NEW SMART TRENDS TECHNOLOGICAL INNOVATIONS IN HEALTHCARE SECTOR: A REVIEW

Ram Goutham T [1], Dr.V.Anbumalar[2] and Dr.T.Kamatchi[3]

2-Professor, Mechanical Department, Velammal College of Engineering and Technology, Madurai

3-Asscoiate Professor, Mechanical Department, Velammal College of Engineering and Technology, Madurai.

Abstract

Healthcare Supply Chain Logistics is series of cycles, labor force required across various groups and development of medicines, surgical equipment, and different items on a case by case basis by healthcare experts to go about their business. The point of Supply Chain in Healthcare is to track down the weaknesses among offices and propose measures to decrease them. It plans to distinguish frail regions to accomplish designated health result and expands interests in worldwide health. The benefits of productive Supply Chain in Healthcare are further developed cycles, proficient use of assets, fulfilled representatives, viable treatment and glad Patients. The meaning of the examination paper is to investigate potential provisos in the healthcare and suggested controls which can be applied essentially to get improvement the healthcare. In Hospitals Integrated Supply Chain ought to be carried out to meet the goals. The Supply Chain guarantees legitimate linkage of hospitals office, tasks, and income cycle. The Supply Chain can be envisioned

as a backend program running which is important to incorporate every one of the various cycles together. The supply chain executed guarantees accessibility of medication/item at perfect opportunity, limiting stock wastage, amplifying patient consideration, coordination in all divisions limiting human mistake/medicine blunders. In this paper, we evaluated the different cutting edge innovations and techniques that could help patients for estimating adherence of patients.

KEYWORD: Supply Chain; Healthcare; RFID

INTRODUCTION

Poor or lacking adherence to recommended regimens causes adverse consequences on health and monetary status of an individual. Various examinations have shown that up to half of patients don't stick to the endorsed meds which will eventually brings about backslide and rehospitalization, upgraded drug wastage through unreasonable measurement, improved protection from medications and make it more trying for the doctors to evaluate viability of the treatment. Albeit World Health Organization (WHO) accepts that improving adherence rates can convey more health benefits than refining specific treatments. In the United States (U.S.), around half of clinic affirmations happened because of poor or insufficient prescription adherence, causing yearly expenses of over USD 100 billion and passings of roughly 125 000 people [1-3].

From the above expressed realities unmistakably why lacking or helpless medicine adherence has been considered as a chronic drug usage in the U.S.1 In worldwide drug market the savvy bundling holds critical significance due to its employability in persistent's medicine adherence. The development of printable hardware has empowered different analysts to utilize its employability in savvy bundling, credited to its adaptability and minimal expense. Considering

savvy bundling, printed hardware can be utilized for item confirmation, dynamic observing of patients, stock administration and dynamic branding. The option of ongoing functionalities in bundling can enhance the bundling, which was recently seen as simply a dispensable pack [4]

In the time of rivalry, no industry can get by without considering much with regards to decreasing consumptions at every possible opportunity. The equivalent is valid for health care industry, which is seeing sharp ascent in cost in practically the entirety of its items and administrations. The alarmingly high speed of up development of cost is making the produce of the business past the scope of the mass. Supply chain in this industry being a critical driver of cost is subsequently commanding all the notice from industry partners. This review centers around talking about the fundamental nature and parts of supply chain of health care industry with impressive consideration on future extensions alongside present patterns. The supply chain in this industry is accepted to be intrinsically complicated and accordingly it is a significant extreme assignment to perceive any enchanted button that will assist with eliminating the failures to drive down costs. As a feature of the exploration for this paper we have done broad investigations of literary works and attempted to acquire knowledge on the intricacy of health care supply chain the executives (SCM) [5].

The latest thing shows that the business battles to meet on-time conveyance. The significant downside stays in the way that each piece of the supply chain works autonomously; making skewed exercises that keeps it from filling in as a framework. We have additionally examined the health care supply chain in Malaysia to have a superior comprehension of the current situation in emerging nations. The writing audit illuminates issues like upgrading of stock administration frameworks in hospitals, total of providers and their items through electronic inventories, utilization of ERP framework to address one more bottleneck in the supply chain, specifically:

wasteful data stream in the framework. At long last the paper tends to specific new methodologies arising in the area that are contributing towards productive SCM rehearses.

They are RFID, Supply Utilization Management, Virtual Centralization of the Supply Chain and Vendor Managed Inventory. The RFID helps accomplishing stock perceivability and precise counts at each phase of the supply chain and furthermore helps diminishing shrinkage and transportation blunders. Supply Utilization Management helps lessening wastages, esteem befuddle and abuse through normalization and appropriate particular. Virtual centralization of the supply chain then again helps working on degree of participation in hospitals accordingly helping them controlling expenses and further developing administrations. The virtual centralization functions is clarified with the assistance of an illustration of CSC : this is together claimed and overseen by different hospitals and healthcare units. CSC unites geologically scattered healthcare units together and permits them to cooperate to accomplish greatest efficiencies in acquirement, contracting and client care. As of now hospitals are searching for new wellsprings of upper hand and cost cutting estimates at every possible opportunity [6].

It is basic to investigate the supply chain the board angles and distinguish regions in which they can work on the nature of administration for proficient patient consideration. Supply Chain Management in healthcare ought to guarantee total end-to-end perceivability of data among providers, makers, merchants and clients. The healthcare supply chain includes the progression of various item types and the investment of a few partners. The primary reason for the healthcare supply chain is to convey items without wasting much time, to satisfy the necessities of suppliers. In light of their capacities, partners in the healthcare supply chain can be isolated into three significant gatherings: makers, buyers, and suppliers.

An assortment of techniques have been assessed to further develop adherence, included monetary motivators to patients, work concentrated intervention, [7-9] and data innovations in regards to health, (for example, savvy drug bundling, mechanized gadgets and criticism systems) [10]. Smart bundling innovation have many structures, for certain coordinated elements, for example, condition observing, occasion recording, input components, update frameworks, status showcases and against forging technology [11]. These highlights are incorporated with intercession programs that have been ended up being the most steady in working on the adherence. Other than these benefits, the brilliant bundling innovation has limits like convenience, measurements adaptability and cost. [12-15].

Shrewd rankle bundling is considered as most ideal choice for the employability of printed hardware. As of now accessible brilliant rankle bundles consistently screen the break of rankles by directing the conductive hint of circuits around the rankle opening [16]. On opening the rankle, the conductive follow around it is interfered with which is identified by a coordinated circuit. The utilization of savvy rankle innovation is great for complex medication plans in which rankles have various medications at various occasions. At last, because of the circuit coordinated in back foil of rankles it is able to identify whether or not the rankle is opened. Quite a long while prior, rankles consolidated with radio recurrence recognizable proof (RFID) innovation were presented. The savvy rankle pack offers benefits over other data innovation healthcare frameworks since its employability needn't bother with the arrangement of a devoted framework or change plan of customary rankle pack. In 2008, Jekle and Krämer showed the unwavering quality and usefulness of shrewd rankle packaging [17].

The work process of savvy rankle begins with the crack of back foil. At the point when a patient takes out the tablet, information in regards to drug type, season of extraction and other

associated data with respect to measurements routine is communicated to a focal information base through a cell phone application. This computerized dynamic observing innovation assists the doctors with intersection check that patients have taken their dose routine at perfect opportunity or not. The appropriateness of this innovation in health care assembles an intelligent stage for correspondence among patients and doctors.

There are different benefits of utilizing this computerized patient consistence checking device, for example, diminished manual observing and documentation work that will eventually upgrade the proficiency of a clinical preliminary, improved adaptability in concluding complex helpful medicines and preliminary work processes, diminished misconduct rate because of poor or deficient consistence, improved information quality, shortening the length of clinical preliminary and sped up endorsement process for new medications and medicines [18]. The idea of shrewd rankle bundling has been examined in different patent applications. Peterson et al. exhibited the idea of printed framework having resistive and conductive components which will conclude the direction of rankle pack. For instance, the burst of the rankle can be recognized by the modification of the network however in this idea, it is basically impossible to discover which of the rankles is ruptured [19] Niemiec depicted the philosophy of multiplexed rankle breaking discovery yet it does not have any kind of embodiment [20]. Brollier utilized fleeting changes adjusted in corresponding to the miniature regulator that works with to distinguish the hour of crack yet not the location [21].

Overview of RFID

RFID was created since the World War ii. By and by, this innovation is utilized to incorporate radio-distinguishing proof on bundling into the marks and furthermore to the rankle

bundling containing pills [22]. Advancement in RFID innovation prompts its pertinence in healthcare area. In hospitals, this innovation is utilized in labeling individual drug compartments and observing the advancement of prescription. Additionally, different sensors installed with RFID innovation can be added to different things to screen the human movement, e.g., checking patients in regards to consistence. At last, various frameworks are accessible that gives observing administrations, for example, update frameworks, item dealing with and organization of medicines. RFID innovation as of now is being used in hospitals and healthcare habitats for approving the personality of patients, dynamic observing and following of patients and newborn children and to cross check that right drug treatment is gotten by right patients or not [23]. The RFID installed global positioning framework makes charging process more advantageous and simpler in hospitals by supplanting the old and convectional pen and paper system [24].

At present, Pharmaceutical organizations are conveying RFID labels with their meds to guarantee its wellbeing and to follow its stock. Data innovation organization like IBM are sending RFID labels on different prescriptions and mass bundling to obstruct falsifying of meds in the supply chain [25-26]. Medication endorsed to the patients is as of now being implanted with RFID labels to upgrade security and wellbeing of medication use [27]. RFID innovation utilize radio-recurrence waves to communicate and get data [28-29]. RFID framework comprises of a tag for example transponder, label peruser, information base and programming application. RFID labels contains a CPU and recieving wire curl for setting up the correspondence. Transmission of information happens between good ways from 10 m to 1 000 m. Put away information on RFID labels is sent alongside the area of the connected resource. Memory of the tag can be perused just or rewritable and explicitly contain capacity limit of 96 pieces.

A framework to distinguish RFID labels dependent on their memory limit and usefulness is proposed via AutoID Labs. Dissimilar to standardized tag innovation this innovation doesn't request view for information transmission. Moreover, information can be perused naturally by means of non-leading material. RFID labels are little and can be connected in various actual structures. Various PC equipment advances (cell phones, handheld perusers, fixed point perusers, PCs) can advantageously fulfill equipment and programming necessities to store and peruse information got from RFID labels. Min et al. effectively showed the RFID following of patients in a short term center. They examined that crude information got includes missed peruses and contain commotion because of which recognizable proof of the area of the tag was prevented [30]. Sandberg et al. shown that RFID framework was utilized to follow the patients who enters some unacceptable premises or working room and alarm the clinical experts, which supported the reassigning of the patients inside the issue of seconds [31].

Marjamaa et al. further developed the documentation interaction in regards to timestamp by utilizing the RFID robotized process and contrasted the acquired outcomes and traditional process [32]. Misidentification of patients in hospitals can cause genuine clinical blunders and is viewed as a likely danger to patient safety [33]. Positive patient ID application by using RFID innovation incorporates a brilliant wristband fitted with an inactive RFID label which is discernible and used to recognize the patient data, for example, name, date of birth, hypersensitivities, protection data, medicine prerequisites and blood type [34, 35]. RFID innovation when coordinated with web of things (IoT)- based sensors can help in assortment of information and patient observing. To screen patients, Aguilar et al. recommended the appropriateness of implantable RFID that serves the capacity of gathering the information with respect to patient health, e.g., observing the internal heat level of patients [36].

RFID frameworks can likewise be utilized to upgrade drug consistence of patients. Sun et al. shown the working of astutely mindful RFID dose (WARD) framework by utilizing savvy RFID wristbands on patients in blend with scanner tags on drug bundling, can help in limiting the danger of medicine mistake and fosters the protected climate in hospitals [37].

Ajami et al. exhibited the high level variant of the framework that incorporates the dynamic and latent RFID labels that permits pinpointing the area of patient in explicit region and furthermore helps in distinguishing the right portion of endorsed prescription. Patient medication consistence frameworks can likewise be utilized when patient leaves the clinic premises by joining the RFID tag to the bundling of the medication that will monitor its opening and closing [34]. However, more refined frameworks are currently accessible in this perspective that incorporates savvy rankle bundling which records the data in regards to breaking of the rankle. With the assistance of connected normal data set by means of an associated data framework, doctors and healthcare experts can get to this information in real time to screen drug consistence of patients. Takacs et al. presented the patient consistence arrangement wherein robot model is implanted with face recognition innovation alongside RFID labeled tablet gadget, work in blend to screen admission of medicines and further develop drug compliance [38].

Similarly, a review showed a model that joins RFID labels to medicines alongside a RFID peruser that capacities in mix with an internet based framework that screen the utilization of prescriptions. This framework likewise alarms the healthcare experts and work force about the lapse of the medications [39]. Additionally, savvy swathes outfitted with RFID innovation can give wound checking information of the patients after their medical procedure that will eventually help in controlled medication delivery. In one more review held at a Greek emergency clinic, show of different uses of RFID advancements was done in which the executives of blood test was made

conceivable by using blood donation center administration framework. The aftereffects of this review recommended that RFID alongside scanner tag innovation can help in better administration of blood tests and lessen the danger of misidentification of blood [40].

Adherence a vital aspect

As per Delamater, "adherence" is the dynamic, synergistic and intentional contribution of the patient in a commonly satisfactory course of conduct to deliver a helpful result [41]. It implies that patients and healthcare experts ought to commonly settle on predefined objectives in regards to therapy and clinical regimens. Assuming that these objectives are not followed, miscommunication between healthcare experts and patients compromises the patient consideration and potential intricacies related with the sickness may occur [42]. Failure to cling to the endorsed medicine is connected with higher backsliding rates, higher readmission rates, poor clinical results, expanded dreariness and mortality and expanded healthcare costs. According to WHO's proposal, adherence factors are ordered into five aspects, those related with the healthcare group, economics, treatment, patient and illness [43].

Non-adherence to prescription can likewise be viewed as either purposeful or inadvertent. Deliberate non-adherence specifies those conditions in which patients purposefully decide to one or the other stop or decrease regulating their recommended drugs. It is totally relying upon the inspiration level of patients [44]. Unintentional non-adherence is related with patients' absence of intellectual capacity and limit, that compromises the capacity of the patients to cling to the treatment routine, e.g., intellectual impedance and absent mindedness can affect the patients' adherence. The deliberate and unexpected cases are not totally unrelated ideas, as inadequately or less roused patients, in the majority of the cases neglect to take their medicines [45]. For fostering

the better comprehend of the adherence viewpoints generally potential elements should be screened and selected [46]. Blair et al. examined information acquired from randomized controlled preliminary of non-permanent parent youngster dyads who got parent kid connection treatment, which showed that paces of non-adherence, treatment steady loss and non-reaction were fundamentally decreased [47].

Another review recognized the elements impacting adherence and checked the adherence of patients who getting the treatment of diabetes mellitus, dyslipidemia and hypertension. In this review, 16 208 patients matured ≤ 65 years were involved and checked their adherences by working out the drug ownership proportion. Results showed that 3%–8% augmentation in adherence was noticed for each infected case and state of mind didn't influence the patients' adherence [48]. Similarly, Rubens et al. investigated the connection between treatment adherence and HIV related disgrace. The adapting systems along to treatment adherence estimated through surveys. Results showed that the nature of care and saw shame focuses altogether anticipated the adherence to the endorsed treatment [49]. In 2019, a review fostered an electronic aftercare program for ladies enduring with serious and ongoing bulimia nervosa and analyzed the adherence to this program. A decrease in adherence throughout intercession was noticed, despite the fact that adherence was not related with seriousness and generally ailment and it didn't influence the results of intervention [50]. In China, Chen et al. directed a subjective report where instant message based intercession program was tried for expanding the adherence of patients' in provincial region. The discoveries showed that the country patients were very little mindful with regards to the infection from which they are enduring, however a huge part of the patients had uplifting outlook towards instant message based mediation program [51].

Smart blister and smart drawer

Smart blisters are referred as pharmaceutical packaging that possesses the capability of tracking the action of taking out a pill. Besides this the printed circuitry in the packaging also collects the information regarding the rupturing time, medication category and name, location etc. By utilizing the smart blisters patients can also get pill reminders on their mobile phones. Additionally, if any type of misconception occurs during the course of medication, both physician and patient can check whether they have taken the prescribed medication at correct time or not. This will minimize the medication error and create a two-way monitoring process that will ultimately help in enhancing the medication adherence of patients [52]. A feasibility study reported the applicability of smart blister pack technology for promoting medication adherence in 2012 [53]. Results demonstrated the effectiveness of smart blister in recording patient related data and other desired information. However, in 17% cases there were events of multiple tablet removal at same time, indicating the unintentional breakage of tablets [54]. Morak et al. developed a telemonitoring solution to record patient medication intake which is based on smart blisters and applicability of mobile phones with near field communication functionality. All the components work in conjugation to record drug-type, dosage information and timestamp. In this study patients diagnosed with diabetes were monitored for the duration of 13 months. A total of 1 760 smart blisters were given to the patients and 14 843 events of taking out pill was recorded by the system. Results indicated the feasibility of this monitoring solution to increase adherence of patients [55].

mHealth —an emerging aspect

As per WHO, mHealth or versatile health is viewed as works on concerning public and clinical health that are supported by the cell phone like PDAs, cell phones, patient observing gadgets and other remote gadgets. mHealth uses the cell phone utility of voice and short informing administration (SMS) alongside complex application and administrations like infrared, bluetooth,

worldwide situating framework, third and fourth era versatile media communications (3 G and 4 G technology) [56] In 2009, WHO led an overview thinking about mHealth in different areas. Results acquired in study exhibited that over 80% of the taking part states affirm the presence of something like one mHealth drive in country. Among the partaking gatherings, 75% announced the presence of at least four sorts of mHealth drives.

There were just 19 nations that didn't affirm the presence of mHealth drive. Nonetheless, no revealing of mHealth drives doesn't imply that no mHealth drives are being done in nations. Nearby and little mHealth project being completed by non-government or private organizations that may not be widely perceived. Also, the overview was limited by the way that members could just give the example of each mHealth bunch. Accordingly, the recurrence of the mHealth drives announced showed the extent of mHealth projects in a nation however doesn't portray the detail of undertaking inside each category [57]. Participating African areas revealed exceptionally less tasks in regards to mHealth, while in southeast Asian locales revealing was more. As indicated by the World Bank, the low-pay member bunches detailed not many mHealth drives in their locales. In any case, the consequences of high-income class were not fundamentally higher when contrasted with low pay bunches in regards to the setting of mHealth. Contingent upon the assorted confinement of announced mHealth projects drives both financially and geologically, it appears to be that mHealth is a technique that have worldwide appeal [58].

The partaking nations that revealed the mHealth drives incorporates crises, crisis complementary administrations, versatile telemedicine, healthcare phone helplines and healthcare call focuses. This health project drives capacities on the voice usefulness of cell phone and portrays the significant piece of these tasks. There were additionally the ventures that include the pertinence of cell phone in observation, choice emotionally supportive networks, health overviews and

mindfulness raising efforts. The outcomes that were gotten from the current writing were not quite the same as the reports that advocate the pertinence of cell phone in infection observation and information assortment. In any case, the vast majority of the examinations depended on seeing the adequacy, plausibility and contrasts between convectional approaches of information assortment and observation of illnesses to mHealth arrangements. Accordingly, these venture drives may not be noticeable to government sources or authorities that lead the survey [59].

Subsequently, it is critical to take note of that diagnosing an illness with the assistance of cell phone necessitates that joining of more modern innovation. Since this would require joining of more explicit sensors that could identify the presence of infection by just opening a program that gets and sends illnesses related information from the focal servers and by fusing the utilization of computerized reasoning the sicknesses can be distinguished. Such drives are relied upon to increment in not so distant future, notwithstanding, as man-made brainpower is turning out to be further developed step by step.

Impact of smart technologies on healthcare systems

Cutting edge innovation has worked together in various ways to uncover the likelihood of pharmacological treatment at last. Understanding the different pathways and advancement of better medicines doesn't benefit immediately until they are exposed to approve the advantages conceivable. Nonetheless, various investigations have exhibited that adherence holds the great effect on financial and clinical results just as on usage of health administrations. Cost is significant component in concluding whether or not patients repurchase the endorsed drugs. Hence, factors that guide in bringing down the expense of drugs will without a doubt help in working on the

adherence. For certain medicines, present day innovation has supported bringing down the cost of the medication and furthermore worked on its wellbeing.

The endeavors to advance nonexclusive recommending are significant measure in diminishing expense. The usage of web presently offers different nonexclusive choices of exorbitant medications. Presently patients can acquire more data about their sicknesses by using the web-administrations upheld by the web to comprehend and deal with their unhealthy condition which includes diminishing the expenses of their endorsed medicine, like enemy of disease prescriptions. Numerous patients having constant infections are furnished with various drug regimens that are to be taken with differing plans, that incorporates developing number of geriatric patients determined to have memory and intellectual issues, different drug stores have begun pressing the prescriptions in dosette box or Webster-pak® which utilizes trend setting innovation to seal the medicines into rankle gets that hinders the combining as one of different meds, getting the disarray free from taking the meds. Innovation gave more capability of cutting edge pill box frameworks, in which item is connected through remote association with a focal server that tracks the patient measurements activity [60].

The dose movement of the patients can be seen online by doctors or patient or parental figures and is modified somewhat through remote association. It gives the highlights of complete updates by utilizing signals, instant messages, email, blares and blazing lights. Likewise, the framework can be customized to email week by week reports. The improvement of medication endorsing PC programs that are associated with a web-based pharmacopeia supports distinguishing incidental effects, signs, contra-signs just as medication communications will eventually upgrade the exactness and readability of recommended prescriptions. These upgrades can be used for giving more protected and productive endorsing rehearses that can help the patients for which the

treatment is recommended. The developing utilizations of cell phones or comparable gadgets that can be conveyed nearness with its proprietors, coordinated with SMS utility and mechanized message sending, has expanded the recurrence of utilizing voice calls and SMS for health united calls. Cell phones and gadgets are explicitly utilized for arrangement updates that at last upgrade the adherence. Applications for PDAs can likewise offer types of assistance like pulse screen, internal heat level screen, electrocardiogram and so forth that can be more valuable in observing the health and forestalls any kind of misguided judgment with respect to health.

Challenges to smart technologies

Till date, European Medicine Agency and U. S. Food and Drug Administration don't execute shrewd adherence observing frameworks if there should arise an occurrence of clinical preliminaries. Likewise, International Council on Harmonization of Technical Requirements for Registration of Pharmaceuticals for Human Use (ICH) has changed its ICH-E9 rule presenting the new term "estimand" which is identified with specialized prerequisites for Pharmaceuticals for human use. Previously, the viability of the investigation of the medication was simply founded on standard of expectation to treat however the overhauled rule hypothesizes a more exact boundary of treatment impact which characterizes the managing boundaries if there should be an occurrence of non-following patients.

In any case, there was no reference of contrast between helpless adherers, non-initiators and stopped patients. This eventually upsets proper differentiation between an essentially non following and genuine 'pharmacological' non responder patient. In the screening of adequacy of medication, it is vital to think on this qualification prior to reasoning that medication isn't helpful dependent on black box of constant medicine use. Thusly, the need of formal rules is required; this

would require joint endeavors of healthcare experts and controllers. Indian government has set up essential healthcare places (PHC) all through the country to give reasonable and quality healthcare administrations.

In any case, the availability at these PHCs isn't palatable. Consequently, PHCs can't offer continuous healthcare answers for the patients situated in distant regions. The mHealth foundation in India should go through severe and intense adjustments. There is a need to cause savvy and manageable biological system and foundation that will to faciletate execution of mHealth the nation over. The capital needed to foster this framework is a major worry as there are lacking assets accessible. Answer for working with sufficient assets for improvement of stable healthcare framework is to pool assets and assets from different plans of government that will eventually make a powerful foundation that will at last serve different areas, for example, healthcare, training, finance and so forth

Conclusion

There exist numerous manners by which the limit and imaginativeness of people in critical thinking and developing new gadgets have worked together in progression of clinical area which helps in further developing future of human in current world. Albeit different meds helps with controlling illnesses and upgrading just as turning out to be more complex in their headway. Notwithstanding the advances, adherence stays a main pressing issue. Present day medicines, definitions and procedures to further develop adherence are being created and tested reliably. Usage of various philosophies that guides in adherence is demonstrated to be best. Notwithstanding all the trend setting innovation, inspiration, self-adequacy and patient convictions

the relationship of specialist and patient remaining parts vital which mirrors that medication practice is a craftsmanship not simply a science.

References

[1]. Velligan DI, Kamil SH. Enhancing patient adherence: introducing smart pill devices. Ther Deliv. 2014;5(6):611-613.

[2]. Chaudri NA. Adherence to Long-term Therapies Evidence for Action. Ann Saudi Med. 2004;24(3):221-222.

[3]. Brown MT, Bussell JK. Medication adherence: WHO cares? Mayo Clin Proc. 2011;86(4):304-314.

[4]. Hall AE, Paul C, Bryant J, et al. To adhere or not to adhere: rates and reasons of medication adherence in hematological cancer patients. Crit Rev Oncol Hematol. 2016;97:247-262.

[5]. Alomi YA, Al-Shubbar N, Lubad N, Albusalih FA. Adherance assessment of medication errors Repoting system at the public hospital in Riyadh, Saudi Arabia. Int J Pharm Clin Sci. 2019;8(2):105-109.

[6]. Osterberg L, Blaschke T. Adherence to Medication. N Engl J Med. 2005;353(5):487-497.

[7]. Nilsson HE, Unander T, Siden J, et al. System integration of electronic functions in smart packaging applications. IEEE Trans Compon Packag Manufact Techn. 2012;2(10):1723-1734.

[8]. Volpp KG, Loewenstein G, Troxel AB, et al. A test of financial incentives to improve warfarin adherence. BMC Health Serv Res. 2008;8(1):272.

[9]. Velligan D, Mintz J, Maples N, et al. A randomized trial comparing in person and electronic interventions for improving adherence to oral medications in schizophrenia. Schizophrenia Bull. 2012;39(5):999-1007.

[10]. Liu MWC, Chien LY, Syukri M. Mon-064 barriers and facilitators of adhering to the treatment regimens among patients receiving hemodialysis in Banda Aceh, Indonesia: a Qualitative Ecological Evaluation. Kidney Int Rep. 2019;4(7):S330.

[11]. Park LG, Howie-Esquivel J, Dracup K. Electronic measurement of medication adherence. West J Nurs Res. 2014;37(1):28-49.

[12]. Checchi KD, Huzbrechts KF, Avorn J, Kesselheim AS. Electronic medication packaging devices and medication adherence: a systematic review. JAMA. 2014;312(12):1237-1247.

[13]. Bisharat B, Hafi L, Baron-Epel O, Armaly Z, Bowirrat A. Pharmacist counseling to cardiac patients in Israel prior to discharge from hospital contribute to increasing patient's medication adherence closing gaps and improving outcomes. J Transl Med. 2012;10(1):34.

[14]. Thompson SC, Walker AT. Use of modern technology as an aid to medication adherence: an overview. Patient Intell. 2011;3:49-55.

[15]. Mediary Corp. Med-ic®. https://www.informationmediary.com/nfc-smart-packagingdevices/med-ic-electronic-medication-blister/. Accessed July 10, 2021.

[16]. Mediary Corp. eCapTM. https://www.informationmediary.com/nfc-smart-packagingdevices/ecap-smart-pill-bottle/. Accessed July 10, 2021.

[17]. Petersen M., Wilson A. Blister package with electronic content monitoring system. http://v3.espacenet.com/textdoc?DB=EPODOC&IDX=WO03055769. Accessed July 10, 2021.

[18]. Jekle C, Krämer I. OtCM (Objective therapy Compliance Measurement): smart blister packages for measuring patient compliance. Hosp Pharm Eur. 2008;40:47-50.

[19]. Petersen M., Wilson A., Sherstyuk M. Method for manufacturing a conductive grid for attachment to a blister package. http://www.patentbuddy.com/Patent/7937829. Accessed July 10, 2021.

[20]. Niemiec M.A. Drug delivery management systems. https://uspto.report/patent/grant/6,574,166. Accessed July 10, 2021.

[21]. Brollier B.W. Momentary switch integrated in packaging of an article. http://v3.espacenet.com/textdoc?DB=EPODOC&IDX=WO2007070487. Accessed July 10, 2021.

[22]. Connolly C. Sensor trends in processing and packaging of foods and pharmaceuticals. Sensor Rev. 2007;27(2):103-108.

[23]. Rosenbaum BP. Radio Frequency Identification (RFID) in Health Care: privacy and security concerns limiting adoption. J Med Syst. 2014;38(3):19.

[24]. Cangialosi A, Monaly JE, Yang SC. Leveraging RFID in hospitals: patient life cycle and mobility perspectives. IEEE Commun Magaz. 2007;45(9):18-23.

[25]. Datz T. Drugmakers Testing RFID Tags: counterfeit drugs are as common as a knockoff Hermès tie or Prada bag on the streets of Manhattan. https://www.csoonline.com/article/2118948/drugmakers-testing-rfid-tags.html. Accessed July 10, 2021.

[26]. Brewin B. FDA Backs RFID Tags for Tracking Prescription Drugs: calls for drug makers to use them on shipping pallets and cases by 2007. https://www.computerworld.com/article/2575045/fda-backs-rfid-tags-for-tracking-prescription-drugs.html. Accessed July 10, 2021.

[27]. Swedberg C. Hospital pharmacies using RFID-enabled medication from QuVa Pharma. https://www.rfidjournal.com/articles/view?17148. Accessed July 10, 2021.

[28]. Ashar BS, Ferriter A. Radiofrequency identification technology in health carebenefits and potential risks. JAMA. 2007;298(19):2305-2307.

[29]. Yao W, Chu CH, Li Z. The adoption and implementation of RFID technologies in healthcare: a literature review. J Med Syst. 2012;36(6):3507-3525.

[30]. Min D, Yih Y. Fuzzy logic-based approach to detecting a passive RFID tag in an outpatient clinic. J Med Syst. 2011;35(3):423-432.

[31]. Sandberg WS, Häkkinen M, Egan M, et al. Autoion and notification of "wrong patient-wrong location'' errors in the operating room. Surg Innov. 2005;12(3):253- 260.

[32]. Marjamaa RA, Torkki PM, Torkki MI, Kirvelä OI. Time accuracy of a radio frequency identification patient tracking system for recording operating room timestamps. Anesth Analg. 2006;102(4):1183-1186.

[33]. Podaima BW, Friesen M, McLeod RD. A review of emerging smart RFID in healthcare. CMBES Proc. 2010;33(1).

[34]. Ajami S, Rajabzadeh A. Radio Frequency Identification (RFID) technology and patient safety. J Res Med Sci. 2013;18(9):809-813.

[35]. Tzeng SF, Chen WH, Pai FY. Evaluating the business value of RFID: evidence from five case studies. Int J Product Econ. 2008;112(2):601-613.

[36]. Aguilar A.W., van der Putten W., Maguire G.Q. Positive patient identification using RFID and wireless networks. http://citeseerx.ist.psu.edu/viewdoc/citations;jsessionid=F1ACCE49AD588F32D34CCA0C0D76E41B?doi=10.1.1.115.709. Accessed July 10, 2021.

[37]. Sun PR, Wang BH, Wu F. A new method to guard inpatient medication safety by the implementation of RFID. J Med Syst. 2008;32(4):327-332.

[38]. Takacs B, Hanak D. A prototype home robot with an ambient facial interface to improve drug compliance. J Telemed Telecare. 2008;14(7):393-395.

[39]. Kurnianingsih M.A.H., Prabuwono A.S. HoMeTrack: rFID-based localization for hospital medicine tracking system. https://www.kau.edu.sa/Files/830/Researches/ 66808_38353.pdf. Accessed July 10, 2021.

[40]. Katsiri E, Pramatari K, Billiris A, Kaiafas A, Christodoulakis A, Karanikas H. RFCure: an RFID based blood bank/healthcare information management system. In: Kyriacou E, Christofides S, Pattichis C, eds. XIV Mediterranean Conference on Medical and Biological Engineering and Computing 2016. IFMBE Proceedings, vol 57. Cham: Springer; 2016.

[41]. Delamater AM. Improving patient adherence. Clin Diabetes. 2006;24(2):71- 77.

[42]. Swieczkowski D, Mogielnicki M, Cwalina N, et al. Medication adherence in patients after percutaneous coronary intervention due to acute myocardial infarction: from research to clinical implications. Cardiol J. 2016;23(5):483-490.

[43]. Allonen J, Nieminen MS, Lokki M, et al. Mortality rate increases steeply with nonadherence to statin therapy in patients with acute coronary syndrome. Clin Cardiol. 2012;35(11):E22-E27.

[44]. Ho PM, Magid DJ, Shetterly SM, et al. Medication nonadherence is associated with a broad range of adverse outcomes in patients with coronary artery disease. Am Heart J. 2008;155(4):772-779.

[45]. Chaudri NA. Adherence to long-term therapies: evidence for action. Ann Saudi Med. 2004;24(3):221-222.

[46]. Molloy GJ, Messerli-Bürgy N, Hutton G, Wikman A, Perkins-Porras L, Steptoe A. Intentional and unintentional non-adherence to medications following an acute coronary syndrome: a longitudinal study. J Psychosom Res. 2014;76(5):430-432.

[47]. Rushworth GF, Cunningham S, Mort A, Rudd I, Leslie SJ. Patient specific factors relating to medication adherence in a post percutaneous coronary intervention cohort. Int J Pharm Pract. 2012;20(4):226-237.

[48]. Blair K, Topitzes J, Mersky JP. Brief, group-based parent-child interaction therapy: examination of treatment attrition, non-adherence, and non-response. Child Youth Serv Rev. 2019;106:104463.

[49]. Juste MA, Miguel AG, Plou BP, et al. Adherence to treatment of hypertension, hypercholesterolaemia and diabetes in an elderly population of a Spanish cohort. Med Clín (Barc). 2019;153(1):1-5.

[50]. Rubens M, Saxena A, Ramamoorthy V, et al. HIV-related stigma, quality of care, and coping skills: exploring factors affecting treatment adherence among PLWH in Haiti. J Assoc Nurses AIDS Care. 2018;29(4):570-579.

[51]. Beintner I, Jacobi C. Internet-based aftercare for women with bulimia nervosa following inpatient treatment: the role of adherence. Internet Interv. 2019;15:67-75.

[52]. Chen XZ, Yu SJ, Li CY, Zhan XX, Yan WR. Text message–based intervention to improve treatment adherence among rural patients with type 2 diabetes mellitus: a qualitative study. Public Health. 2018;163:46-53.

[53]. Healthcare PACKAGING. Schreiner MediPharm: smart Blister Pack for Clinical Trials: digital tools help manage and track process, turning an ordinary blister pack into an efficient patient compliance montoritoring tool. https://www.healthcarepackaging.

com/issues/regulatory/press-release/13294889/ schreiner-medipharm-smart-blister-pack-for-clinical-trials. Accessed July 10, 2021.

[54]. van Onzenoort HA, Neef C, Verberk WW, van Iperen HP, de Leeuw PW, van der Kuy PHM. Determining the feasibility of objective adherence measurement with blister packaging smart technology. Am J Health-Syst Pharm. 2012;69(10):872-879.

[55]. Morak J, Schwarz M, Hayn D, Schreier G. Feasibility of mHealth and Near Field Communication technology based medication adherence monitoring. Annu Int Conf IEEE Eng Med Biol Soc. 2012;2012:272-275.

[56]. Haberer J. Encyclopedia of Behavioral Medicine. Medication event monitoring systems. Cham: Springer; 2020.

[57]. Gillespie D, Hood K, Williams A, Stenson R, Probert C, Hawthorne A. The use of the Medication Event Monitoring System (MEMS) for assessing medication adherence for chronic conditions: use and results from a 12 month trial of patients in remission with ulcerative colitis (UC). Trials. 2011;12(Suppl 1):A130.

[58]. Rollings NJ, Zimmerman RR, King TS, Sorkness CA. Medication event monitoring system (MEMS®): the asthma clinical research network (ACRN) experience. J Allergy Clin Immunol. 2004;113(2 Suppl):S158.

[59]. World Health Organization. mHealth: New Horizons for Health Through Mobile Technologies. Geneva: World Health Organization; 2011.

[60]. MedMinder. MedMinder is more than just a pill dispensers. https://www.medminder. com/pill-dispensers-2/. Accessed July 10, 2021