

## **Abstract**

For years, experts have been suggesting ways to balance healthcare accessibility, quality and costs. Lean healthcare has emerged in recent years as a way of introducing innovative ideas to improve processes. Among the tools of lean healthcare is the two-bin kanban system introduced into many hospitals in a wide range of countries. In this paper we will apply the lean healthcare concept to our analysis of how the two-bin system can increase the efficiency of hospitals and reduce various types of waste, such as surplus inventory, expired products, and unnecessary staff movements. We will also address how recently introduced RFID technology enhances the performance of the two-bin system, allowing the status of stock on wards to be known as soon as labels are removed. This permits inventory to be managed proactively, helps optimize replenishment rounds, and alerts the materiel management department of potential stockouts the ward.

## **Introduction:**

For years, experts in a variety of fields have been suggesting ways to balance healthcare accessibility, quality and costs. The majority of these experts have focused on either global solutions to the healthcare system or on clinical solutions to clinical problems. More recently, however, researchers have been examining the optimization of processes, both as a potential source of savings and as a means to resolving problems in hospitals that impact the delivery of care (Landry and Beaulieu, 2002; Landry and Philippe, 2004; Tucker and Edmondson, 2003; Tucker and Spear, 2006; Spear, 2005). Over the past ten years, one such area that has gained in popularity is the deployment of operations management tools, particularly those related to quality management (Mango and Shapiro, 2001). Even more recently, an increasing number of authors have proposed implementing lean manufacturing practices for the healthcare sector, which has given rise to the concept of lean healthcare (Ballé and Régnier, 2007; Manos et al., 2006; Spear, 2005).

The system known today as lean manufacturing originated with Toyota five decades ago as the Toyota Production System (TPS) (Krafcik, 1988; Liker and Meier, 2006). Among the best known of the TPS tools is the kanban system, a decentralized inventory management and scheduling system that manages the flow of parts according to rules (Chaussé et al. 2000). Often compared to the order point system (Turbide, 1993), an adaptation of the kanban approach, the two-bin (or empty-full) system was deployed for the first time in the hospital sector in the late 1980s by Danish and Dutch companies Scan Modul System and Medi-Math. Since then, the two-bin system has been introduced into many hospitals in a wide range of countries and adapted to the management needs of the hospital in question. Today, with lean healthcare becoming more widespread, many researchers are using the term kanban or two-bin kanban replenishment system to refer to this system (Barry and Smith, 2005; Black, 2008; Douet and Storper, 2001; Graban, 2009; Zidel, 2006).

In this paper we will apply the lean healthcare concept to our analysis of how a two-bin system can increase the efficiency of hospitals and reduce various types of waste, such as surplus inventory, expired products, and unnecessary staff movements. A lack of supplies can also be a disruption that takes key resources away from the institution's core mission: the delivery of care (Linden and English, 1994; Miller et al., 1997; Tucker and Edmondson, 2003; Tucker and Spear, 2006). Within this context, an examination of replenishment methods takes on added importance.

In the first section of the article, we will position the two-bin system in relation to other periodic inventory hospital replenishment methods, whether used in general wards or specialized units such as the operating room. This section will also discuss a recent innovation: radio frequency identification (RFID) technology, which enhances the two-bin system. In addition, we will discuss organizational impacts by citing the tools and principles of lean management, i.e. 5S, visual control, poka-yoke, method and process standardization, and others, as well as the two pillars of TPS: just-in-time and jidoka. The second section of the article will present the benefits of

the two-bin system within the context of the waste reduction approach espoused in lean practices.

## **Hospital replenishment systems**

Our study of replenishment modes targets the status of medical supplies in all general and specialized nursing units (hereafter referred to as wards). This highly specific context differs from the industrial sector in two fundamental ways. Firstly, the core mission of a healthcare institution is to provide care to patients. Medical supplies simply support the delivery of this care. Yet, and secondly, as facilitating goods (using Grönroos's augmented service offering concept (1990)), the absence of these items can have dire consequences on the care offering, the hospital's core service. In light of these conditions, it is easy for nursing staff to give in to the temptation to hoard large numbers of supplies to prevent potential stockout situations. However, this is an expensive tendency, particularly at a time when healthcare institutions in so many industrialized countries are having to make do with limited resources (Naylor, 1999). Moreover, surplus inventory can result in wasted space and time searching for products and can increase the number of expired products due to a lack of control, which not only has a financial impact but more importantly jeopardizes patient safety.

In hospitals one finds two broad categories of supply management systems: perpetual inventory and periodic inventory. For the first, inventory records are updated on the ward (or at the point of use) each time supplies are delivered to the ward or picked for patient care. The ward's inventory status is therefore known at all times (official inventory). Generally, automated secure cabinets are used to stock supplies and register each transaction by specifying, with respect to products charged to the patient, for example, which employee picked which items in which quantity for which patient. Various technologies are used to capture data in these cabinets. These include keyboards, biometric readers, and bar code or RFID-enabled cards to identify employees; keyboards and touch screens to identify patients; shelf position press buttons for supplies; and RFID smart shelves for supplies tagged at the unitary level. Similar technology is available to retrofit open storage systems, which is less expensive than installing secure cabinets. Finally, weight sensor bins have also been introduced in the US to automatically identify supply usage as it occurs.

In the periodic category, supplies are replenished in batches and only accounted for and charged to the user department as orders are picked in the central warehouse for delivery to the ward or upon receipt from vendors in the case of non stock items. There is therefore no real-time supply status available at the ward level (unofficial inventory), and replenishment decisions are based on periodic inventory, i.e. inventory counts done at predetermined intervals. In the scenario cited in this article, the medical supply replenishment cycle on the wards is comprised of four main activities: order (counting of quantities on the ward); pick (assembly of orders in the warehouse or by an external supplier); transport (forwarding of the order to the

ward); and put away (placement of supplies in their storage unit) (Blouin et al. 2001). Each of the four principal periodic replenishment methods (requisition, exchange cart, par level—also known as the top-up approach—and two-bin) necessarily involves a different division of tasks among stakeholders on the ward and in the materiel management department. Each of these modes also comes with its own advantages, drawbacks and way of operating. Table 1 presents a description of each replenishment method.

**Table 1 - Description of replenishment modes (periodic inventory)<sup>1</sup>**

<b>Mode</b>	<b>Description</b>
Requisition	Nursing staff conduct regular inventory counts combined with consumption estimates. Products identified as low in inventory are noted on a requisition form that is forwarded, either manually or electronically, to the materiel management department. Based on this requisition, required supplies are picked and sent to the ward in question. With this mode, it is often nursing personnel who are assigned the task of putting away the delivered products in the storage units.
Exchange cart	Medical supplies are placed on a cart positioned in a storage area on the ward. Products are taken from the cart and consumed, with the cart being exchanged according to a predetermined schedule by an identical, fully stocked replacement cart. During the replenishment period, the first cart is returned to central stores to be restocked. According to the set schedule, the newly replenished cart will later be exchanged for the cart on the ward.
Par level	Rounds of the wards to be replenished are conducted according to a predetermined schedule. During the rounds, a storekeeper takes inventory of medical supplies on the ward. The quantities counted are entered electronically. The information is then downloaded to the IT system, which compares the quantities counted with established quotas and generates a pick list or requisition in the case of non stock items. The picked or ordered products are then delivered to the wards and put away by a storekeeper.
Two-bin (empty-full)	Each medical product type is stored in a separate space and divided between two bins or two compartments within a bin. When the first of the two bins or compartments is empty, nursing staff remove the label (and its holder) identifying the product from the front of the bin and affix to a wall-mounted rail. These labels then trigger replenishment at regular, predetermined intervals. The replenishment information is transferred to an information system, which generates either a pick list for items stored in the central warehouse or a requisition for items sourced externally. The medical supplies are delivered to the ward and put away in the empty bins by a storekeeper.

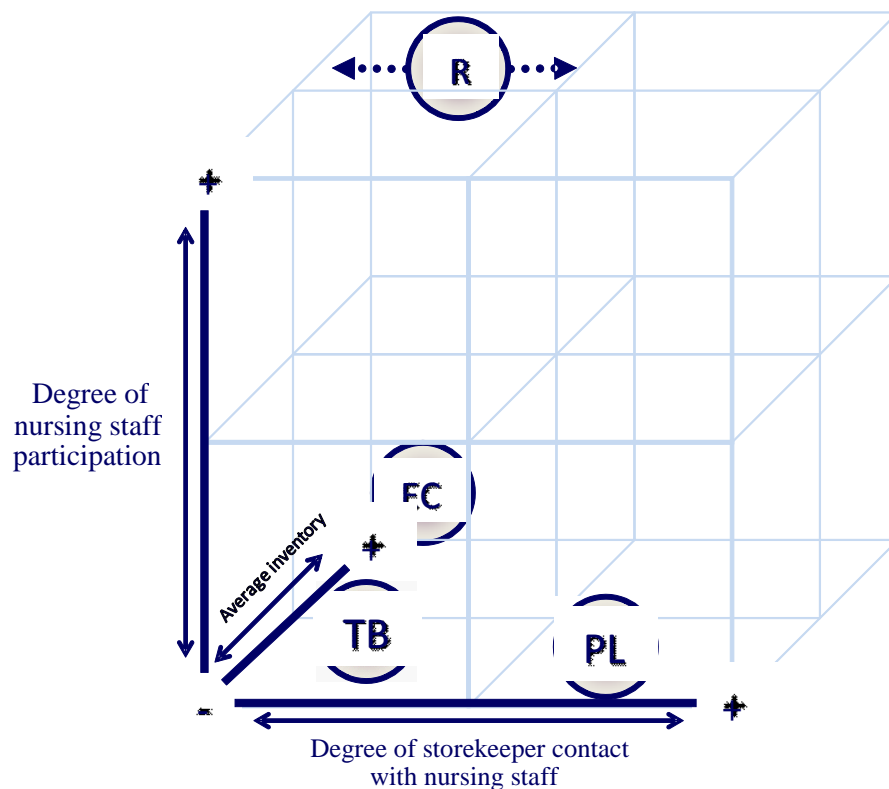
The order in which replenishment modes are listed in Table 1 is not random; it follows the chronological sequence of their entrance into the healthcare sector. The exchange cart was introduced to address a basic need: the transfer of replenishment responsibilities from nursing personnel (who handle the requisition system) to a centralized administrative unit that performs these tasks for all wards and user departments in a healthcare organization. The par level method and later the two-bin system were introduced as attempts to optimize replenishment processes while keeping nursing personnel involvement in the process to the absolute minimum.

<sup>1</sup> Translated and adapted from Landry et al.; 2004, p. 14.

These systems operate as a sort of internal Vendor Managed Inventory (VMI) within the hospital, where the material management department acts as a supplier. The systems can also be distributor-driven when stockless materials management (or point of use) distribution programs are in place (Rivard-Royer et al., 2002).

A research project led by Landry et al. (2004) identified a number of replenishment system performance dimensions. The study initially named two criteria for the evaluation of replenishment system performance. The first was the degree of contact between storekeepers and nursing personnel on the ward (and in a broader sense the presence of storekeepers on the ward). The second was the degree of nursing personnel participation in the replenishment process. These criteria echoed frequently cited disruptions to the normal flow of patient care activities (Tucker and Edmondson, 2002; Tucker and Spear, 2006). We would add a third criterion, the average amount of inventory that the system must maintain to provide a given level of service (figure 1).

**Figure 1**  
**Positioning of replenishment systems**



Legend:

R = Requisition, EC = Exchange cart, PL = Par level, TB = Two-bin

The two-bin system tends to perform better over the range of matrix dimensions than the other replenishment systems. In our analysis of the contribution of the two-bin system to lean healthcare, we will use the 5S method as a framework to which other lean references are added. The 5S rules are as follows: 1) Sort (Seiri): Sort out unneeded items and keep items based on frequency of use; 2) Straighten (Seiton): Organize to reduce waste; 3) Shine (or Scrub) (Seiso): Keep the workplace clean on a daily basis; 4) Standardize (or Systematize) (Seiketsu): Develop a consistently organized workplace using the preceding rules, defining uniform work practices and implementing mini-systems; 5) Sustain (Shitsuke): Implement an auditing system for ongoing support of the first four rules (adapted from Graban, 2009; p. 100).

The vast majority of hospitals using the two-bin system also use vertical high-density modular storage equipment (cabinets). The deployment of such a system requires that each product be examined in order to define supply quotas, storage space, replenishment frequency, etc., which in turn addresses the first S (Sort).

These same modular storage units respond to the second rule: Straighten. Conventional storage units (fixed shelving, etc.) take up much more space and can lead to multiple storage areas being required, many far removed from one another, which hinders their accessibility. A hospital will inevitably gain from standardizing to the extent possible how supplies are arranged in the storage cabinets throughout the institution. Of course, hospital wards have a variety of vocations, but the intent should be to place common items in the same areas to help staff locate products quickly.

Counting supplies to determine the quantity to replenish is a long and tedious process that is eliminated when the two-bin replenishment system is used. A study has demonstrated that the par level system requires 20 to 30 seconds per order line, while the two-bin system takes just 5 to 6 seconds per line for the same activity (Landry et al., 2004).

The model deployed in Canadian applications uses two labels for each item (one label for each bin): a white label with a colored stripe (e.g. red) for the primary bin (the bin from which supplies are drawn first) and a darker label (e.g. red background) for the secondary bin. The use of different colored labels helps ensure that nursing staff do not remove supplies from the second bin until the primary bin is empty. The color coding helps standardize the process and prevent errors from being made (e.g. taking supplies from the wrong bin), which could result in supply shortages on the ward. Colors are also used to distinguish medical supply general categories, e.g. white for dressings, red for blood related supplies, blue for items from central sterilization, green for respiratory products, beige for specialty items on the ward, yellow for urinary supplies, and purple for all other supplies. Given that nursing staff in the Canadian hospitals surveyed are rarely assigned to a single ward on a permanent basis, that many different employees work in a ward, and that casual nursing staff are used to replace regular staff, color-coded labels can become an

invaluable tool to help employees find supplies and can reinforce visual control—an important component of lean healthcare.

Similarly, a supplier to Canadian auto manufacturers implemented a color-coded kanban system to avoid any possible confusion between articles in production and those already finished (Chaussé et al., 2000). As the authors of this study explained, beyond the kanban “card” (or two-bin label) being used as a materiel management tool, the card’s design can promote visual control and become a vital element in a poka-yoke (mistake proofing or anti-error) system. We also see in this innovation an application of the “Straighten” rule, as it facilitates the locating of supplies. The fourth S, Standardize or Systematize, is also present, with the system’s operation being refined to prevent errors and reinforce its benefits. One Canadian hospital, Hôpital du Sacré-Coeur de Montréal, has taken visual control a step further, applying these same colors (red, yellow and white) to code emergency department carts according to their specific use and stocking KCL in a brightly colored bin to distinguish it from other solutions (IVs) due to the danger it poses if used in error.

In addition, with the modular storage system, the space assigned to a product is based on the quota initially established. Space constraints in the storage system prevent knee-jerk or ad hoc increases in quantities stocked. Quotas can be revised, but this must be done using a broader approach, where certain items might see their quotas raised, while others may be reduced based on average consumption figures and various management parameters, such as overall available space. In this way, space constraints help ensure that supplies remain organized.

The system is designed so as to have the user of supplies be the person who triggers replenishment by removing the label once the bin is empty. This means that all users must exercise discipline. However, emergencies that occur in hospitals can distract employees and erode their disciplined use of the system. Nicol (1989) and Welch (1983) noted that constant discipline assures the successful functioning of the two-bin system in the industrial sector. Not removing a label can lead to stockouts, but nursing staff have a vested interest in ensuring this step takes place, for they are the people most affected by stockouts. Therefore, unlike the par level system, minor involvement is required from nursing staff (please see Figure 1). A number of American hospitals ask their storekeepers to identify empty bins to determine which products need to be replenished, thus relieving nursing staff of the task. However, the storekeeper must open each drawer in each supply module to find the empty bins; this takes more time overall, increases the risk of stockouts as empty compartments can be missed, and negates the possibility of using the RFID-enabled approach presented in the following section. As a result, several hospitals are now moving away from this practice. In fact, nursing staff will generally not have to remove more than one or two labels per shift, a task that becomes even less significant when these few gestures are compared to those that must be made by nursing staff who use automated cabinets or open perpetual inventory applications at the point of use for each transaction (see discussion on perpetual inventory system presented at the beginning of this section).

Inventory is also much more tightly controlled with the two-bin system, as fixed rather than approximate quantities are replenished. With the par level system, we observed that storekeepers do not in fact conduct an exhaustive count of remaining quantities during their ward rounds but rather arrive at an estimate based on their own “good” judgment. In these circumstances, control of the inventory levels that should be maintained on the ward can gradually be lost. In fact, the data collected on actual consumption on the wards during this type of replenishment cycle does not allow the various management parameters to be accurately updated (minimum quantities, safety stock, replenishment frequency, quantity replenished)—an important observation cited by Landry et al. (2004)—thus undermining the performance of any replenishment mode. The two-bin system is often supported by an information system that makes the updating of quotas systematic.

## **Variations of the two-bin system**

Through a series of observations conducted in various regions of the world, we noted that the two-bin system is not limited to a single application in the sites where it is deployed. One private French hospital, Clinique Saint-Martin, uses removable bins; when the first bin is empty, nursing staff on the ward place it on a cart. The cart is then brought to the pharmacy (in France, the pharmacy is responsible for sterile medical supplies), where the bins are refilled and sent back to the wards (Beaulieu et al., forthcoming). We see this as a hybridization that combines features of the two-bin and exchange cart systems. A similar approach is used in some American hospitals, such as the Virginia Mason Medical Center in Seattle (Black, 2008; Zidel, 2006).

Park Nicollet Health Services, another American hospital, has deployed a two-bin system featuring cards. When the first bin is empty, a card is placed in a slot. The cards are then retrieved by an inventory specialist. Cards can also carry bar codes and be scanned on the ward itself (Black, 2008).

Some Japanese hospitals have deployed a similar variation of the two-bin system, adopting kanban cards that are deposited in a box at the entrance to the nursing station and gathered each day by materiel management personnel (in Japan, this department is named Supply, Processing and Distribution or SPD) for scanning in central stores. Once the kanban cards have been scanned, they are destroyed and a new card printed to accompany the supplies being replenished. This approach has the added advantage of reducing disruptions to the work zone (known as *gemba*), an area considered very important in Japan. At the Toyota Memorial Hospital (Japan), supplies stored in bins are wrapped in small lot sizes, each containing a kanban. In this case the number of kanban cards per item is not limited to two.

In some European countries, it is common to use a single label to manage the two bins. This label is initially affixed to the front of the active bin, i.e. the bin used first

by nursing staff. Once this bin is empty, the label is removed and placed on a rail to await scanning. As mentioned above, the model deployed in Canadian applications uses two labels for a single product (one label for each bin). When the first (front) bin is empty, its white label with a color stripe is removed. The second, darker label will be removed only if the second bin is also emptied. A dark label on the replenishment board therefore signifies a stockout for the product on this ward. Because of the noticeable difference in the color of the two labels, nursing staff are able to easily identify such a situation and alert the materiel management department. A parallel can be drawn here with the practice of *jidoka*, a cornerstone or pillar of TPS, where the production system features safeguards that automatically detect abnormalities, signal them (often using visual signals or *andon*), and take immediate corrective measures.

In all of these situations, the two-bin replenishment process is constrained by predetermined replenishment rounds. According to Turbide (1993), in the industrial sector, *kanban* differs from the two-bin approach in its ability to trigger production orders and schedule production. In the healthcare sector, the two-bin system and other replenishment modes do not allow the workloads of employees assigned to the replenishment cycle to be managed other than through a predetermined and often fixed schedule.

However, this situation is changing. With the introduction of a technological innovation from company Logi-D, several Canadian hospitals now use the two-bin system supported by RFID. In this version of the two-bin system, the bin's label looks like any other but is equipped with a passive (no battery) high frequency (HF) transponder. A reader is installed behind each of the replenishment boards where labels from empty bins are affixed. This board is connected to the hospital's information technology network. The moment an RFID label enters the reading range of the antenna, communication is established with the materiel management system to enable a request to be generated according to pre-established replenishment rules (discussed below).

RFID technology allows inventory to be proactively managed and the status of stock on wards to be known as soon as labels are removed, thus helping to optimize replenishment rounds. This reflects the above-mentioned *kanban* function of signaling the demand for production. RFID reinforces and automates *jidoka* by immediately alerting the materiel management department via pager or other device that a second label has been affixed to the board, in case a stockout exists on the ward.

Because two-bin is a mini-system (4th S), RFID technology also allows for certain audits and better monitoring of the discipline surrounding the use of the system (5th S). For example, if a dozen labels are transmitted to the information system within a very short space of time, it may be because a member of the nursing staff has gone through the storage area pulling labels from empty bins—labels that should have

been removed at the moment the last item was taken out of the bin. Reminders could then be issued to staff in the department on the correct use of the two-bin system.

## **Benefits of the two-bin system**

To identify the benefits of the two-bin system, we can once again draw from the lean manufacturing model. Ohno (1988) identified seven categories of waste, i.e. seven elements that add no value to the final product or service: overproduction, waiting, transportation, over-processing, inventory, motion, defects/rework. In many of these situations, the two-bin system can help eliminate waste.

Firstly, contrary to a popular misconception, the two-bin system helps reduce surplus inventory. It enforces discipline not otherwise present in the replenishment system, and it prevents the arbitrary counting of supplies inherent in all other periodic inventory systems. Inventory is therefore much better controlled. Inventory turnover is built into the put away process, thus ensuring that supplies do not “stagnate” in their storage units, potentially exceeding their expiry dates and generating losses and patient safety risks. In addition, depending on the information system selected to support its operation, the two-bin system can allow users to trace certain products all the way to the patient (e.g. IV solutions), a major advance.

The reduction of unnecessary staff movements is a key benefit of the two-bin system. The use of high-density cabinets often allows medical supplies to be stored where required. Fewer stockouts mean that nursing staff need not call for support or walk to a different ward or to the warehouse area to retrieve supplies that are missing from their own area. The introduction of RFID technology has eliminated the need to conduct ward rounds to gather data, thus doing away with movements with little or no added value and disruptions on the ward (*gemba*), particularly in hard to access areas. For example, Hôpital du Sacré-Cœur de Montréal has transformed its secondary storage points in the emergency department (i.e. storage units in examination rooms that had been replenished from a central storage area in emergency) into more than 30 primary storage points replenished from the central warehouse (Beaulieu and Landry, forthcoming).

While our comments target medical supplies, we also observed that the system has been applied to a variety of product categories, such as forms, office supplies, cleaning products, pharmaceutical ward stock, etc. It is therefore possible to standardize replenishment in any given institution. This approach can enable integrated and uniform replenishment management instead of the function being spread among multiple departments. As noted above, the development of standard practices is a cornerstone of the lean concept. Standardization creates a controlled environment, making it possible to determine the impact of any improvement efforts undertaken.

RFID technology opens up new possibilities to reduce staff movement. Historically, replenishment rounds take into account the volume of activities on the ward while targeting overall balance in the workload. We have already noted that rounds to record replenishment needs have been eliminated through RFID technology, which in turn frees up employees who can be assigned to tasks of greater value. In addition, the RFID labels transmit a signal once supplies in a bin have been consumed. It is therefore easier to synchronize the replenishment frequency with the consumption volume on the ward. Based on this logic, some wards could see their replenishment frequency drop while others would see theirs rise. This revision of cycles could also be made more dynamic; it could be conducted more often in order to be better aligned to the level of activity on the ward. And the quantity of supplies stored in each bin need not necessarily be the same. By increasing the amount stored in the first or primary bin and reducing that stored in the secondary bin by the same amount, the number of replenishments could be decreased over time. Some hospitals already do this for their direct purchase supplies. RFID technology has introduced the possibility of proactively managing supplies by triggering replenishment rounds based on a range of criteria (number of products to replenish, time elapsed since a label has been on the board, stockout when a label from the secondary bin appears on the board, etc.). This technology also reinforces sound supply chain management principles by aligning the information and material flows. RFID technology also helps simplify the identification and retrieval of labels from the replenishment board as part of the put away process, in that the tag being replenished sends a signal to a portable RFID reader when passed in front of it.

Graban (2009) went beyond the classic forms of waste to add another category: the waste of human potential. Almost every industrialized country is having to deal with nursing shortages (Evans, 2009; Cresswell, 2007). This kind of situation puts additional pressure on employees currently on the job. Many such observations have been documented, with some studies concluding that nursing staff are overburdened (Bourbonnais et al., 1998) and others reporting professional burnout (Rollins, 2008). A major international study conducted in the US, Canada, England, Scotland and Germany concluded that nursing staff retention (job satisfaction) is directly connected to work design and assignment, i.e. employees are less inclined to remain with the institution when assigned non-clinical tasks, such as delivering and retrieving food trays, housekeeping duties, transporting patients, ordering, coordinating, and ancillary services, leaving them less time for clinical responsibilities. (Aiken et al, 2001). Another study demonstrated that work intensification leads to decreased job satisfaction among nursing staff. (Zeytinoglu et al, 2007). An efficient replenishment system cannot in itself resolve these problems, but it can ensure that existing personnel are more able to devote their time to clinical activities (Landry and Philippe, 2004).

## Conclusion:

To operate on a day-to-day basis, an organization such as a healthcare institution requires various supplies and materiel. To avoid disrupting operations, the organization must maintain inventory on hand. It therefore becomes necessary to conduct replenishment activities that aim to bring inventory back to its initial levels, while, to the extent possible, minimizing the costs associated with the replenishment process. Within this perspective, Plossl (1998) stated that there exists a sort of conflict between consumer and supplier, wherein the former wants to have required supplies on hand at all times, while the latter strives to minimize the costs associated with replenishment. Because of this reality, an effective replenishment system must be implemented to reconcile these different visions. As explained by Tersine (1975) more than 30 years ago, a wide range of inventory control and replenishment systems exist; none is perfect, and each comes with its own advantages and limitations. Any given system must take into consideration the value of supplies, frequency of replenishment and random nature of the demand. Table 2 summarizes the lean concepts and how they apply to the two-bin system.

**Table 2 – Summary of lean concepts present in the two-bin system**

<b>Lean concept</b>	<b>Application</b>
Kanban	The two-bin system is an inventory management system similar to kanban. When combined with RFID technology, it also allows for more efficient scheduling of resources.
5S	The two-bin system prompts organization of the physical storage space and standardization of replenishment practices (mini-system). The replenishment board enables visual management, and RFID technology supports the audit process.
Jidoka	RFID technology or the duo-label system featuring different colors (light vs. dark) allows all stockouts to be immediately flagged.
Visual control and poka-yoke	The color-coding of labels helps make the picking of supplies safer and allows products to be categorized. When high-density storage units are used, the module's configuration limits the storage capacity to the established quota, thus preventing the hoarding of supplies.

With resources stretched to the limit, it is also vital to reduce areas of waste in healthcare institutions. The two-bin system deployed in the sector, particularly when supported by RFID technology, offers features that reflect a number of lean healthcare practices, helping to avert situations that can otherwise cause problems for clinical staff and patients alike.

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