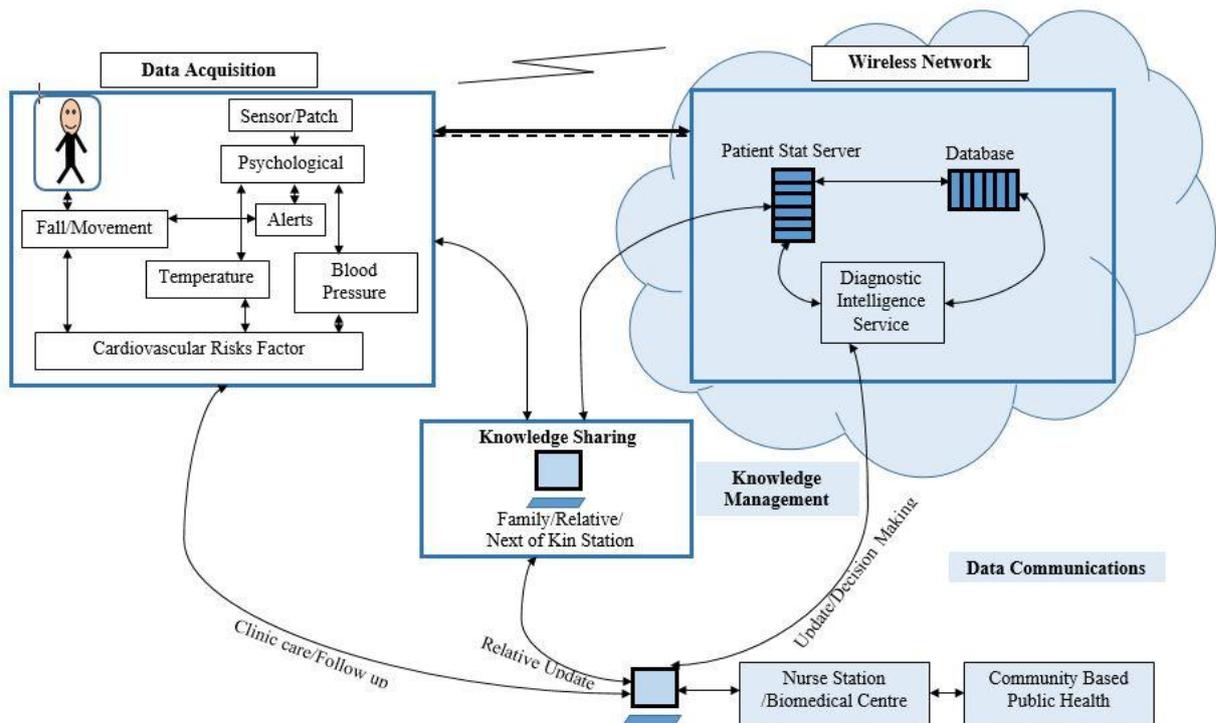


Figure 3. Robust Alzheimer Monitoring System in Nigeria

## V. CONCLUSION

Adequate knowledge availability can greatly increase the amount of care given to AD patients. Hence in this review, a knowledge based perspective by the implementation of wireless sensor networks was considered. The components required for the acquisition of information as regards the patients was also discussed. These components vary in operation, purpose and configuration. Hence for interoperability and passable communication between various sensor nodes, a wireless sensor network based protocol is designed for both small scale and large scale sensor monitoring. Each sensor is monitored in real time by this body of wireless sensor network which is captioned as a Body Sensor Network in this paper. When sufficiently implemented, the body sensor network incorporates an intelligent system that analyses previous data from the patients and by a neural/fuzzy

prediction sends relevant data to a community based hospital. Data communication is done in packets using GPRS as this is the basic network that is available in major parts of the country.

The incorporated system minimizes the cost of treatment of AD patients as monitoring will be effectively carried out by the proposed BSN based system instead of employing a human monitor. In addition, the system ensures effective and relevant knowledge of the AD patient is available to caregivers. The implementation of an intelligent system that does part data analysis suffices for this. It is also resolved that when relevant knowledge is promptly made available to the caregiver, the safety of the AD patient is better guaranteed and the live span of the patient hence increased. Hence this wireless sensor network knowledge based perspective for treating AD patients offers a better chance of providing care.

Further areas of research has to look into the implementation of the WSN knowledge based system in the care of AD patients by developing devices that carry out functions as seen in Figure 1. This device when developed has to be incorporated with an intelligent system, with sufficient algorithm for forecasting and prediction, that will provide relevant data via a wireless module to a data monitoring system or community based hospital for action to be taken as regards the patient.

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