American Journal of
Experimental and Clinical Research

Am J Exp Clin Res 2018;5(4):314-320

Original Article

Creation and implementation of a lean improvement process (6S) designed to improve pharmacy work space organization and standardization

Elizabeth Paschka, Suzanne Salutric*, Raoof Abdellatif
Department of Pharmacy, Northwestern Memorial Hospital, East Huron Street, Chicago, Illinois, USA

Abstract. Northwestern Memorial Hospital (NMH) is an 894-bed academic medical center hospital in Chicago that is the primary teaching affiliate for the Feinberg School of Medicine and has nearly 1,900 affiliated physicians representing virtually every medical specialty. The central pharmacy at NMH underwent a 6S initiative in order to improve the workplace. 6S is a lean improvement process designed to improve work space organization and standardization. A Project 6S team was assembled to coordinate implementation and maximize efficiency throughout the project. The following discusses the steps followed and projects completed in order to apply the 6S methodology at Northwestern Memorial Hospital. 6S is a lean improvement process designed to improve work space organization and standardization. A lean process is a system for continuous advancement and was originally a management philosophy developed by the Toyota Production System. 5S organization method that is derived from five Japanese words that describe how to organize a workplace for efficiency and effectiveness. The 5S's are sort, straighten, scrub, standardize, and sustain. 6S is a modification of the 5S's, but adds safety as the sixth S. Overall, 6S is a process for creating and maintaining an organized, clean, high performance workplace. It promotes activities of continuous improvement in an organization.

Keywords: Lean improvement, 5S, 6S, pharmacy work space, standardization

Introduction

Northwestern Memorial Hospital (NMH) is an 894-bed academic medical center hospital in Chicago that is the primary teaching affiliate for the Feinberg School of Medicine and has nearly 1,900 affiliated physicians representing virtually every medical specialty. The central pharmacy at NMH underwent a 6S initiative in order to improve the workplace. 6S is a lean improvement process designed to improve work space organization and standardization. A Project 6S team was assembled to coordinate implementation and maximize efficiency throughout the project. The following discusses the steps followed and projects completed in order to apply the 6S methodology at Northwestern Memorial Hospital. 6S is a lean improvement process designed to improve work space organization and standardization. A lean process is a system for continuous advancement and was originally a management philosophy developed by the Toyota Production System. 5S organization method that is derived from five Japanese words that describe how to organize a workplace for efficiency and effectiveness. The 5S's are sort, straighten, scrub, standardize, and sustain. 6S is a modification of the 5S's, which adds safety as the sixth S. Overall, 6S is a process for creating and maintaining an organized, clean, high performance workplace. It promotes activities of continuous improvement in an organization [1].

The purpose of any 6S initiative is to optimize productivity and reduce waste by organizing the workplace and using visual cues in order to achieve more efficient workflow [2-5]. Standardization throughout the physical space and staff members is key to maintaining an enhanced efficiency [2-5]. There is meant to be an easily identified place for everything so that items are ready for use at all times. Some of the expected benefits of 6S implementation are improved work quality and efficiency, lowered costs and reduction of waste, strengthened staff communication, reduction in errors, a safer work environment, and increased job satisfaction [2-5]. The goals of Project 6S at NMH is to increase pharmacy efficiency and workflow, reduce waste in the pharmacy, prevent medication errors, provide staff with a safer and more workable environment.

There are 8 inpatient pharmacies at NMH. The 6S project was completed in the central pharmacy located in the Feinberg building. There are a number of decentralized satellite pharmacies located throughout the hospital as well.

* Corresponding author: Suzanne Salutric, BS (ssalutric@mail.roosevelt.edu).

In the central pharmacy, staff fulfill various tasks in order to keep the hospital operating smoothly. The discussion of 6S improvements relies on understanding of the basic workflow processes that occur at NMH in the pharmacy, which are describe in the following [1].

Front/Satellite

Technicians that are working on the satellite shift have various responsibilities including: Filling "Cart Fill" and Omnicell orders, processing medication requests from nurses, assisting hospital staff at the window, answering the phones, tubing medications to various floors, and sorting medications by Omnicell destination [6].

The first task that is done in the morning is "Label Run", which is essentially processing patient specific orders and Omnicell orders of batched medications. The batched medications are bulk medications (mini-bag, advantage antibiotics, etc.) that are processed in the clean room, given a 30 day expiration, and stored out in the central pharmacy workflow. Technicians who are completing these tasks will find the medications required for filling and label them based on location (for Omnicell) or patient (for patient specific orders). Once the Omnicell medications are filled by the technicians, they are delivered to Pharmacy Technician Specialists, who will verify that the correct medication is going to the correct Omnicell. For the patient specific doses, the technician will deliver this to the pharmacist who will verify the order is correct and appropriate, and then they will place in the appropriate tubing station if the medication permits tubing. If not, the pharmacist will place in the front for the nurse to pick up at the window. Once these medications are verified by the Technician Specialist, another technician will come to sort these medications into various bins located on a rolling cart. Each bin is assigned to a specific Omnicell [6].

Medication requests are another task that the technicians need to be taking care of throughout the day. They are messages sent down from nursing staff to the central pharmacy when the nurses are out of a dose or cannot find a dose that needs to be administered to a patient. Technicians must determine if it is appropriate to resend a medication to the floor by assessing the patient's profile and determining if the medication is in an Omnicell close to the nurse station. If the medication is appropriate to resend, the technician will reprint a label and the central pharmacy will fill the medication and deliver appropriately. Technicians will also be assisting nurses and other hospital staff at the window. Frequently throughout the day, staff will stop at the window to request medications from the central pharmacy. These medications cannot be tubed through the hospital tubing system and need to be signed out from pharmacy staff in most cases, whether it is due to expense, hazard, or control status. For instance, some medications that cannot be tubed to the floor include controlled substances, blood products, and chemotherapy products. Pharmacy technicians also answer all phone calls that come to the central pharmacy and direct them if needed. In most cases, the questions from nursing staff and other hospital staff can be answered by the technicians, but if it needs to be directed to a pharmacist they will direct the phone call. Periodically throughout the day, technicians working in the front satellite tube out medications to the floor. These medications are patient specific medications that have been checked by the pharmacist and placed into appropriate tubing sections. The nurse will gather all medications going to that floor, place the any medications that are potentially breakable in bubble wrap, and send it through the tubing station. It is important to note that medications cannot be tubed if they are hazardous, controls, or blood products. Medications that are over one liter need to be tubed separately.

Delivery

Technicians on Delivery shift are responsible for restocking the cups station, which is a section of the pharmacy that is primarily unit dosed liquid medications. They will fill all medications that need to be sent up to each Omnicell, then pass it to the Technician Specialists for verification.

Once all medications for the morning shift are verified and sorted into the appropriate bin specified by floor, the technician will deliver the orders to the prospective Omnicells.

Oral Solutions

No technicians are specifically assigned to this shift, but once the labels print out for oral solutions (around 2pm each day), technicians will fill patient-specific oral medications. These medications will be drawn up into syringes and labeled for each individual patient. Once the technician is done filling and capping the syringes, they are brought to the pharmacist to verify that the order is correct and appropriate, and then sort to the specific tube station.

Talyst

The Talyst machine is an automated carousel system that optimizes medication storage and allows for tracking and organizing of medications [7]. Each medication has a specific location in Talyst. Once a medication order is queued, the Talyst will automatically spin to that location and allow the technician to pick the appropriate amount of medication out. Once the medication is scanned by the technician, the Talyst will spin to the location of the next order. Technicians on this shift will fill orders for the Omnicells located throughout the hospital [7]. Once Omnicell orders are complete, they are delivered to Technician Specialists to verify the order. Throughout the day, new orders will come in that are patient-specific orders either from the pharmacist or from pharmacy technicians performing medication reconciliations. When new orders are queued, it is important to fill as soon as possible in order to optimize patient care and minimize phone calls to the pharmacy. New orders are separated from Omnicell orders and are sent to the pharmacist for verification. In addition, technicians working on this shift must restock the Talyst when the order comes in from the stockroom each day and place each drug in the appropriate location. When medications are returned to the floor by nursing staff because they were not administered to the patient, technicians will place these items back into the

Figure 1. Cups station

Figure 2. Oral solutions

Figure 3. IV storage

Talyst.

Clean Room

The staff in the clean room are responsible to prepare intravenous (IV) medication orders. This is generally composed of either patient specific doses or pre-batching IV medications that are fast movers. The orders will print in the clean room, and technicians will prepare doses as they come in. These are then verified by the clean room pharmacist. Once verified, the orders are taken outside the clean room in order to be tubed or picked up by nurses. The clean room staff are required to follow guidelines presented in USP 797 to ensure sterility of these IV medications. The pharmacist in the clean room is also responsible for tracking and verifying total parenteral nutrition orders (TPNs).

Materials and Methods

A team consisting of department leaders was assembled to assist in the planning and execution of Project 6S. The team included a Pharmacy Manager, Pharmacy Practice Coordinators, Pharmacists-In-Charge (PIC), Pharmacy Technician Specialists, Pharmacy Technicians, PharmD Candidates, and Performance Improvement Leaders.

A training session was held for the designated Project 6S team. The topics included an overview of 6S and how it applied to the pharmacy at NMH. The training was completed approximately one week prior to the scheduled organization days in the pharmacy. Team meetings were conducted periodically to discuss plans for implementation of 6S into the central pharmacy. Plans for the new layout were discussed before initiation so that ordering of new equipment and supplies could be completed before the first day of organization work.

An assessment tool was developed by the Improvement Leaders to track the success of the project. The assessment was designed to be given to pharmacy staff members before and after implementation of 6S to gauge a difference in workplace satisfaction and organization (See Appendix A).

6S Components; how it applied to Project 6S at NMH

Sort

Sorting is the first stage of 6S. Sort refers to the removal of unwanted or unneeded items from the workstations throughout the pharmacy [2-5]. Any clutter or excess equipment is cleared in order to make workflow more efficient.

The team assessed the necessity for all equipment including: refrigerators, printers, shelving, workstations, etc. All of the old bins, expired product, unused supplies and equipment were removed from the pharmacy. The built-in cabinetry in the back of the pharmacy was removed because they were not being used effectively. New shelving units that allow for more storage of medications were installed.

The supplies and medication overstock from underneath workstations was removed for relocation in order to free up leg space at the desks. Subsequently, the ordering process was addressed to manage overstock issues. 6S team members began putting overstocked items into the Talyst as possible. PAR levels, or necessary inventory levels to aid in replenishment, w ere changed to reflect a

Figure 4. Cubixx and fridges

Figure 5. Front satellite

more accurate stock expectation.

Straighten

Straighten is the organization of items in each workflow area to make each area more efficient [2-5]. Ideally, items would be placed in a location where obtaining them is not a hassle for employees and they do not have to travel too far. Overstocked items should be stored close to appropriate workstations for ease of access. Areas are labelled as much as possible so employees knew where each item is and where the overstock items are [4]. Labels are placed both on the bin and on the shelf near the end of each bin, so that return locations are clear even if the bin is removed during normal workflow processes. In regards to general organization if the pharmacy, the new bins were organized and arranged to be appropriate for each work area. Each bin was labelled according to content. Then they were organized either alphabetically for medications (oral liquids, cups section, tall man lettering) or schematically based on how often contents are used. Items used most frequently were placed in prime position and storage/overstock items to be below the knee/above sightline and not as accessible. The items to be used in specific locations were stored in the vicinity of that work station to make workflow more efficient (Fig. 1). Gravity shelving was installed for liquid oral medications. They were previously stored on the countertops, and this new shelving cleared up additional usable space. New bins were obtained and labelled. Each bin contains one or two medications depending on stock bottle size. The medication name and strength was printed on the front of the bin (Fig. 2). There used to be two different places to store these medications: stock bottles on the countertop, and returned unused syringes had their own bin. In normal workflow, the staff should have been checking the returned bin first in order to reduce waste, but often times this did not happen. In the new system, the stock bottle and returned oral syringes were placed in the same bins. The new method made it easier for employees to remember to check the returned syringes first so they can be reused and reduce the waste associated with expired medications not being used.

New glove holders were installed on the wall by the sink to prevent clutter on the shelving, counter tops, and workspace. A location near the back of the pharmacy that is dedicated to IV bags/fluids storage. New shelving units were brought in and arranged to house all of the boxes containing these medications. IV fluid bags were arranged together, IV medication vials were kept together, and finally pre-batched IV medications were stored together. Each medication or fluid was given its own tag denoting the appropriated location (Fig. 3). This was done so that the staff would know what belonged in the space even if it was out of stock. The label included the name and PAR levels. A separate removable tag was developed to signify if the item had been purchased in a recent order. When a pharmacy employee places an order, they are to clip the tag to the cart, and when the order comes in the clip will be removed. This prevents redundancy in ordering and overstock.

Sit/stand convertible workstations were implemented in the pharmacy in order to declutter the counter tops. A majority of the workstation was previously taken up by the computer and keyboards, making it difficult for staff to find empty counter space. The standing desk is able to be moved up and down which makes it easy to move the computer station out of the way. Additional straightening was done: two printers were ordered to replace the previous four printers throughout the pharmacy. The models of the new printers are identical, which decreases the ordering of different types of toner and supplies for different types of printers.

The Cubixx refrigerator was relocated to be closer to the clean room. The Cubixx refrigerator is an inventory management tool that controls product type, expirations, and stocking criteria [8]. At NMH, the Cubixx is used for blood product storage and helps to eliminate the risk of revenue loss due to expiration and product loss. The fridge area was arranged to be more efficient (Fig. 4).

In the pharmacy, there are many carts to aid in workflow and medication movement. These carts are used when technicians disperse to make Omnicell deliveries

within the hospital. They are helpful for staff, but also tend to get in the way. A set of nesting carts were ordered to solve the problem of cart abundance. These carts fit inside one another when not in use and were a space-saving solution at NMH. One large shelving cart was used in the front of the pharmacy to store the sorting bins. Each floor of the hospital has its own bin, and medications for that floor are placed in the bin to wait until delivery by the technicians. Prior to 6S, these bins were laid out over the counter tops and took up a majority of the workspace. The cart freed up the space and made it easier for staff to find which bins they were looking for. The cart is labelled to reflect where each of the bins are supposed to be on the cart, so that they can be returned correctly after technician floor deliveries (Fig. 5).

A full-sized employee refrigerator was brought into the pharmacy for the staff. Previously, there were two mini-fridges for employees to use that were underneath the desk space. Removing the two old units freed up leg space at the workstations. The new refrigerator was placed in the back of the pharmacy.

Scrub

The scrub phase is completed once all of unnecessary items have been removed. Scrub refers to cleaning all areas within the pharmacy to allow for safe and sanitary working conditions [2-5]. This included areas that are not normally cleaned on a daily basis, for example: hard to reach places, behind the computers, under desks, etc.

Initial cleaning was performed immediately after the sort phase in order to make the daily upkeep easier on employees. During the straighten process, each individual shelf and bin was sanitized. Every surface was wiped with bleach every before being put back into place. All of the unnecessary or untidy existing labeling was removed from shelving and replaced with new, cleaner-looking labels.

Standardize

Standardize is the integration of 6S organization into the everyday work flow. Standardization refers to the ongoing application of knowledge on how to keep the efficient workflow [2-5]. This step is crucial for identifying best practices and maintaining consistency.

When the new bins were ordered, contents were considered to determine how many of each size and color to order. A color coding system was developed to standardize the pharmacy storage. Five colors were used to distinguish contents to the pharmacy staff: clear, blue, teal, purple, and red. Clear bins house any supplies. Examples of what would be placed in a clear bin would be extra office supplies, plastic bags, compounding tools, etc. Medications were chosen to be stored in blue bins. Teal bins were used for the oral solutions stock including syringes, vials, and bags. In the back storage area of the pharmacy, both purple and red bins were used to store IV bags and batched medications. Purple was the color for general IV medication storage, while red were used to show a cautionary medication. If there were medications on the ISMP list of Look-Alike drug names or otherwise easily confused, they were placed in the red bins to act as a visual reminder to double-check before pulling from the bin [9].

Every new bin was labelled with what it contained inside. This was done for consistency throughout the pharmacy. The order levels (PAR levels) were also included on the front of the bin where appropriate, to make the ordering and stocking process easier. Font size and label lengths were considered for the frequency of use and ease of reading depending on the location within the pharmacy. When daily order arrives, the delivery cart was previously put wherever there was empty space within the pharmacy. The 6S team designated a specific location for the cart to sit until the order can be put away. The location was marked with tape on the floor to that there is a standard location for every order.

Sustain

Sustain is the continued practice of the core ideas of 6S and incorporation into the day to day functions in the pharmacy [2-5, 10, 11]. Plans are set in place to keep the workplace as tidy and organized as when the initial sort, standardize, and scrub phases were completed [10, 11]. Specific tasks delegated to employees in order to make individuals accountable for keeping the workplace functional. The goal is for the processes to become a part of the everyday work culture to ensure the continued improvement and integration of the 6S initiative [10, 11].

The previously discussed tape markings on the floor for locations of carts and delivery spaces will make it easier for the pharmacy staff to maintain a clean and efficient workspace. Previous practice for backordered items was to order a large stock when the product was available in order to prevent shortage. In order to sustain the prevention of major overstock issues, employees who complete the ordering process are to make sure that items can be returned to the manufacturer or wholesaler. This will make sure that we do not have more stock than necessary in the pharmacy.

The Project 6S team also created a Sustainability Checklist. This checklist defines cleaning tasks, responsibilities and accountability for each employee on each shift in the pharmacy. The NMH Sustainability Checklist was designed based on their daily shift schedules. Two different checklists were created: one for the employees on the first shift and a second for the second shift. (The lists are posted in a central location in the pharmacy, to be changed daily by the PIC in the morning.) The tasks included were slightly different to encompass more cleaning throughout the day and preventing the same tasks being unnecessarily repeated. The employees are assigned specific tasks to complete before the end of shift based on their scheduled position for the day. Staff members are expected to initial next to their responsibilities once they are completed. Since it is posted in a communal location, all staff on shift can see the checklist and see what tasks have already been completed. The checklists will be reviewed daily by technician leadership and the pharmacist in charge. (See Appendix B)

The Pharmacy Manager and Pharmacy Practice Coordinators will have a higher level 6S Sustainment

Checklist they go through periodically to ensure that 6S principles are being followed. The management team will complete a check in the central pharmacy once per week and report their findings. (See Appendix C)

Along with pharmacy staff cleaning expectations, there was a discussion with the NMH Environmental Services staff (EVS). A meeting was coordinated between the pharmacy staff and EVS managers to set a common expectation for cleaning of the pharmacy.

Safety

The addition of safety to the 6S platform is especially important for work in pharmacy. It refers to making the workplace a safe place for employees by removing possible hazards and addressing anything that may pose a safety risk in the future [2-5]. This also promotes a efficient workplace that reduces medication errors and promotes patient safety. An ergonomic assessment was completed by the human resources department. The sit/stand convertible workstations were considered for each workstation in the pharmacy. Each of the thirteen workstations were assessed for the necessity of this desk. Based on the counter height and typical workflow tasks performed at the designated location, the team landed on implementing seven convertible workstations within the pharmacy. The physical organization of the items on shelves was also considered for ergonomics. Bins and equipment that are frequently used were placed on shelves close to eye/hand level. Any supplies or equipment used less frequently was considered for placement on high shelves or very low shelves. This was done for efficiency of workflow and to prevent bending over or straining of pharmacy employees. The physical organization of the pharmacy was also considered for the safety of the pharmacy staff. Size and placement of cabinets and desks were evaluated to minimize blocking of walking space and potential fire hazards. Similarly, the numerous carts have designated locations for storage when not being used which prevents excess clutter preventing access to the exits. (The nesting cart will also aid in avoiding excess clutter.) In regards to the labelling on all shelving and bins, there were many safety topics taken into considerations. ISMP Look-Alike Medications were denoted using approved tall man lettering for labels on shelving and bins [9]. In addition, caution stickers were placed on the bin to act as an extra visual reminder of the care to be taken before pulling look-alike or sound-alike medications [9]. Many of the workstations were previously cluttered by cords and wires from computers, keyboards, phones, printers, and scanners. The IT team at NMH provided a plan for electronic cord management. The computer towers were mounted to the underside of the desk, which rerouted the wires to under the desk and freed up additional counter space. This was also a safety consideration since less accessibility to the wires provides less of a risk of electrical accidents. The general safety precautions in the pharmacy were also verified. The exits are clearly labelled and evacuation plans in place for staff safety. The sharps and spill kits are clearly labelled for prevention of accidental exposure. There are separate garbage bins for expired medications and chemotherapy disposal. There is nothing stored within eighteen inches from the ceiling.

Assessment

Tracking the improvement of organization and efficiency are a vital part of any process enhancement. As discussed in methods above, an assessment tool was created in order to track the staff's attitude and satisfaction with the pharmacy work space before and after Project 6S at Northwestern Memorial Hospital. Questions for each of the 6S's were developed to evaluate how the pharmacy ranked in each of the individual six categories. To assess sort, the staff were asked questions regarding surfaces containing unnecessary items, and whether excess or obsolete items are removed periodically. In regards to straighten, the phrasing was about equipment and tools being clearly marked and organized, locations for items are clearly marked, and standard information boards establishment. Underneath the scrub category, the staff answered questions about floors and surfaces being clean, garbage disposal and collection, and opinions on work environment (air quality, temperature, humidity, lighting, dust, floors, etc.). The standardized assessment discussed roles and responsibilities being identified for keeping work areas clean and organized and if any sort of visual management indicating whether certain tasks have been done. The assessment questions for sustain covered topics including posted standard workflow, standard cleaning and maintenance completion, standard information boards are being used and have current/relevant information, work area is clean and orderly with no unsafe conditions. Finally, the safety portion asked about required safety information being posted, fire extinguishers and emergency equipment being clearly marked and functional, verification of basic job skills training completion, and whether unsafe conditions are promptly resolved.

Results

The week before the major organization tasks were completed, all of the pharmacy staff were given a blank copy of the 6S assessment questions. They were asked to answer honestly and completely. The team was available to help in answering questions about the form when it was initially passed out. In the sort section, pharmacy staff noted that they were satisfied with the organization of products and felt that any unnecessary items or equipment were removed from the workspace (75% increase in satisfaction). For straighten, pharmacy staff noted that all products and supplies were appropriately and clearly labeled. The spaces made for these items were appropriate to the workflow conducted in these spaces (50% increase in satisfaction). In scrub, pharmacy staff noted that the floors and countertops were properly cleaned and maintained. In additional, all trash was disposed of properly (37.5% increase in satisfaction). For safety, pharmacy staff noted that required safety information was posted and easily accessed and basic job training skills were completed (37.5% increase in satisfaction). For standardize, pharmacy staff noted that the standardization of this project could not be implemented without the use of

paperwork (12.5% decrease in satisfaction). Finally, for sustain, pharmacy staff noted that standardization procedures were being followed in order to keep the pharmacy organized, clean and functional (87.5% increase in satisfaction). Overall, the scores from after 6S implementation were substantially higher than the scores from before implementation (46% prior to 6S, 92% after 6S).

Conclusion

The implementation of 6S has made a tremendous impact on the workflow and overall satisfaction of the pharmacy staff in the central pharmacy. By incorporating the 6S values and assessment strategies, we were able to see a direct and immediate impact in the morale of staff and efficiency of workspaces.

Acknowledgement:

The authors would like to acknowledge Cassandra Scaman, Anam Dhorajiwala, Noelle Chapman, Elise Wozniak, Ana Fernandez, Alex Keppel, Betty Joseph, Isai Sanabria, Paul Nguyen, and Ai-Chi Weidemann.

Conflict of interest

The authors declare no conflicts of interest and no financial support.

References

1. Amerisource Bergen. Cubixx Solutions. 2018. Available at: https://www.cubixxsolutions.com/

2. Kitcheck. Kitcheck tour. 2018. Available at: https://kitcheck.com/

3. Institute for Healthcare Improvement. Improvement report: lean thinking applied to pharmacy processes. 2003. Available at: http://www.ihi.org/resources/Pages/ImprovementStories/MemberReportLeanThinkingAppliedtoPharmacyProcesses.aspx\

4. Institute for Safe Medication Practices. FDA and ISMP lists of look-alike drug names with recommended tall man letters. 2016. Available at: https://www.ismp.org/tools/tallmanletters.pdf

5. Mann J, Dipper A, Rowe E, et al. Lean Six Sigma in the Pharmacy Department. Pharmacy Times. 2014. Available at: http://www.pharmacytimes.com/publications/health-system-edition/2014/september2014/lean-six-sigma-in-the-pharmacy-department

6. McMahon T. Introduction to 6s. 2008. Available at: https://www.slideshare.net/ALeanJourney/introduction-to-6s

7. Northwestern Medicine. Northwestern Memorial Hospital. Available at: https://www.nm.org/locations/northwestern-memorial-hospital

8. Omnicell Inc. Lean thinking in the pharmacy and the role of omnicell technology. 2014. Available at: https://www.scottsdaleinstitute.org/docs/sponsors/Omnicell/2014-03.Lean-Thinking-in-the-Pharmacy.pdf

9. Osakue EE, Smith D. A 6S Experience in a Manufacturing Facility. 2014. Available at: https://www.asee.org/file_server/papers/.../file/.../6S_EXPERIENCE_DRAFT-B.pdf

10. The Pharmaceutical Journal. Using the Lean approach to transform pharmacy services in an acute trust. Available at: https://www.pharmaceutical-journal.com/news-and-analysis/using-the-lean-approach-to-transform-pharmacy-services-in-an-acute-trust/10884114.article

11. Shiu J, Mysak T. Pharmacist clinical process improvement: applying lean principles in a tertiary care setting. Can J Hosp Pharm 70: 138–143, 2017.

12. Talyst. Solutions: medication inventory software. 2018. Available at: http://www.talyst.com/