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When Knowledge Management and the Neonatal Intensive Care Unit Add Up to a Triplet Success Story

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Abstract

Introduction: Patient records as we see them today are constantly developing and with present day innovations it is clear that "the sky is the limit" for obtaining a complete record and clear picture about the patient's medical history. It is our belief that a complete medical record from as early as the first moments of life initiated immediately after birth can be most effective to physicians and other medical staff treating patients, especially in the Neonatal Intensive Care Unit.

Overview of technology: Documents are coupled to the content identifiers and conveyed to the data warehouse via the various transfer protocols. Once a patient is transferred to an external medical center, the receiving institution can access the electronic patient record, treat the patient and contribute their information accordingly.

Discussion: To avoid mismatching of information we recommend that every newborn is immediately allocated with a permanent Patient Identification Number (PID), with very little or no updates to the Hospital Information System (HIS). Every change in patient demography has the potential to cause inaccurate patient records. It is imperative that patient Information be extracted with no delay enabling immediate treatment.

Conclusion: An efficient data warehouse with accurate and easily accessible patient information in a data sharing system make medical records available from across health systems and locations thus eliminating unnecessary and duplicate tests as well as providing information necessary for treatment of those very young patients.

Keywords: NICU; Electronic patient records; Data warehouse; Patient identification; Knowledge management

Abrevations: EPR: Electronic Patient Record; ERP: Enterprise Resource Planning; HIS: Hospital Information System; HIE: Health Information Exchange; RIS: Radiology Information System; HL7: Health Level 7 standards; MRN: Medical Record Number; NICU: Neonatal Intensive Care Unit; PACS: Archiving and Communication System; PID: Patient Identity Number; SAP: Applications and Products in Data Processing

Introduction

As far back in history as the fifth century BC, Hippocrates, the father of medicine, recognized the necessity of patient records. He advocated that the medical records should reflect the course of disease as well as indicate its possible cause. In the 19th century as the invention of more diagnostic techniques and instruments came about so the terminology developed with the necessity to express new findings in patients as a result thereof. Patient records then developed from mere notes in a ledger arranged chronologically as time oriented medical records to patient oriented medical records in 1907. It was in 1920 that set the tone of present day patient records, as stated by Bemmel and Hogan [1]. Patient records as we see them today are constantly developing and with present day innovations it is clear that "the sky is the limit" for obtaining a complete record and clear picture about the patient's medical history. It is our belief that a complete medical record from as early as the first moments of life initiated by the midwife immediately after birth can be most effective to physicians and other medical staff treating patients, especially in the Neonatal Intensive Care Unit [NICU]. This will afford the potential to reduce medical errors and increase the quality, efficiency and reliability of information in the EPR [2].

While concern regarding "e-iatrogenesis" has been discussed due to faulty electronic health implementation we express that this mode of action will increase the safety of the newborns [3,4].

According to the protocol of the Israeli Knesset (Parliament) committee of science and technology [5,6] The Israeli Ministry of Health aspires to set a standard by implementing an ERP system in most health institutions in Israel inclusive of twenty four hospitals and four medical aids. By standardizing the systems in these institutions it is believed to result in less medical mistakes, fewer unnecessary duplicate tests performed when patients are transferred from institution to institution as well as to enhance immediate consultations across medical centers.

Poria medical center is a medium sized accredited general hospital in northern Israel with state of the art equipment and technology. The hospital has 326 inpatient beds, 9 operating theaters, 12 daycare beds, 9 dialysis stations, 36 newborn cots and 18 NICU stations. As a Regional and unique hospital it provides services in almost all medical professions, except for pediatric heart and thoracic and neurosurgery. Those cases are transferred to tertiary hospitals for treatment. There are approximately 3,000 births per annum and 3,400 newborns. The NICU being an intensive care unit specializing in the care of ill term newborn or premature newborn infants of which together with the nursery some are from multiple births but most are singletons. The atmosphere in the NICU is fast paced and every moment can have a significant role in the outcome of the infant's treatment with an impact on the rest of the child's life. The wonders and challenges are set forth in the case we are about to present where the use of Electronic Patient Records (EPR) played an extremely significant role.

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Overview of Technology

At Poria Hospital Patient information is recorded on a SAP system (Applications and Products in Data Processing) ISH-m.e.d module based ERP (Enterprise Resource Planning) program which is the main platform. ERP systems being integrated software applications functioning throughout organizations are evolving to incorporate new technologies [7] such as data warehousing. There are systems integrated to the SAP by Health Level Seven (HL7) standard interfacing achieving data integration [8] with systems such as laboratories, radiology, obstetrics and gynecology imaging, finance and accounting, etc. Another system is a data warehouse, which are defined as [9] infrastructures for exchange of meaningful information interoperability among different systems (e.g., medical aids and hospitals) and programming languages providing the basis for integration between applications on different platforms through a communication protocol. (Figure 1) shows the flow of information. The content identifiers including patient demography, risk factors' chronic illnesses and medications are initiated once the patient is registered. Documents are coupled to the content identifiers and conveyed to the data warehouse via the various transfer protocols; the external medical center receiving the patient can access information and contribute their information to the data warehouse. (Figure 1)

All information concerning the patient's current health and history are stored in the Electronic Patient Record (EPR) which is archived in main central servers with DRP (disaster Recovery Plan) backup and protected by a firewall. In the past, patient records were kept as hard copies in physical files, in the medical archives or in "best of breed" systems scattered over the hospital. As mentioned by McCoy [10] it has been established that EPR's are useful tools to the staff managing a patient and thus can be a positive contribution to the wellbeing of a patient admitted to a hospital and his aftercare. All files are easily and quickly accessible on line with no necessity to have them drawn from the medical archives physically or retrieved from outdated "legacy" systems. Studies have shown that there is no meaningful difference in time consumed for preparing EPR's as opposed to handwritten records [11]. Moreover, Apkon and Singhaviranon [12] have stated that handwritten records can be difficult to read and no statistics can be electronically extracted.

In 2012 The Israeli government hospitals gradually started introducing a Health Information Exchange system (HIE). This system collects patient information from most medical institutions in Israel and can be accessed by medical professionals in hospitals. Accessibility permissions are allocated to physicians, nurses and other health care

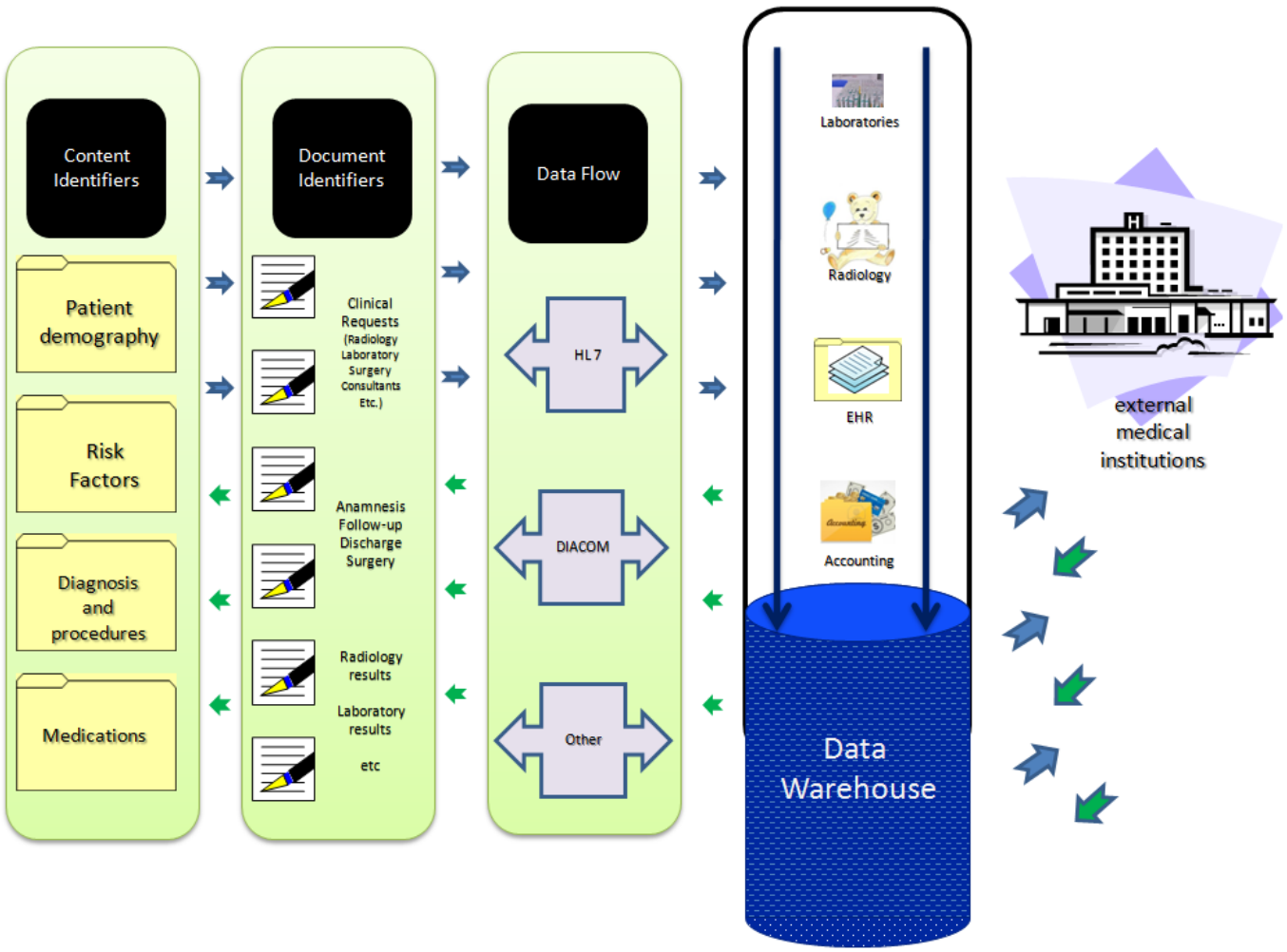

Figure 1: Flow of Information. The content identifiers include patient demography, risk factors chronic illnesses and medications are initiated once the patient is registered. Documents are coupled to the content identifiers and conveyed to the data warehouse via the various transfer protocols; the external medical Institution receiving the patient can access information and contribute their information to the data warehouse.

providers alone, to view data pertaining to admitted patients during their stay, or ambulatory patients on the day of their visit. The HIE only contains specific clinical data transmitted from various systems in the healthcare community according to strict rules filtering certain conditions, procedures, etc. according to Patients' Rights Act of 1996 [13]. All documents in this system is "read only", no document can be altered, modified, copied or printed, thus preventing malice. A study on the implications of the system at one hospital found that the information received from the HIE helps and improves accuracy of diagnosis, helps to provide quality care and improve efficiency of the service provided [14].

Patients of the nursery and NICU departments are frequently at risk of misidentification errors as a result of similarities in standard identifiers such as similar names, dates of birth, etc. Gray et al claim that [15] this risk persists even after exclusion of multiple births and are substantially higher than has been reported in other hospitalized populations.

Newborn babies with no personal medical history, at the time of birth have their mother's medical history including her pregnancy, labor and delivery. Those babies have the most to gain from an EPR with their entire medical record commencing from the moment of birth [16,17]. Comprehensive and accurate records from the earliest stage of life can prove to be imperative for their wellbeing later on in life as well.

From admission to discharge, the need for streamlined documentation is critical for excellent NICU coordination of care. Time is at a premium in a busy NICU; the stay may last three months or longer and the discharge process is lengthy and complicated. An Electronic Patient Record [EPR] helps improve continuity of care by providing doctors, nurses, and other treating staff with an organized, understandable picture of the baby's status and mother's record. In some cases consultations are requested from tertiary medical centers, and in more severe cases babies are transferred to those centers. Use of an across country medical data warehouse is an extremely helpful tool in those cases.

Our aim is to emphasize the values of system integration to achieve an optimal level of data transfer for a most efficient method of data warehousing to benefit neonates from the first moments of life, throughout the country. As most government general hospitals (in Israel) work with similar platforms realized the potential of a practical common data warehouse for all of those hospitals to access. It is thus possible to consult with those hospitals for specific specialties not available in the primary care hospital, or in the event a patient is transferred, the receiving hospital is prepared to treat the patient with no time wasted. Patient data is easily accessible by a common key or identifier (PID) which is the national identity number. According to Healthcare News, having data available from across health systems all over the country eliminates unnecessary and duplicate tests, examinations and procedures etc., as well as provide EPR data including high risk information regarding any specific patient [18].

The importance of all medical data registered in the patient's records alone is not sufficient, it is important that the medical record made available to a tertiary hospital is well organized containing relevant information pertaining to the specific event or events. For example in most cases if a patient has many laboratory tests done, over a few days, by default only the first baseline result and the last current result would be ample, but should also be possible to access all results if needed. In some cases it has been reported that doctors have found it difficult to find the necessary data due to mounds of unorganized information [19].

One of the major challenges of management of unstructured medical data is that of finding or creating key or identifier information in hospital information systems based on diverse platforms. There are usually two basic kinds of identifiers – document identifiers and content identifiers. A document identifier is data that identifies a document, such as a report title and date, an email address and date, a document registration number and so forth. A content identifier is information in the substance of the document that identifies what the information is about. Content identifiers may include a patient number, a hospital entry number and date, an identity number, and so forth making it easier to retrieve the medical history for a particular case. A given patient may have different identifiers in different institutions. In one institution the document identifier may be a name, in another the identifier is a medical record number, and yet another patient has his national identity number (i.e., PID), and so forth. As mentioned by Inmon [20], in order to integrate the unstructured data into a data warehouse, the identifiers must be consolidated and normalized. It is for that reason the national identity number is the common attribute among the medical centers.

Upon admission, the SAP system allocates three main identifiers for each patient: Hospital Medical Record Number (MRN), which is a unique identity number for each patient. Every hospital has a different series of numbers so that there is no ambiguity of information shared. This number cannot be changed and it follows the patient from his first visit through his last visit and includes all aspects of administrative issues such as accounting; and, case number which identifies each visit and appends the health records accordingly; and, National Identity Number (i.e., PID) which is linked to the demography at the ministry of interior.

As the first step in admitting any patient, a receptionist searches for the patient in the Hospital Information System [HIS] via the SAP system database by his national PID or passport number if he is a tourist. Patient demography in the HIS is updated via an interface with the Ministry of Interior database, or entered manually. If the patient does not exist in the database a new hospital MRN is automatically allocated. Once the HIS is updated a visit is created; it is this visit that is connected to a new case number. Each process such as clinical requests and documentation pertaining to the specific patient during that visit is appended to the case number enabling easy access to the electronic file [17].

An Israeli Ministry of Health Directive of 2011 [21] has eliminated temporary identification numbers for newborns and requires a permanent Id Number to be issued within two hours of birth. The directive emphasizes that all tests and treatments should be carried out with the newborn's permanent PID. In rare cases of emergency clinical requests and documentation are entered into the baby's file under a temporary PID and once the baby has been allocated with his permanent PID, the patient information is then updated and merged into one file.

The problem is when a newborn baby does not have a permanent PID in the hospitals database and urgent clinical requests were processed. Requests are prepared according to the temporary PID and inbound results from various modalities are at risk of being mismatched when files are updated. This problem also persists in cases where a baby having temporary PID is transferred to another hospital and patient information is conveyed to the central data warehouse. If patient information is updated after the information has been conveyed, there are the same risks of mismatching files. The consequences can be either delay in retrieving data as the babies identity has changed

and the physician will search for the temporary PID; or as the SAP system comprises many interfaces, one field may reject the record and a particular result may be omitted resulting in a classic e-iatrogenisis case where the technology may be the cause of an adverse event to the baby. If the baby's condition requires an urgent transfer, or a consultation from a tertiary hospital, time may be lost due to an error that could have been evaded in the database.

Case Story

A 27 week pregnant mother carrying In-vitro Fertilization (IVF) triplets was admitted to the operating theater for an emergency cesarean section due to premature contractions and chorioamnionitis. After delivery room resuscitation and stabilization the extreme premature triplets were admitted to the NICU. Three midwives were present at the birth and each baby was received and registered immediately in turn individually. In NICU the medical staff had information pertaining to the babies before they were actually transferred from the delivery room. This information includes data referring to the mother's pregnancy and problems during the course of delivery follow up as well as laboratory results and radiology images.

At different stages of their hospitalization the three babies required thoracic surgery and one of them needed neurosurgery as well. The services were not available in the periphery region of northern Israel; therefore it was decided to transfer each of them to tertiary hospitals for their surgeries. Those medical centers were well organized to address the babies' needs upon their arrival with very little necessity of further duplicate testing as information was made available to the various treating institutions by use of a central database. The babies were immediately treated and later on returned to the initial hospital that in turn was fully informed of their conditions and equipped to assume further treatment. Once discharged to community care, all information was made available to the pediatrician and community nurses for follow up treatment. Information made available to the community care givers is not limited to a discharge summary alone as was practice in the past, but the entire patient record from the very first moments of life [22]. They are being followed up both in the hospital outpatients department as well as in the in the community incorporating interactions with the various disciplines via the EPR.

Information recorded in various documents such as admittance document, laboratory results, ICD9 diagnosis are automatically inset in discharge letters. There are express templates that ensure quick and accurate workflow as well as a "copy text" button which allows an entire note to be copied into the various documents such as progress notes.

Discussion

In the Handbook of Medical Informatics, [1] claim that some clinicians only use the final reports for their decision making without referring to the source data due to the fact that not always electronic images such as CT scans or electrocardiograms are transferred. We emphasize the importance of relevant data made available in the data warehouse, although if there is too much insignificant or unstructured information it may be more time consuming or even difficult to retrieve information.

Cheng reported [23] a new study outcome indicating that roughly a third of primary care physicians have reported to have missed certain reports due to the overabundance of information. Digital communication is faster and more easily accessible; a well-structured EPR is the basis of uncomplicated utilization of data throughout the medical world. If the sequences of medical events are not laid out in an organized manner, mounds of information can indeed result in missing out important information. This is true regarding the newborn in the NICU even though one can misconstrue the fact that baby is very young and has very little medical history. On the contrary these premature and/or sick neonates often are hospitalized for long periods of time after discharge from the NICU and readmission to other departments with many radiology examinations and laboratory tests, etc.

Herbst K et al. explain [24] their design of introducing a data warehouse that will entail entire provinces in South Africa where each hospital maintains their own application server distributing patient information to a central server. Demographic information and a problem list are conveyed to the data warehouse which forms a basis for epidemiological needs. The emphasis in our case is that the information should be made available from the very first moments of life so as to collect an entire and inclusive EPR enabling up to date and inclusive information at any given moment.

Shabo A et al. acknowledge [22] that EPR within health enterprises is already a common and well appreciated practice and focuses on an EPR that will include the entire life of the patient. They base one of their models of a "lifetime" EPR on creation of a "virtual health record" that collects data from the patients' assortment of medical care givers and concentrates them in one central record. This is what contributed to the success in various treatments of our triplets, especially due to the fact that their EPR commenced from the very first moments of life with a permanent common PID making it easily immediately accessible in other medical facilities.

Drummond discusses [25] the fact that critical caregivers need fast data from the laboratory and other treatment machines; she goes on to say that urgent complicated workflows are common in (N) ICU's. This affirms our reasoning for immediate registration of a newborn from the very first moments of life by the midwife in the delivery room. Ash et al. claim [26] that the EPR is constructed of many interfaces, some of which may not send or receive data correctly to or from the EPR. Every change made to the babies PID will hinder availability or speed of vital information resulting in e-iatrogenisis therefore the importance of precise registration immediately after birth.

Conclusion

In this paper we have presented a case where three sick premature neonates were transferred to tertiary hospitals having Electronic Patient Records as useful tools for the staff managing them. We have established the fact that the use of EPR as early on in life as possible contributes to a full picture of the patient's condition, enabling expedites clinical orders connected to the patient's permanent EPR with almost no temporary documentation. In our case the babies were allocated with their permanent PID's immediately upon birth.

We conclude that the more accurate the patient identity numbers are with little or no changes at all, the less likely there will be files mismatched or misplaced. Furthermore we express the importance of data warehouses and data sharing to make medical records available from across health systems and locations thus eliminating unnecessary and duplicate tests as well as provide necessary information as it is needed from the very first moments of life.

While our case was deemed successful and the use of the EPR in the receiving hospital was found useful to the medical staff, we have found very little information in the literature regarding registration of newborns immediately after birth to afford swift and accurate health information exchange for extremely young neonates. We believe that further research should be done in this field.

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