Diagnostic point- of-care (POC) tests with an approach to data management

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ABSTRACT

Introduction: Diagnostic point- of- care (POC) tests are considered as an approach to ease the diagnosis of diseases, deliver quicker patient care, and improve patient safety. The aim of this study was to review the diagnostic POC tests with an approach to data management.

Material and Methods: In this review study, PubMed, Science Direct, Google Scholar, Scopus, and Wolters Kluwer databases were searched from 2000 to 2020 using a combination of related keywords. A total of 96 articles were retrieved of which 48 articles considered as relevant. The content of these articles were then analyzed with respect to the aim of the study. The inclusion criteria for the articles were: 1) they focused the POC test; 2) addressed data management aspects; 3) written in English. Articles that only addressed the POC tests from a clinical or technical perspective and with no indication of data management were excluded.

Results: Rapid and timely collection and processing of test results, the capability of exchanging test results, and capabilities such as documentation and data quality control play a significant role in reducing the average length of stay in hospital, planning, decision-making, organizing, controlling clinical and managerial activities, and achieving the efficiency of services provided.

Conclusion: In addition to applying diagnostic POC tests technologies, medical settings should have necessary approaches for managing data generated by these technologies to improve better use of data in service delivery.

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INTRODUCTION

With the development of information and communication technology, the healthcare industry, like other industries, has undergone a number of changes [1], which include the provision of services through devices used for performing POC tests [2]. According to a definition by Medicines and Healthcare Products Regulatory Agency (MHRA), any tool used to produce POC test results is part of the POC devices. This definition could include simple devices such as blood glucose meters to very complex devices such as blood gas analyzers [3]. Thanks to capabilities such as portability, ease of use, fast processing, and provision of test results; the POC devices could lead to the reduction of costs, increase of the user satisfaction, acceleration of patient care, and management of limited resources, especially in deprived areas [2, 4, 5]. The mentioned capabilities of

POC testing devices extend the range of their use from deprived healthcare centers to advanced hospital centers. As a result, the volume of data generated by the devices increases and makes it demanding for physicians and administrators to collect, interpret, and manage the results of POC tests [5, 6]. One of the solutions is the deployment of data management system for handling data generated by these devices [7]. By definition, a data management system is a system through which data is collected, stored, processed, and retrieved [8]. This system could facilitate central control, coordination, analysis, and interpretation of POC reports and test results. In addition, this system is capable of making tests data processing shorter, which in turn is effective in accelerating decision-making and improving the provision of care [8, 9]. Regarding the role of data management in improving the provision of healthcare services, According to a number of studies,

the properly organized and processed data will improve the provision of healthcare services [10-12]. Accordingly, considering the capabilities of the data management system with respect to the POC test devices and their significance in providing quality healthcare services, this study aimed to review the POC testing with an approach to data management.

MATERIAL AND METHODS

In this review study, the relevant English articles published between 2000 and 2020 were searched in PubMed, Science Direct, Google Scholar, Scopus, and Wolters Kluwer. The search terms included, but not restricted to, POC data management system, POC technology, POC device, and a combination of these terms. Initially, 96 articles were retrieved. After initial screening, 30 irrelevant articles and 18 duplicate articles were removed. Finally, 48 articles were selected for review. A data extraction form was used to gather data from the selected studies, and the content of these studies was then analyzed considering main components of data management, including data collection, data quality check, data processing, and data exchange.

RESULTS

In this section the findings are presented in relation to key parts of data management that should be taken into consideration in relation to POC test devices to make appropriate use of data generated.

Data collection and type of collected data

The aim of data collection is to apply quality data in decision-making and patient care. In general, the collected data are categorized into two groups of demographic and medical data. Demographic data includes identity information and characteristics such as age and gender [12]. Medical data mainly consist of diagnostic and therapeutic details including of the nature of disease or problems, date and time of the onset of the problem, current condition of the problem, care plans, and medical orders [12, 13].

Data collection methods

Data are collected manually and electronically. The manual method is mostly based on paper forms and data entry requires human intervention in which omitted data might be experienced. In the manual data collection, data are filled in paper forms and the results are attached to the patient's record. However, in the electronic method, data are collected using the data management system and the results are stored in the patient's electronic records. The electronic method is a structured data entry approach in which data are automatically entered into the electronic health records [14-16]. Data are entered using the

keyboard, scanner, radio-frequency identification technology (RFID), sensors, voice recognition technology, and touch screen. The recorded data are more complete and more reliably available to users through the data management system [13, 17].

Data quality control

Quality data is a basic requirement to deliver a prompt treatment and improve the effectiveness of care. Data management system with automatic data entry and the quality control plays a key role in improving patient care and supporting care delivery [13, 17-20]. Without a data management system, there might be issues around the reliability of data collected in terms of the accuracy, completeness, and validity. Moreover, the use of timely, accurate, and comprehensive data is not only important for patient care, but for documenting, managing and healthcare planning [21].

Data processing

Data processing, as a set of operations on data based on required indicators, generates specific results or reports. The adoption of the data management system could improve data manipulation and creation of necessary reports. Data management system prevents data redundancy with the storage and centralized processing of data and allows data retrieval and sharing [3]. During data processing, patient data (demographic and clinical ones) is analyzed and made available to users in the form of administrative or clinical reports. Administrative reports such as billing reports of performed tests are significant for managers and planners and care reports are also essential for the continuity and follow-up of treatment [22].

In terms of data processing type, processing could be seen in the centralized and decentralized forms. In the centralized approach, control, coordination, and data analysis are performed automatically through the data management system [8, 23]. The speed of data retrieval in the centralized processing is high and due to the necessity of quick access to reports and the type of the technology used in POC devices, reports are more complete and accurate and include required details.

Another advantage of using a data management system is the automation of precision measurement in POC devices. The precision of each test performed by POC devices must be checked continuously. Precision measurement is known as a basis indicating the degree of the replicability of the test results and the compatibility of current and previous test results. The higher the precision of the devices, the quicker the processing will be. In the centralized processing, the precision of the device is measured automatically using the data management system.

High processing capability and the speed of reports creation are critical for care delivery. In the decentralized processing, data is controlled and analyzed using the analyzers of devices, and the data is stored in the memory of devices for only a short time, depending on the storage capacity of devices [24-26]. As compared to the centralized processing, the analyzers of the POC devices do not allow real-time processing but processing is usually performed in less than 5 minutes. However, in some cases, the speed of data processing and retrieval in POC devices is slower than that of similar devices in central laboratories and may even take less than one minute [27].

Regardless of the type of processing, the data organization in the prepared reports is performed based on the format required by the users, and the reports are prepared in different ways based on the type of tests or devices used.

Data exchange

The data exchange between the data management system of the POC devices and the laboratory information system and the electronic health record is effective in facilitating the care process and is performed by improving access to information [28]. Quick access to the results of POC tests and data exchange between systems play a central role in improving the safety of the patient and the efficiency of healthcare service delivery [20, 29]. One of the most remarkable benefits of a data management system is the capability of data sharing between the laboratory information systems and the electronic health records [22, 29, 30, 31].

Vashist et al. remarked the capability of a data management system in data sharing among the POC test device, the LISs the EHRs. These researchers considered the use of these devices as a supplement for performing some diagnostic tests outside the central laboratory, which in turn could improve the speed of decision-making and help to reduce unnecessary costs [6].

The capability of connecting to networks and communications

The existence of an information network is necessary for data sharing, and the POC devices must be able to connect to this network. The connection of devices into the network could be wired or wireless. Wireless LANs use radio frequencies (RF) and rely on Spread Spectrum, which is less sensitive to radio and wave interferences [26, 30]. In wired networks, the devices in the network are physically connected and interact to each other through wires (cables) [3, 9].

Data exchanges between data management system and POC devices are either unidirectional or bidirectional. In the unidirectional communication,

there is one fixed transmitter and one fixed receiver, and the information is sent by the transmitter and received by the receiver [26, 28]. Bidirectional communication implies the capability of transmitting test results from devices to the data management system and vice versa (transmitting patient data from the data management system to devices) [16, 19].

Usability capabilities

The usability of an information system, by definition is degree to which the system is used by users efficiently, effectively and together with satisfaction [32]. One of the most imperative usability capabilities of a data management system is the documentation of test results at the POC [12, 14]. Evidence has indicated that documenting POC test results could improve care quality and patient safety [15, 33, 34]. The capability of displaying POC test results (data presentation) [35] and the auto-alert feature could encourage the use of POC devices [1, 17]. Regarding the display capability, various types of information can be displayed on the screen depending on the type of device and users' needs. For instance, the presence of a data management system helps to display real-time information in monitoring devices that continuously process and measure a patient's vital signs at the patient's bedside. The capability of displaying or even printing the POC test results is also one of the key features of POC devices [36]. The auto-alert feature also helps improve patient care and safety when test results do not meet the normal and defined standards [37, 38].

DISCUSSION

Management of a wealth of data generated by POC test devices is a challenging issue in healthcare settings and the use of electronic approaches such as a data management system is inevitable to collect, process, store and share data efficiently and effectively. The findings of the present study revealed that the data management system could facilitate service delivery to patients through improved and timely access to information at the point of care.

In a study conducted by Lewandrowski, the findings revealed that the electronic data collection was preferred to the manual data collection in which the results of POC tests were manually entered into the patient records and there was no mechanism for collecting and storing data generated by POC devices [19]. In addition, the proliferation of POC devices such as injection pumps, vital monitors, blood concentration measuring devices, blood pressure monitors, and ultrasound in various parts of hospitals has made it difficult to collect the data manually [17]. Nicholas' study indicated that the use of electronic approaches could eliminate difficulties with data management [24]. Moreover, the studies conducted by Luppia and Louis showed that the test results

provided by POC devices can be automatically collected and transmitted through a data management system and through barcodes, Radio Frequency identifier (RFID), voice recognition technology, and sensors [23, 39]. Vashist et al. noted that due to importance of data collection tools in data management, the use of these tools should be taken into consideration from the early design stage of POC devices [6]. Knowing that POC test devices collect a variety of bio-data such as blood pressure, weight, and blood glucose level from patients' bedside electronically and then transfer it to the electronic health record, a data management systems is required to apply data quality checks [16]. Data quality control is a set of actions taken to monitor the accuracy, validity, and comprehensiveness of data generated by devices to make sure the reliability of data for patient care the POC tests [26]. Asadi et al. in their research pointed out that the accurate and complete data play an important role in the quality of healthcare services [40].

In addition, the findings of the current study showed that a data management system could make data processing more efficient and less time consuming [27]. Quick data processing is of great significance in specific units of hospitals such as cardiac care unit (CCU) and emergency department (ED) that the accessibility of data has a pivotal role to play in service delivery [2, 41]. The findings of Nouri et al. research that studied the effect of POC test devices on the CCU admissions showed a reduction in the hospital stays from 2.2 days to less than a day following the use of POC test devices at the point of care [42]. The effect of the POC test devices in the above reported study could be due to higher and more accurate data processing allowing the medical team to make relevant decisions based on test results at the point of need.

The findings of current study also indicated that a data management system could facilitate data sharing. Immediate transmission of POC test results is expected to be achieved using the data management system [23]. Data sharing by POC devices along with the adherence to data sharing standards could eliminate the manual transfer of the patient sample to the laboratory and also reduces the workflow of the POC test results from the patients' bed to the hospital information system [29]. The study conducted by Futrell showed that the flow of information from the POC devices to the data management system and vice versa allows treatment personnel to access electronic health record information as needed and in the shortest time [43].

However, data sharing requires integration of POC data management systems with LIS and electronic patient records and the lack of this integration could impact on the efficiency and effectiveness of data management systems. The integration of systems

requires the adoption of data exchange standards. According to William's study, these requirements include the ability to apply the connection and execution standard for each device, which means that the device can be automatically detected and be ready to use after the device is first connected to the data management system without any special settings made by the user.

Data exchange also requires setting and applying communication standards, developing a high speed network, and developing a robust infrastructure for connectivity of POC test devices with LISs, EHRs, and other relevant systems [28, 44].

Having the necessary usability capabilities is also one of the features that results in the efficient and effective use of the POC data management system. Paying attention to the usability capabilities in the process of designing this system will cause a better interaction between the users and the system and ultimately leads to users' more effective use of the system. Improving collection of data and facilitating documentation of test results are among the important usability capabilities of the data management system [17]. Based on the findings of the Kohle study, the timely and accurate documentation of the data helps to improve patient safety [33, 34]. Lewandrowski has introduced documenting POC test results as an approach to increase the integration of POC devices in different parts of hospitals, especially intensive care units and makes the provided healthcare services to be more effective [45].

CONCLUSION

In the present study, the POC data management system reviewed in terms of data collection, data processing, data exchange, and usability aspects. The results revealed that the provision of healthcare services using the data management system leads to the improved performance, information flow, control, monitoring, and effectiveness of providing the POC services. These systems can improve the quality of medical care, improve patient safety, and improve the efficiency of care provided.

AUTHOR'S CONTRIBUTION

All authors contributed to the literature review, design, data collection and analysis, drafting the manuscript, read and approved the final manuscript.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest regarding the publication of this study.

FINANCIAL DISCLOSURE

No financial interests related to the material of this

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