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What Technologies Based on Unique Patient Identifiers Are Used for Patient Identification in Healthcare?

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Abstract. Ensuring the correct identification of the patient is key to matching the correct patients with the proper care (e.g. correct administration of medications and treatments), but it is also applied, for example, to monitoring the patient's movement in the hospital environment. This scoping review aims to find out what technologies based on unique patient identifiers are used to identify patients in healthcare facilities to increase patient safety and to identify future research trends. PRISMA-ScR guidelines were used, and the search focused on Web of Science and Scopus citation databases from 2000 to February 2024. Thirty-two papers dealing with patient identification methods from the point of view of person identification were found. The solutions found were built on the technologies (linear or 2D) of barcodes, RFID and NFC tags. None of the patient identification solutions found offer complete accuracy due to the human factor, and each solution targets a different problem context associated with a particular type of health facility. Future research can focus on the combination of multiple technologies, including biometric methods, to improve identification and tools to support decisions about the use of technology in a particular context and health facility (e.g. hospitals, medical nursing homes).

Keywords. Barcode, BCMA, RFID, NFC, review, UPI, UWB.

1. Introduction

Errors in the identification of patients in health facilities are one of the causes of endangering patients' health. Incorrect identification of the patient can cause incorrect diagnosis, wrong medication, incorrect dosage, or even performing surgery on the wrong patient. Unique patient identifiers (UPI), matching algorithms and other data extensions or add-on technologies like biometric systems can be used for correct identification. This paper aims to provide an overview of the proposed solutions, emphasising the technologies based on UPIs, which are used for patient identification in health facilities to increase patient safety. For individual technologies, the process in which identification is used is examined, as well as the advantages and disadvantages of its use.

In the scientific literature, the following technologies based on UPI are mentioned in particular: barcode, radio frequency identification (RFID), near field communication

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(NFC). In the field of patient movement monitoring, ultra-wideband (UWB) is also mentioned [1]. A small number of review articles dealing with patient identification using UPI in healthcare were found in the Scopus and Web of Science databases. The most relevant article [2] does not focus primarily on the technological aspects but on the process aspects associated with patient identification. Also, other review articles [3,4] focus on a general description of solutions and their benefits or problems at the organizational level. On the contrary, this article comes from a technological perspective.

2. Methods and Results

This scoping review was prepared according to PRISMA guidelines [5] with extension for scoping reviews. It focuses on Web of Science and Scopus citation databases and the period 2000 to February 2024. Due to the limited length of the paper, we focused only on solutions based on using a data carrier or UPI. In our search, we did not include add-on technologies such as biometric identification systems that do not require UPI. Following word combinations were used to search for papers "patient identification" and "identification of patients" and wristband or "radio frequency" or "ultra-wideband" or Zigbee or NFC or radiofrequency in abstract.

Only papers available in English were included. Searched articles were recorded in the Zotero citation tool, with the help of which duplicate entries were removed. The records were then downloaded to the web-tool Rayyan where the selection according to the abstract was carried out. Inclusion in the review was verified based on full-text examination. Papers describing the design and/or implementation and use of patient identification technologies were included. Review articles were not included. If multiple versions were found, only the most recent one was included. Based on the above word combinations, 252 papers were found. After removing duplicates, 150 articles were examined. A total of 32 articles were included. Complete results with an overview of all included articles can be found in the supplementary material [6]. The file contains the technologies used, context of use and advantages and limitations of technologies.

2.1. Barcode technology

The technology of reading barcodes from wristbands to increase patient safety, especially during dispensing and medication processes, shows a significant reduction in error rates immediately after deployment and persists for a long time after the implementation phase [7]. The use of barcodes eliminates the most common source of errors, which is the human factor. In the same way, patient identification enables increased safety in the transfusion process [8,9]. 70% of errors are attributed to failure of bedside pre-transfusion control. The introduction of a method of verifying the patient and the blood bag using barcode scanning is cost-effective and brings a significant improvement in the safety of the transfusion process [9]. The same proposed processes can also be used in the case of two-dimensional (2D) codes [10]. Compared to linear barcodes, 2D codes have higher readability [10]. Patient identification through barcode scanning helps reduce errors in the blood sampling process as well [11].

2.2. Radio frequency identification

RFID uses high-band frequencies and is used to read data over a distance of several meters. The tag is usually placed in the patient's wristband [12]. The choice of wristband is essential from the point of view of readability. Some products available on the market may have poor readability [13]. In terms of placement, the RFID tag as a part of the neck tag also shows good readability [14]. RFID tags can be used to identify the patient, but they can also contain important data, e.g. allergies, blood type and prescribed medications [15]. The use of implanted tags is proposed in the paper [16] for cases when the patient is unable to provide information about himself.

The RFID tag placed on the medical card enables its quick search and quick access by physicians to important health information [17]. Paper [18] proposes the simultaneous use of RFID tags together with a resource allocation system for the efficient allocation of a nurse to a patient based on urgency. The implementation of RFID technology is widespread especially in connection with medical administration for patients in inpatient wards. Labelling includes patients, medical staff, administered drugs. During the process, the patient, the nurse and the medicines are verified [13]. A possible variant is also a combination of patient identification using an RFID tag and medication verification by scanning a barcode [19]. The second most common error after drug-related is surgery-related error. Increasing safety in the operating room environment brings the use of RFID technology to identify patients, staff, equipment, drugs and medical devices. Patient information can be automatically displayed after passing through the RFID reader, which recognizes the patient's tag and sends basic patient information to the operating theater screen [20]. RFID tags can also be used for remote monitoring and identification of patients and access control, for example, in a geriatric home care facility. The tags are also part of the patient traceability solution, where it is checked whether the patient has arrived at the destination.

2.3. Near field communication

The identification system based on the use of NFC tags uses the advantages of this technology, which are mainly data security, simplicity of data exchange, reading speed, availability of reading using mobile phones and low price [21]. The use of an NFC tag is also proposed as an alternative for identifying mentally ill patients. The tag can be placed on the patient's wristband or attached to clothing. Using the mobile application, the healthcare worker will obtain information about the patient, medical history and contact information. Smartphones or tablets with integrated tag reading for patient identification can allow information to be accessed when approaching the tag, significantly reducing the time spent by physicians checking patients [22].

Two problems associated with UPI are mentioned in the papers: patient misidentification and data security. A key issue for solutions based on patient identification and access to patient records using a mobile application and NFC tags is data security. Therefore, a solution based on mutual authentication between the server and staff using private keys was proposed [22]. To reduce errors caused by tag confusion, it is possible to add a photo of the patient to the displayed record [23]. Combining technological approaches brings a new quality of services and reduces errors. In paper [24], the authors propose that, if there is no device supporting NFC tag reading, information can be obtained by scanning a QR code.

3. Discussion and Conclusions

Identification of patients by scanning barcodes from a wristband requires the activity of medical staff. In the case of the Barcode Medication Administration (BCMA) process, the wristband may be missing, damaged, or unavailable on a sleeping patient, and verification cannot be performed. Nurses can also scan patient barcodes remotely if they place the barcode on a trolley or door. If another patient's identification wristband is used, it can be a life-threatening situation [10]. Training of medical staff is therefore important [9]. Although 2D codes allow for encoding more information and occupy a smaller area, the limitations regarding their use are the same as linear codes. Compared to other technologies, barcodes are the cheapest solution [25].

In the case of using RFID tags, it is also necessary to consider possible interference with other devices. It is not only for this reason that testing before implementation is recommended. This should prevent false readings caused by electromagnetic field interference from different devices, metal objects, liquids, etc. [26]. An important aspect of the use of RFID and NFC in the healthcare sector is ensuring the hygiene of both the tags and the reading device [19].

In the case of patient identification by a medical professional, the use of NFC tags is more appropriate. The advantage is that only one tag can be read and the need to approach within a few centimetres, which contributes to higher security and more accurate identification results [21]. The advantage is the availability of a reading device in the form of mobile phones, and the disadvantage is the limited storage capacity of tags [21].

None of the technologies mentioned in found papers can demonstrate absolute certainty of patient identification and ensure suitability for all processes in health facilities. An important paradigm for reducing the chance of misidentification is the use of more UPIs [4]. Although many solutions combine different approaches to patient identification, only [24] combines the above technologies and their benefits. The direction for future research can be the combination of multiple technologies and approaches, including biometric methods, in connection with the diverse problem contexts of health facilities. The above needs to be supplemented with tools to support decisions about the use of technology in a particular context. Another research direction could be using other technologies, e.g., UWB, which brings new features. However, whatever technology is used for identification, it is important to explain the reasons for the implementation and its benefits not only to medical staff, but also to patients, as well as to assure them of data security and privacy.

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