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LETTER TO EDITOR

Preventing Medical Errors Using mm-Wave Technology; a Letter to the Editor

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Dear editor

About 795,000 people die or are permanently disabled each year due to diagnostic errors and related harms across clinical settings, according to estimates based on nationally representative disease incidence data for 2012 to 2014 (1). Studies show that the number of medical errors is increasing annually (2). This undergoing research study has its impact on improving human healthcare and reducing diagnostic errors due to fast, accurate, and robust data storage, transmission, and analysis with the use of information technology (IT) (3). Reducing diagnostics errors using IT in primary care and, generally, in healthcare is limited and huge steps must be taken to establish the use of IT for this purpose. To address this issue, the study proposes the use of ultrafast wireless big data transmission in primary care, specifically in remote smart sensors monitoring devices. It suggests that wireless transmission with a speed up to 100 GB/s (12.5 GBytes/s) within a very short distance (1-10 meters) is necessary to reduce diagnostic errors. High-speed data transfer could facilitate rapid transmission of medical images, such as CT scans, MRIs, or ultrasound images, between different systems or departments within the hospital. This would allow for faster interpretation and analysis of critical medical data, aiding in the diagnosis and treatment of patients in the ICU. The ability to transmit large amounts of data quickly, could facilitate telemedicine applications. For instance, doctors or specialists located remotely could have real-time access to patient data, video feeds, and diagnostic images, allowing them to provide expert consultations without being physically present in the ICU.

Using a controlled experimental setup that mimics the challenges and requirements of an Intensive Care Unit (ICU), researchers can evaluate the feasibility, performance, and potential benefits and applications of deploying high-speed wireless systems (4,5). The present study used real-time data from an experiment in an ICU scenario to resolve the technical difficulties of growing and expanding emergency care needs in terms of fast data transmission and diagnosis, speed, computation capability, fast wireless communication, big data analysis, and massive storage (Figure 1 A & B) (6-8).

In order to achieve a significant increase in health quality, healthcare must be transformed. IT can play a very important role, in particular, in terms of improving safety, prevention, and treatment. Smart and hygienic maintenance imposes strict requirements for reliability and timeliness. In order to achieve a 1ns transition and delay latency we need radical changes in today's internal network architecture. The delay of greater than 1ns, which corresponds to a greater number of degree transitions and phase shifts is said to have serious consequences for health and other medical precision equipment. Telecommunication companies should make every effort to support systemic public health. Remote 5G and beyond platforms increase the efficiency and effectiveness of the consultation. At least two million people worldwide receiving primary and intensive care face disability and/or prolonged hospitalizations as a result of medical diagnostic errors (9), Table 1.

It's important to recognize that while the proposed deployment of high-speed wireless systems in ICUs has potential benefits, further research, validation, and practical implementation are necessary to assess its real-world impact on patient care, safety, and overall healthcare outcomes. Millimeter-Wave (mm- Wave) generally refers to 30-300 GHz; a frequency range that can carry enormous amount of data and when combined with improvements in coding techniques, can carry thousands of times as much data as a low-band signal.

The mm-Wave frequency band is capable for various applications, such as wireless sensing, medical imaging, and

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short-range communications. New mm-Wave technology enables telemedicine research and diagnosis. Remote reading of X-rays is a pioneering application of mm-wave, and the use of remote diagnostics extends the topics of cardiology, ophthalmology, pathology, dermatology, and even mental health. Health and IT departments can support the diagnostic documentation and facilitate the monitoring and tracking of the patient's status, reporting of anomalies, and the exchange of information, as well as error detection. Some potential uses of mm-waves for medical applications are as follows:

1. Medical imaging and diagnostics
High-speed data transfer at 100 Gbps (12.5Gbytes/s) could facilitate rapid transmission of medical images, such as CT scans, Magnetic Resonance Imaging (MRIs), positron-emission tomography (PET), or ultrasound images between different systems or departments within the hospital. This would allow for faster interpretation and analysis of critical medical data, aiding in the diagnosis and treatment of patients in the ICU.

2. Real-time monitoring and telemetry
In the ICU, patients are often connected to various monitoring devices that continuously measure vital signs, such as heart rate, blood pressure, and oxygen saturation. With a high data transfer rate, the collected data can be transmitted in real time, enabling healthcare professionals to monitor and respond to changes in the patient's condition promptly. This could support more effective patient management and allow for timely interventions.

3. Telemedicine and remote consultations
With the ability to transmit large amounts of data quickly, a high-speed connection could facilitate telemedicine applications in the ICU.
For instance, doctors or specialists located remotely could have real-time access to patient data, video feeds, and diagnostic images, allowing them to provide expert consultations without physically being present in the ICU.

4. Research and data analytics
In an ICU research setting, where large amounts of data are collected for analysis and research purposes, a high-speed connection can facilitate the transfer of data to research systems or cloud-based platforms. This would support advanced data analytics, artificial intelligence, machine learning algorithms, and research initiatives aimed at improving ICU care and patient outcomes.

5. Medical imaging and health data
Health Big Data can be transferred, analyzed, and compared against Imaging Model Tools utilizing Artificial Intelligence (AI), Machine Learning, Deep Learning, and Augmented Reality (AR) technologies. Fiber optic communication and optical medical imaging techniques can be investigated as well. Big data analysis in the health sector can reduce treatment costs, prevent diseases, and improve overall quality of life. Big data refers to the large amount of information generated by digitization. Medical researchers can use large amounts of data, which can be transferred wirelessly over a second; for example, on treatment plans and recovery rates of cancer patients, to determine treatments with the highest success rates. Radiologists no longer need to look at images, but will need to analyze the results of algorithms that will inevitably study and remember thousands of images.

Capacity of different medical imaging modalities

The current capacities of different medical imaging modalities are shown in Table 2. The massive data bandwidth increase (Table 3) of the proposed mm-wave indoor network capabilities with respect to the current capacities, speeds and capabilities offered to medical society can be clearly observed.
Effective communication and data exchange are necessary to control patients with infection and to manage critical situations.
Research data shows that IT can reduce the frequency of errors of various types and possibly the frequency of side effects associated with them. The main category of strategies to prevent mistakes and side effects includes tools that can improve communication and make knowledge more accessible. This provides basic information, facilitates calculations, performs real-time checks and monitoring, and provides decision support. The data are visual images of the inner body, which can be created in various ways (e.g., X-ray, ultrasound, computed tomography, magnetic resonance imaging, and positron emission tomography), collected for diagnostic identification. Visual images are usually interpreted by a radiologist, emergency doctors, or cardiologists. Diagnostic analytics can find the root-causes and identify image anomalies, as well as filter and correlate big health data.
It's important to consider several factors when deploying such mm-wave systems, including:

1. Regulatory considerations
The use of specific frequency bands for wireless communication is subject to regulatory requirements and spectrum allocation.
Compliance with relevant regulations and obtaining the necessary licenses would be necessary for the deployment.

Table 1: Reported Information Technology-related medical errors

Errors
Abnormal imaging errors
Communications errors
Follow-up errors
Tracking errors
Outpatient communication medical errors
Delayed communication in radiology
Ordering and interpretation errors
Detection errors

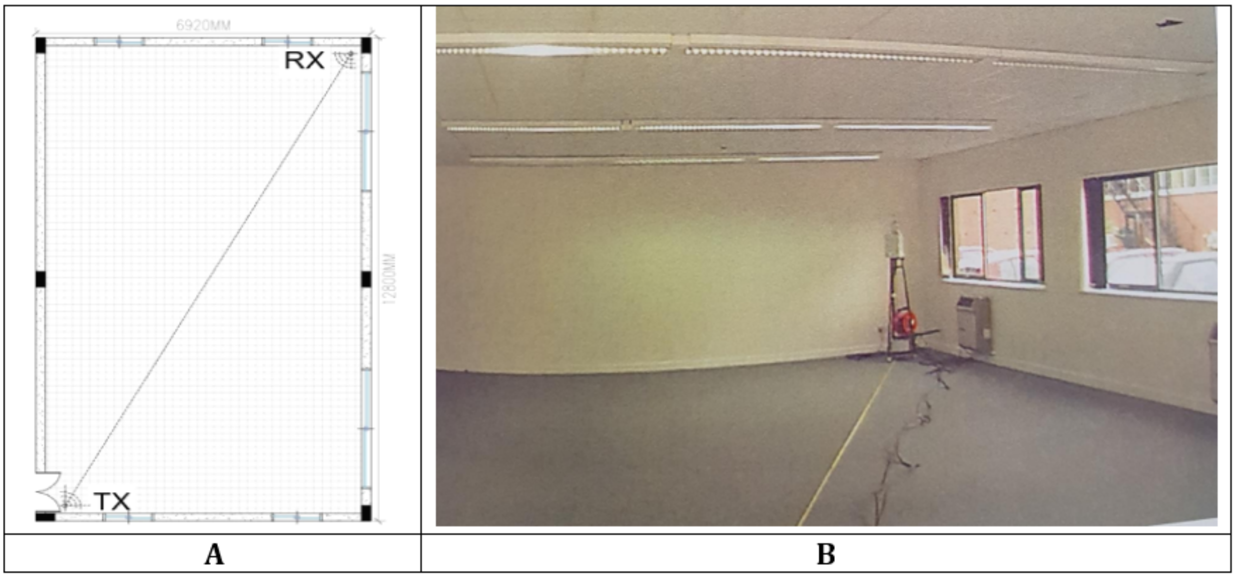

Figure 1: The Intensive Care Unit (ICU) room scenario. B: A photograph of the ICU experiment scenario (source: Siamarou A.G).

Table 2: Current data rates/capacity for medical devices against mm-wave technology

Medical Device	**Data rates/ capacity**
Ultrasound, radiology, and cardiology	256 Kbytes (image size)
Magnetic resonance imaging	384 Kbytes (image size)
Scanned X-ray	1.8 Mbytes (image size)
Digital radiography	6.0 Mbytes (image size)
Mammography	24 Mbytes (image size)
Compress and full motion video (telemedicine)	384 Kbps to 1.544 Mbps
Indoor (1-10m) mm-wireless technology	100 Gbps/ 12.5 GBytes/s

Table 3: Data capacity in bits/bytes

1 byte (B) contains 8 bits of information
1 KB contains 8000 bits of information
1 MB contains 8,000,000 bits of information
1 GB contains 8,000,000,000 bits of information
100 Gbits/s equals to 12.5GB ~ 100,000,000,000 bits of information

2. Technical feasibility

While millimeter-wave frequencies offer high data rates, they also have limitations in terms of signal propagation and range. The deployment of such systems would require careful consideration of the infrastructure, antenna design, and potential challenges related to signal attenuation and interference within the ICU environment.

3. Integration and compatibility

Seamless integration with existing healthcare systems, medical devices, and IT infrastructure within the ICU is crucial for successful deployment. Compatibility and data security considerations should be addressed to ensure efficient and secure data exchange.

4. Costs and practicality

Deploying advanced wireless systems can involve significant costs, including equipment, installation, maintenance, and training.

Conclusion

Research on reducing diagnostics errors in primary care/ICUs using IT is limited. The medical society had identified the problem but the support from governments and telecommunication companies is inadequate. Data capacity and fast data transmission and communication in primary care/ICUs are inadequate to cover the expanding needs of the patients. This work identified the need for reducing diagnostics errors using IT and conducted an experiment, simulating an ICU application scenario environment. Outcomes suggest timely deployment of such an indoor system (1-10 meters' distance) at the mm-band in ICUs offering 100 Gbp/s (12.5Gbytes/s) wireless throughputs. It will significantly reduce permanent disabilities, prolonged stay, unnecessary tests, and diagnostic delays in ICUs. Future research should be aimed at a prospective assessment of the prevalence and impact of diagnostic errors and possible strategies to address them.

Declarations

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Conflict of interest

The author declares that there are no competing interests.

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Compliance with ethical standards

This article does not contain any studies with human or animal participants.

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