HIMSS

Davies Award of Excellence Case Study
Program Year 2024

Smart Hospital Innovation with Intelligent Logistics Model

- Samsung Medical Center -

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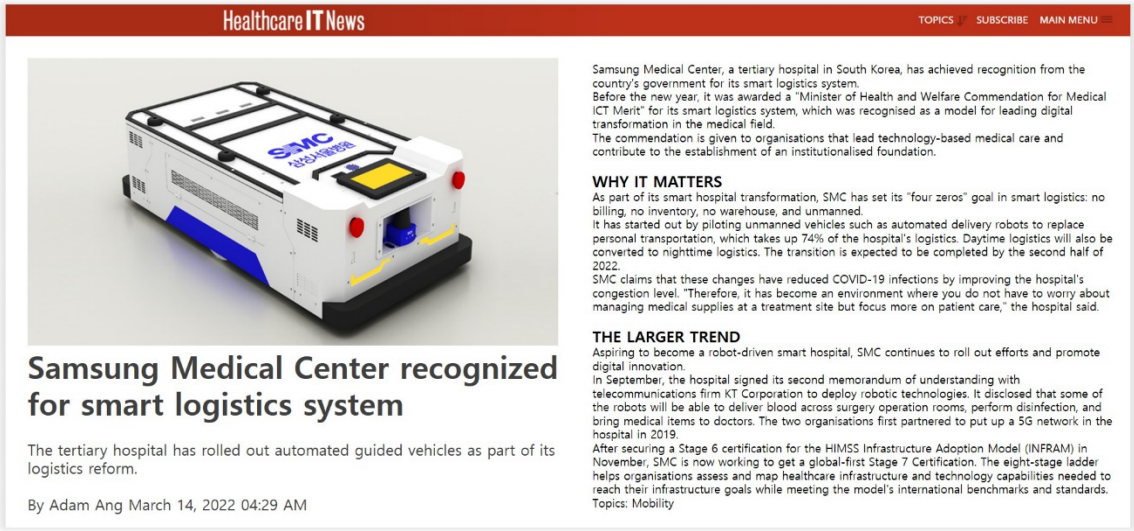
Executive Summary

- The current evaluation criteria for the Davies Award focus primarily on direct clinical outcomes achieved through services provided to patients. However, we propose to introduce a novel evaluation of indirect medical services within the emerging field of medical logistics. Medical logistics plays a crucial supporting role behind direct clinical services and is a key factor affecting personnel and resources. Though challenging to evaluate in terms of direct patient outcomes, logistical tasks can detract from the time healthcare providers spend on patient care. A recent survey of registered nurses in the United States identified time wasted on non-patient care activities, such as restocking supplies, as a major factor negatively impacting bedside care. Improving hospital inventory management can reduce logistics costs and the workload of healthcare staff, thereby improving the quality of patient care.
- The global healthcare crisis posed by COVID-19 has led to resource burnout despite the dedicated efforts of caregivers. HIMSS has shown increasing interest in addressing medical-resource burnout, with a growing global demand to support caregivers. Various efforts are being undertaken to quantitatively measure caregiver burnout. HIMSS must propose new evaluation

metrics to address this issue to enable more advanced IT-based medical services. Implementing an evaluation system for background services like logistics, as demonstrated in our case study, will be instrumental in reducing caregiver burnout and enhancing the quality of healthcare services.



Healthcare IT News

TOPICS | SUBSCRIBE MAIN MENU

Samsung Medical Center recognized for smart logistics system

The tertiary hospital has rolled out automated guided vehicles as part of its logistics reform.

By Adam Ang March 14, 2022 04:29 AM

Samsung Medical Center, a tertiary hospital in South Korea, has achieved recognition from the country's government for its smart logistics system.
Before the new year, it was awarded a "Minister of Health and Welfare Commendation for Medical ICT Merit" for its smart logistics system, which was recognised as a model for leading digital transformation in the medical field.
The commendation is given to organisations that lead technology-based medical care and contribute to the establishment of an institutionalised foundation.

WHY IT MATTERS

As part of its smart hospital transformation, SMC has set its "four zeros" goal in smart logistics: no billing, no inventory, no warehouse, and unmanned.
It has started out by piloting unmanned vehicles such as automated delivery robots to replace personal transportation, which takes up 74% of the hospital's logistics. Daytime logistics will also be converted to nighttime logistics. The transition is expected to be completed by the second half of 2022.
SMC claims that these changes have reduced COVID-19 infections by improving the hospital's congestion level. "Therefore, it has become an environment where you do not have to worry about managing medical supplies at a treatment site but focus more on patient care," the hospital said.

THE LARGER TREND

Aspiring to become a robot-driven smart hospital, SMC continues to roll out efforts and promote digital innovation.
In September, the hospital signed its second memorandum of understanding with telecommunications firm KT Corporation to deploy robotic technologies. It disclosed that some of the robots will be able to deliver blood across surgery operation rooms, perform disinfection, and bring medical items to doctors. The two organisations first partnered to put up a 5G network in the hospital in 2019.
After securing a Stage 6 certification for the HIMSS Infrastructure Adoption Model (INFRAM) in November, SMC is now working to get a global-first Stage 7 Certification. The eight-stage ladder helps organisations assess and map healthcare infrastructure and technology capabilities needed to reach their infrastructure goals while meeting the model's international benchmarks and standards.
Topics: Mobility

Figure 1. Healthcare IT News (March 14, 2022)

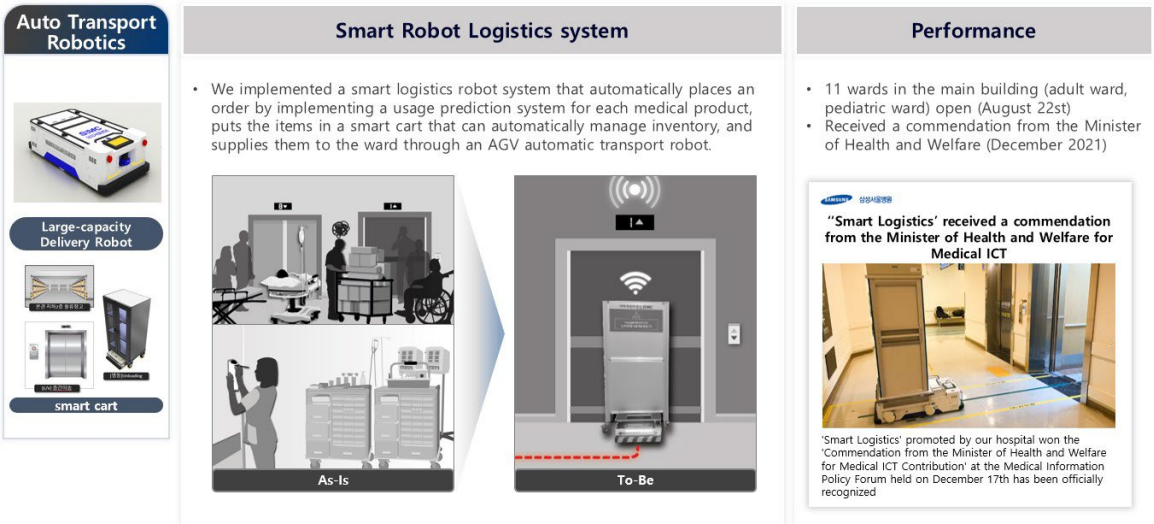


Figure 2. Samsung Medical Center's Smart Robot Logistics System

Define the Clinical Problem and Pre-Implementation Performance

- Background
  - In 2019, celebrating its 25th anniversary, Samsung Medical Center declared itself an "Advanced Intelligent Hospital" and has been undertaking a Digital Transformation (DX) project across various hospital operations such as medical care, logistics, and operational resources.
  - A key example of the digital transformation project is the logistics automation system, which uses Automated Guided Vehicle (AGV) robots to automatically supply necessary medical materials and IV fluids to each ward during the night.
  - This logistics automation system provides an optimal medical environment, allowing healthcare staff to focus more on patient care than on manual logistics tasks.
- Necessity
  - Currently, hospital logistics require efficiency-focused changes to overcome the limitations of real-time medical support needs, labor resource constraints, and space shortages.
- Real-time medical support
    - Due to additional administrative tasks, such as inventory checks and requisition processes for necessary medical materials and IV fluids in the wards, there is a lack of focus on patient care.
    - An automated system is needed to predict and deliver the standard quantity of necessary medical materials and IV fluids to the medical field daily.

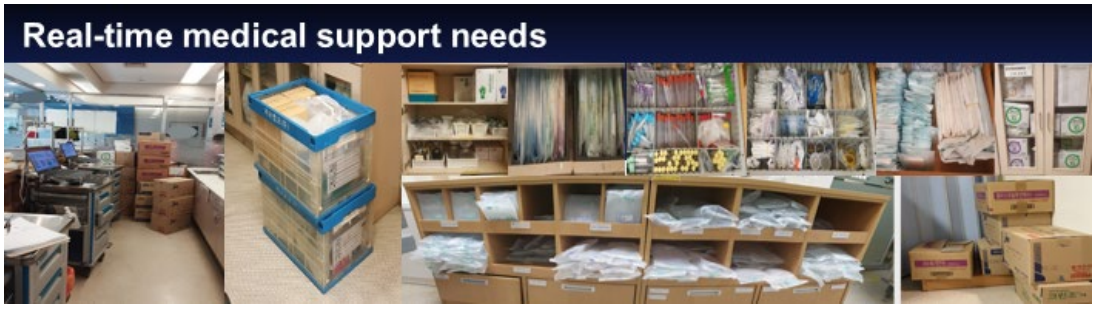
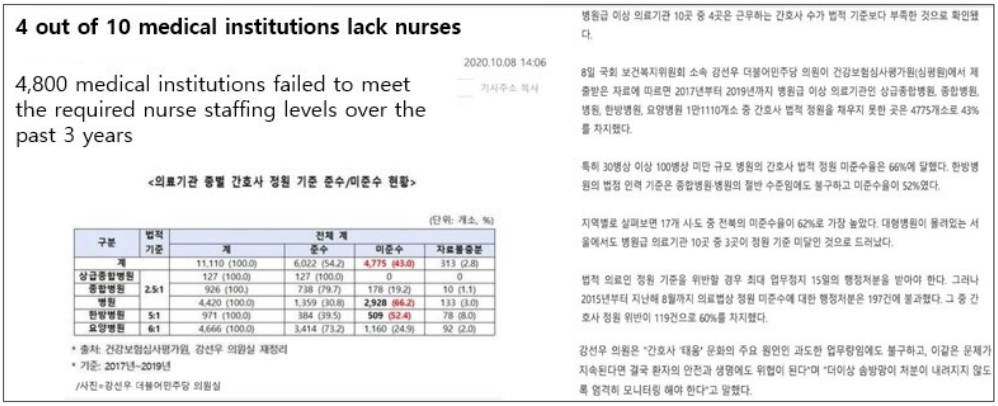


Figure 3. The ward requires a large amount of medical materials daily, and it requires real-time supply.

- Labor resource constraints
    - Changes in the social environment and trends in population make it challenging to maintain labor-intensive work structures. In Japan, hospital and logistics company closures are rampant due to labor shortages, a phenomenon currently mirrored in Korea.
    - In our healthcare system, 4 out of 10 hospitals don't have enough nurses. A newspaper said that in the last three years, about 4,800 hospitals didn't meet the required number of nurses. The main reason,

according to *Money Today*, is that nurses have too much work.



4 out of 10 medical institutions lack nurses

2020.10.08 14:06

4,800 medical institutions failed to meet the required nurse staffing levels over the past 3 years

<의료기관 종별 간호사 정원 기준 준수/미준수 현황>

(단위: 개소, %)

구분	법적 기준	전체 계			
		계	준수	미준수	자료불충분
계		11,110 (100.0)	6,022 (54.2)	4,775 (43.0)	313 (2.8)
상급종합병원	2.5:1	127 (100.0)	127 (100.0)	0	0
종합병원		926 (100.)	738 (79.7)	178 (19.2)	10 (1.1)
병원		4,420 (100.0)	1,359 (30.8)	2,928 (66.2)	133 (3.0)
한방병원	5:1	971 (100.0)	384 (39.5)	509 (52.4)	78 (8.0)
요양병원	6:1	4,666 (100.0)	3,414 (73.2)	1,160 (24.9)	92 (2.0)

* 출처: 건강보험심사평가원, 강선우 의원실 재정리
* 기준: 2017년~2019년

/사진=강선우 더불어민주당 의원실

병원급 이상 의료기관 10곳 중 4곳은 근무하는 간호사 수가 법적 기준보다 부족한 것으로 확인됐다.

8일 국회 보건복지위원회 소속 강선우 더불어민주당 의원이 건강보험심사평가원(심평원)에서 제출받은 자료에 따르면 2017년부터 2019년까지 병원급 이상 의료기관인 상급종합병원, 종합병원, 병원, 한방병원, 요양병원 1만1110개소 중 간호사 법적 정원을 채우지 못한 곳은 4775개소로 43%를 차지했다.

특히 30병상 이상 100병상 미만 규모 병원의 간호사 법적 정원 미준수율은 66%에 달했다. 한방병원의 법정 인력 기준은 종합병원·병원의 절반 수준임에도 불구하고 미준수율이 52%였다.

지역별로 살펴보면 17개 시·도 중 전북의 미준수율이 62%로 가장 높았다. 대형병원이 몰려있는 서울에서도 병원급 의료기관 10곳 중 3곳이 정원 기준 미달인 것으로 드러났다.

법적 의료인 정원 기준을 위반할 경우 최대 업무정지 15일의 행정처분을 받아야 한다. 그러나 2015년부터 지난해 8월까지 의료법상 정원 미준수에 대한 행정처분은 197건에 불과했다. 그 중 간호사 정원 위반이 119건으로 60%를 차지했다.

강선우 의원은 "간호사 '태움' 문화의 주요 원인인 과도한 업무량임에도 불구하고, 이같은 문제가 지속된다면 결국 환자의 안전과 생명에도 위협이 된다"며 "더이상 솜방망이 처분이 내려지지 않도록 엄격히 모니터링 해야 한다"고 말했다.

Figure 4. Money Today (daily newspaper), Oct, 2020

- Unlike other industries where logistics automation has been promoted, the medical industry still relies on labor-intensive logistics systems. Various delivery facilities, such as conveyors, autotracks, and pneumatic tube systems, have been established but are utilized at less than 20% capacity.

Figure 5. A nurse checking the inventory of medical materials in the hospital ward

- Changes in work
  - With the progression of specialization and segmentation in medical care, the types and quantities of supplies delivered to hospitals are rapidly increasing, adding to the workload of on-site nurses who manage these complex and diverse supplies.
  - In the first 25 years since its establishment in 1994, Samsung Medical Center saw a 50-fold increase in outpatient visits and a 15-fold increase in medical supplies, which has continuously increased nurses' workload. The nurses' direct involvement in organizing and managing delivered materials makes it difficult for them to focus on their primary role of patient care. Efficient logistics management is necessary to prevent nurse attrition and to improve medical quality.

Additional explanation:
Even compared to 100 years ago, logistics has changed little. Direct delivery is still used in around 74% of cases, while the use of automation facilities is only about 26%.

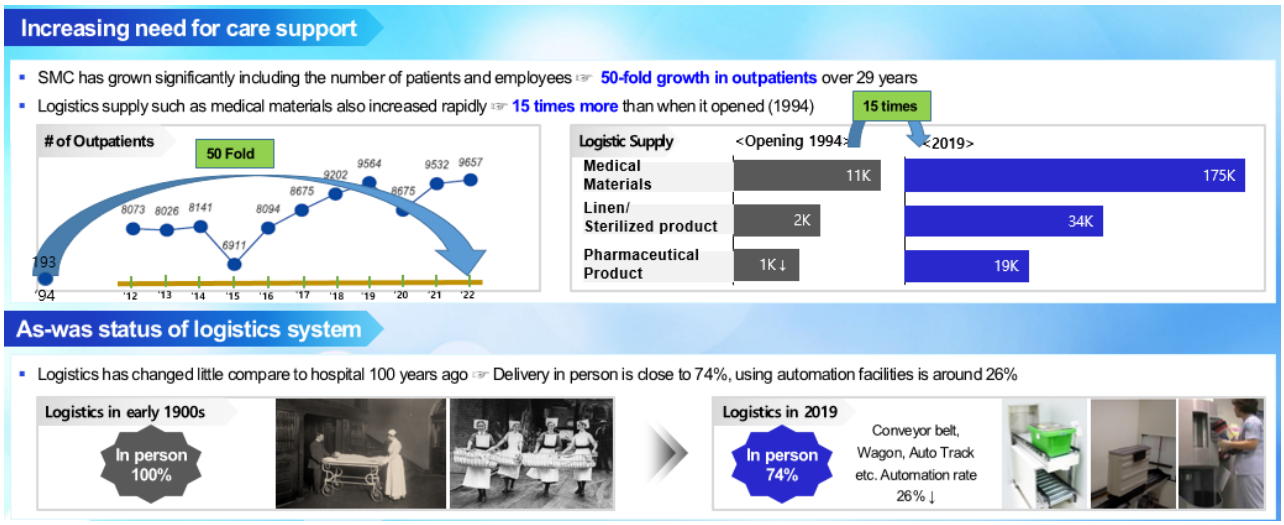


Figure 6. Increasing need for care support at SMC

At Samsung Medical Center, the nurse-to-patient ratio is maintained at 1:8, which may affect the workload of nurses and the quality of patient care. An efficient solution was needed to address this issue.

Figure 7. SMC nurse working environment

- Space shortages
  - To accommodate the continuously increasing number of patients and to provide high-quality patient care, measures are needed to overcome the restrictions of limited hospital space.
  - Samsung Medical Center attempted to secure medical space by relocating non-medical spaces (administrative offices, faculty offices, etc.) to areas outside the hospital. However, due to constraints in the logistics system, storage facilities had to remain within the hospital.
  - Therefore, it became necessary to relocate the logistics warehouse outside the hospital and to establish a remote, smart, logistics system to optimize medical space within the limited hospital area.

Figure 8. A hospital ward cluttered with medical materials, leaving no free space

- Target Baselines for Success prior to the Launch of the Project
  - Nurses spent about 14% of their time on non-clinical tasks
    - To maximize the efficiency of nurses and reduce their workload, we began by focusing on reducing non-clinical tasks. Therefore, before starting the project, we conducted a preliminary check of the target baseline time and ratio and determined that nurses spent about 14% of their time per day on non-clinical tasks.

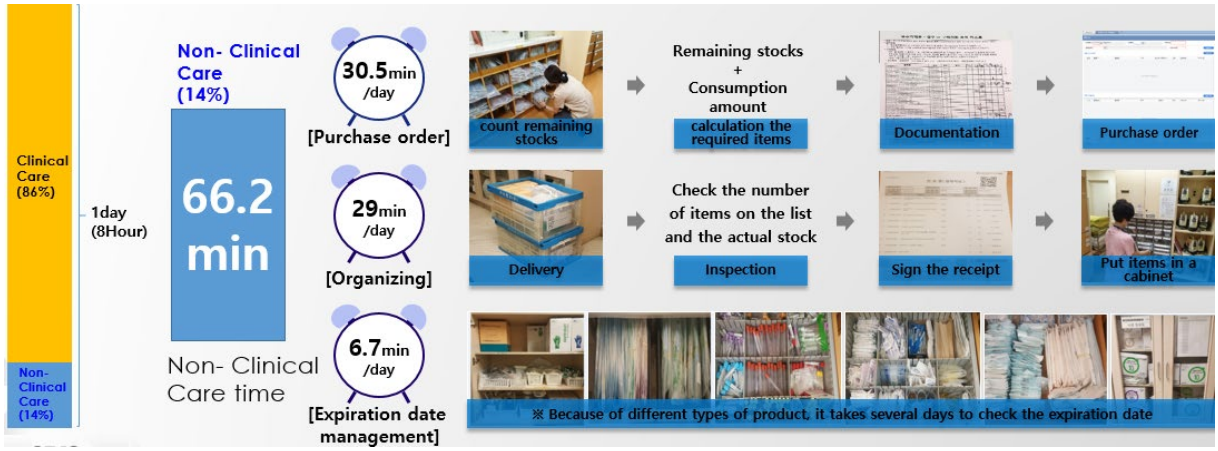


Figure 9. Nurses spent about 14% non-clinical tasks.

Design and Implementation Model Practices and Governance

- Objectives
  - To address the issue, a Logistics Innovation Task Force has been established. This team consists of experts from various relevant departments who have been enlisted to contribute to the project. The screenshot below sequentially displays the signatures of Task Force participants, participation objectives, review contents, TF organization, and progress schedule.
  - The final step in the process has been successfully completed, and the Smart Logistics Expansion Result Report was presented at the end of December 2022.

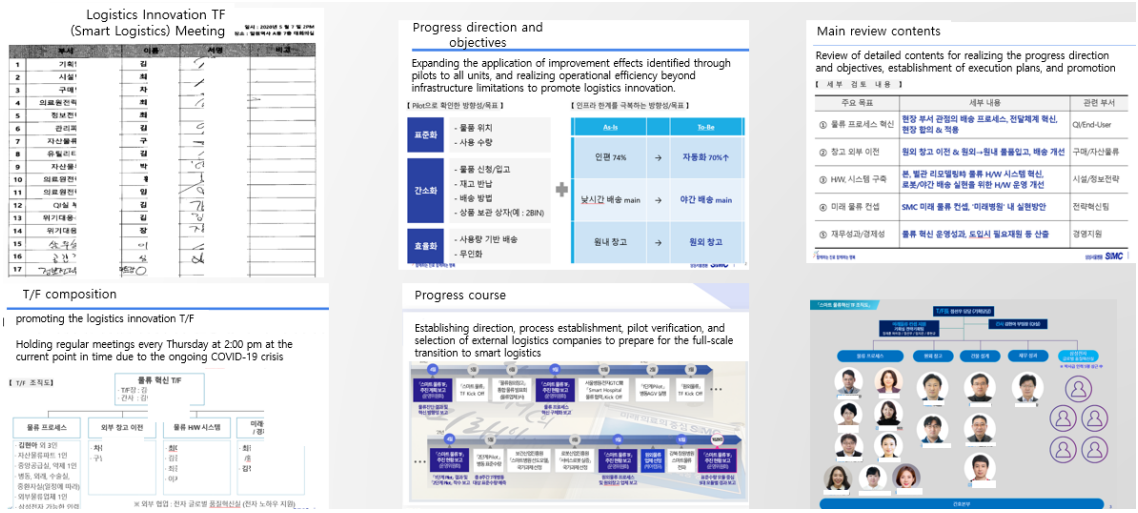


Figure 10. TF participant signatures, objectives, review contents, organization, and progress schedule

- Framework for establishing an advanced logistics system
  - Transform the requisition system for medical materials used in the clinical field into a regular supply system based on **standard quantities**, establishing a process that **automatically** requisitions and delivers materials **without manual requests**.
  - Expected outcome: The creation of a "no-requisition" environment in the clinical field by eliminating manual requisition processes.
  - Additional explanation: Settings for data acquisition
    The setup for data collection involves obtaining annual procurement volume data for medical supplies from the Enterprise Data Warehouse (EDW). The control chart (C-chart) is used to calculate the data. The daily standard quantity is determined by adding two standard deviations (σ) to the average of the procurement volumes.
    After the new supply process is implemented, actual consumption data will be available.

- Obtain annual purchased quantity data of medical items from EDW (Enterprise data warehouse)
- Calculated using Control chart (C-chart)

$M_{(\text{purchased quantity})}$: Average of Purchased quantity / σ : purchased quantity Sigma $= \sqrt{M_{(\text{purchased quantity})}}^{2}$

Standard quantity for 1day$(min) = M_{(\text{purchased quantity})} + 2\sigma$	$(M+2*\text{SQRT}(M_{(\text{purchased quantity})}))$
Standard quantity for 1day$(max) = M_{(\text{purchased quantity})} + 3\sigma = \text{UCL}$	$(M+3*\text{SQRT}(M_{(\text{purchased quantity})}))$
Standard quantity for 7days $= (M_{(\text{purchased quantity})} + \sigma) * 7$	$\{M+\text{SQRT}(M_{(\text{purchased quantity})})\}*7$

- Daily standard quantity = Average of **Purchased quantity** + 2 sigma(σ)
  → After starting a new supply process, we could get real consumption data.

Figure 11. Settings for data acquisition

- Creating an environment for enhanced focus on patient care
  - **Eliminate non-clinical activities.** Eliminate the need for nurses and other medical staff to inspect and manage the inventory of medical materials when the materials arrive, allowing the staff to concentrate on patient care and thereby providing an infrastructure for optimal patient care.
  - Expected Outcome: Improved nursing efficiency through "no-inspection" and "no-inventory" processes and reduction in the number of inefficient tasks.
  - Additional explanation: Data analysis
    During the preliminary analysis phase, we calculated the time manually using the shadowing method to determine the time spent on the manual requirements of the preparation process.

Figure 12. The target value was calculated by monitoring the nurse's working process.

- Improving the logistics environment by minimizing logistics movement during peak patient hours
  - Develop a logistics process where deliveries are automated during low-usage times such as **late night and early morning** to avoid the inconvenience and safety risks posed by overlapping patient movements and logistics deliveries during the day.
  - Expected Outcome: Significant reduction in congestion experienced by patients and caregivers in the clinical setting, enhanced patient satisfaction, and minimized risks during the delivery process.
  - Additional explanation: Congestion Evaluation and Measurement Methods: QR Login Time
    The operating time for the AGVs was determined by measuring the congestion level through QR logins of patients entering and exiting the hospital gates, and then selecting the time period with the lowest congestion, which was during the night.

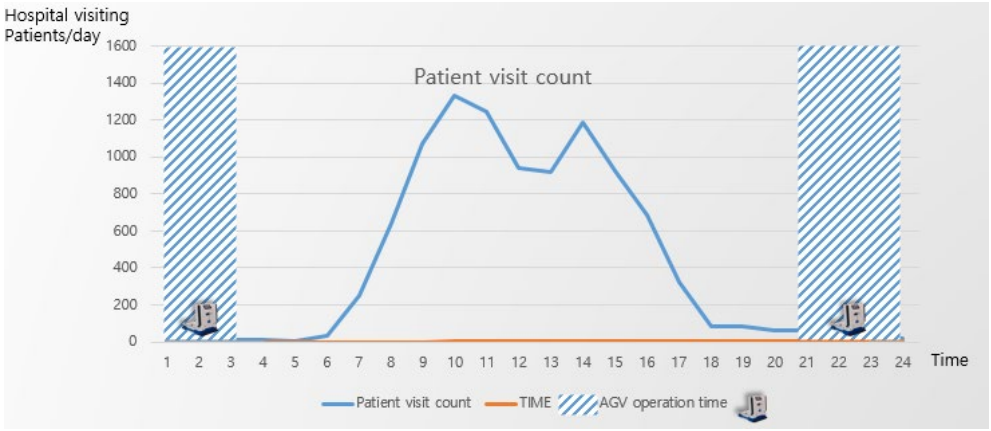


Figure 13. Congestion levels of visitors by the QR login count and AGV operation time during the least congested night time

- Global model for no-requisition, no-inspection, automated medical material management
  - Established as a pioneering mode, this model is the first of its kind and can be **expanded globally**.
  - Expected Outcome: Promotion of the standardized global model domestically and internationally.
- In summary, a total of five smart logistics system designs were conducted to improve the efficiency of the medical logistics process: standard quantity-based regular supply; automatic supply without manual requests; elimination of non-clinical activities; delivery starts during low-usage hours, such as late-night and early-morning hours; and establishment of an expandable, pioneering model.
-

Advanced Logistics System	
01	Transform the requisition system for medical materials used in the clinical field into a regular supply system based on **standard quantities.**
02	Establishing a process that **automatically** requisitions and Delivers materials **without manual requests**.
03	**Eliminate non-clinical activities** such as inspection and inventory management of medical materials by nurses and other medical staff upon arrival, allowing them to concentrate on patient care
04	Develop a logistics process where deliveries are automated during low-usage times such as **late night and early morning** to avoid the inconvenience and safety risks posed by overlapping patient movements and logistics deliveries during the day
05	Establish as a pioneering model that can be **globally expanded**, being the first of its kind.

Figure 14. Five innovative designs for the smart logistics system

Clinical Transformation Enabled through Information and Technology

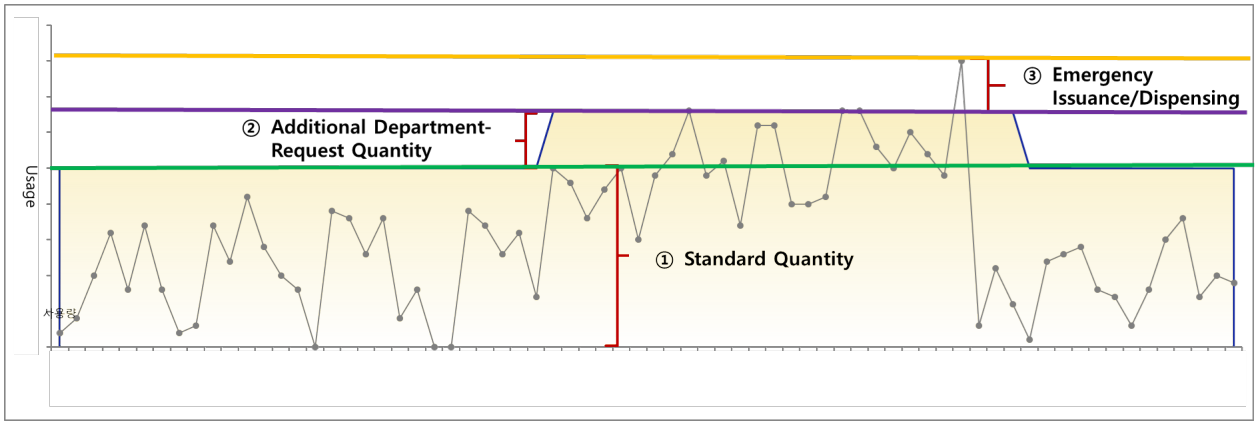
- Detailed Description (Technical)
  - Under the support of the Logistics Integrated Management System, we developed an intelligent inventory management model for ward medical supplies. Based on this, we developed a module that calculates the standard quantity of required items at clinical sites and established an automated delivery module to deliver medical supplies promptly.
    - **Smart Standard-Quantity Model**: Implementation of a Standard-Quantity Module for each medical department
      - The Standard-Quantity Module calculates daily required quantities by standardizing patient attributes, conditions, admission/discharge numbers, and variations in medical supplies and IV fluid usage by day for pilot wards.

    Additional explanation:
    The "smart" standard quantity is calculated by adding the usage during the three previous months plus two standard deviations (σ) to the average of the usage. This value represents the amount of supplies that should be available on a daily or weekly basis to maintain a service level of 97.5% without running out of items.

$$Standard\ quantity(1day) = (Average\ of\ consumption\ for\ 1day) + 2\sigma(consumption\ for\ 1day)$$
$$Standard\ quantity(7days) = (Average\ of\ consumption\ for\ a\ week) + 2\sigma(consumption\ for\ a\ weak)$$

Figure 15. Standard-quantity model

The process is based on the **standard-quantity model**, allowing real-time adjustments upon **departmental requests**, and also enabling **emergency issuance** of resources as needed. These **three patterns** are currently utilized in the supply-management operation of the smart logistics system.



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Classification		Content	Remarks
Baseline	① Standard Quantity	The measurement of standard quantity is updated <u>every three months</u> ✓ Based on the usage date from the last three months from the Quality Improvement Office, Recommendations have been updated. ✓ The supply is provided on a daily or weekly cycle to cover 97.5% of the required quantity.	Below the green line
On-demand	② Additional Department-Request Quantity	These adjustments are reflected in the standard quantity <u>on a daily basis</u> ✓ In case where more medical materials are temporarily needed, the department can modify the standard quantity in DARWIN(HIS/EMR) in real-time. ✓ The updated standard quantity will be reflected in the supply amount for the following day.	Between the green and purple line
Emergency	③ Emergency Issuance / Dispensing	The emergency request is supplied <u>immediately</u> ✓ Emergency Issuance: When a department needs additional quantity on the same day or required one-time additional supplies that do not warrant an adjustment to the standard quantity, the emergency issuance system can be used. ✓ Borrowing: When the needed items are available in a nearby ward, borrowing is possible instead of the emergency issuance.	Between the yellow and purple line

Figure 16. The standard-quantity model consists of three patterns: Baseline, on-demand, and emergency.

The premise is that up to 97.5% of usage is covered by the standard quantity supplied, with occasional additional quantities (the remaining 2.5%) managed through the emergency distribution system. In figure 17, the graph titled "Standard Quantity Validation" that the standard quantity is adequately

maintained at less than or equal to 2.5%, as the emergency distribution is at only 0.3% in the "Urgent Demand Rate" graph.

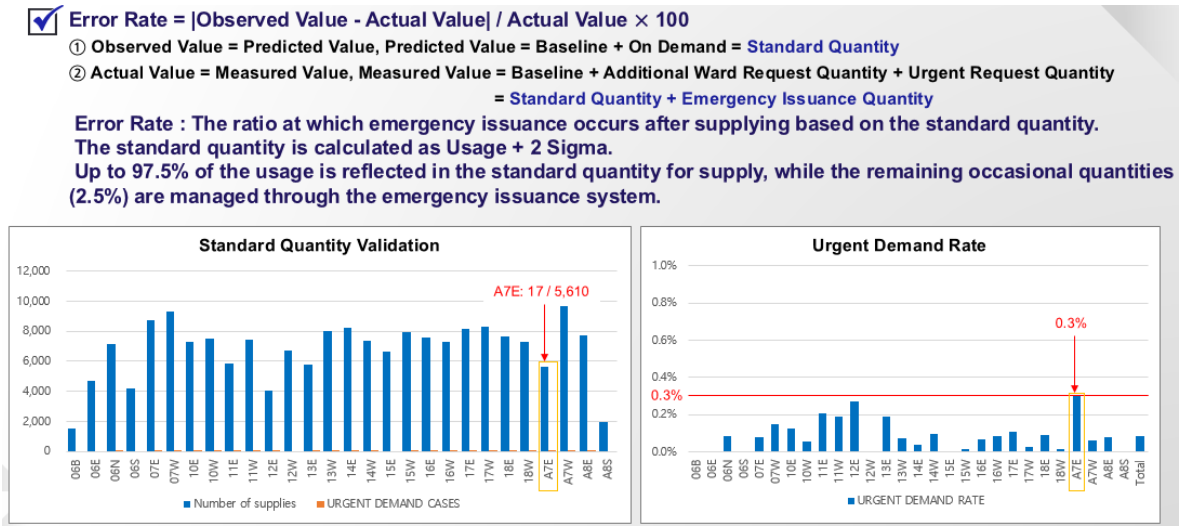

Figure 17. Standard-Quantity Model Validation

For smart standard quantities, planning is based on actual data from a three-month period. If there is no usage at all, it will be excluded. If daily usage is consistent but the volume is low, we recommend moving from a one-day supply to a seven-day supply. We also monitor the usage and recommend adjustments if needed, either to reduce or increase the quantity.

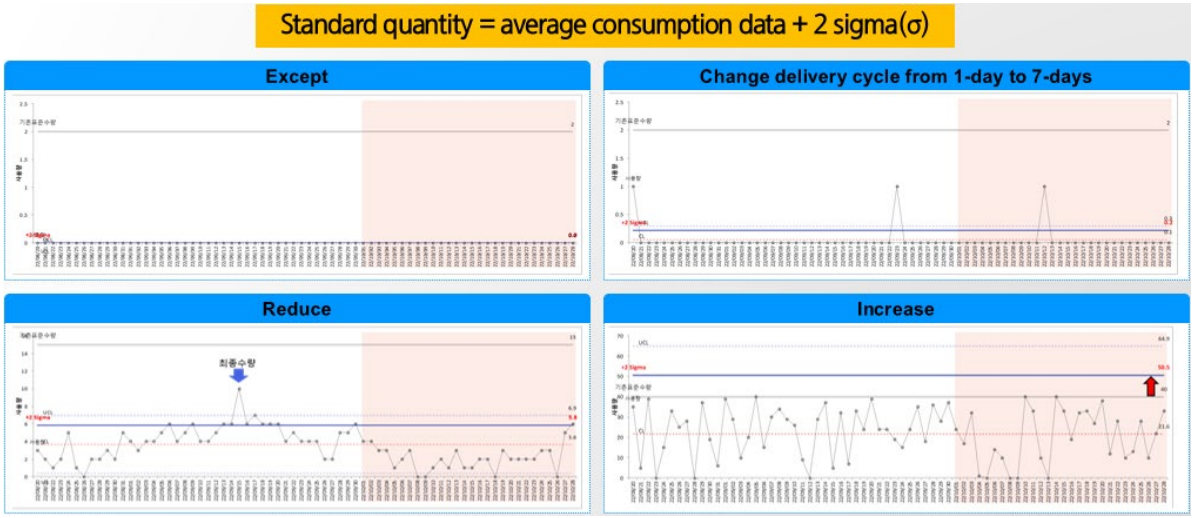

Figure 18. We can monitor the usage and recommend adjustments if needed, either to reduce or increase the quantity.

- Intelligent Inventory Management Model: Gradual establishment of a "Smart Cart Module" for automatic inventory management based on material entry and actual usage at clinical sites, and of an "Intelligent Inventory Management System" for automatic quantity detection during warehouse entry and return.
  - Smart Cart Module: Production of "**Magic Carts**" loaded with standard quantities daily, reflecting clinical site requirements, and creation of a "Smart Control Box" to allow real-time monitoring of location and status from warehouse entry to clinical site movement.

Additional explanation:

We have newly designed and created a new type of cabinet for each ward to allow AGV robots to deliver standard quantities of clinical materials daily. This innovation is called the **Magic** (**M**obile & **A**utomated **G**uidance**-**based smart **I**nventory **C**are) **Cart**.

Figure 19. Magic Cart features

The Magic Cart is designed to meet the requirements of clinical sites, with standard daily quantities loaded onto an AGV robot. The Smart Control Box feature enhances safety during transportation and allows for real-time monitoring of location and status from the warehouse entrance to movement in the clinical site.

Figure 20. Magic Carts & Smart Control Box

- Automatic Inventory Management Module: Calculation of inventory levels based on quantity and item during Smart Cart entry, and final quantity determination through barcode/RFID confirmation of returned items during cart return. RFID recognition is applied for item usage in the ward.
  Additional explanation:
  We have developed a barcode system optimized for workflow, enabling the provision of various patient materials, such as five dressings and five needles for wound care, at the same time. This on-site, friendly workflow barcode-scanning system improves efficiency and reduces errors in the delivery process.

Figure 21. Elimination of the Inspection Process

- Development of a barcode system to enable automatic processing of materials used in conjunction with EMR and prescription codes.
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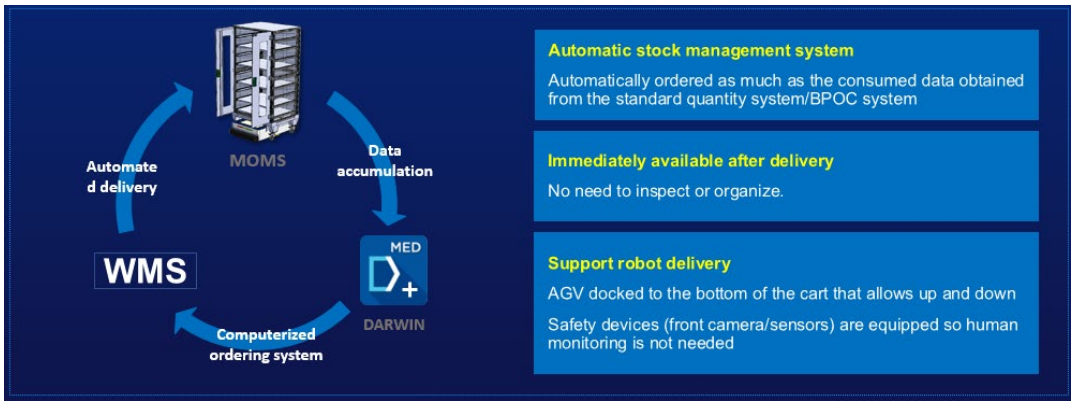


Figure 22. Automatic stock management process

- Automatic Delivery Model: Operation and Support Modules for automatic delivery from the warehouse to clinical sites after internal warehouse entry.
  - Automatic Delivery Module: Large-capacity Delivery Robot (Automated Guided Vehicles) automatically recognize cart entry during internal cart loading, enabling delivery to designated locations within the ward. These robots are equipped with cart connections and safety devices for secure delivery.

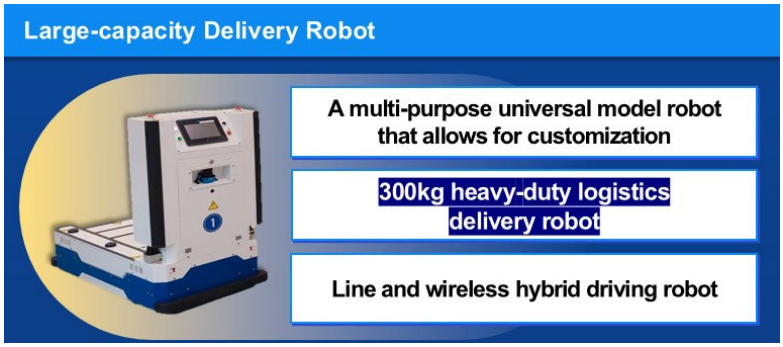


Figure 23. An Automated Guided Vehicle (AGV)

  - Automatic Delivery Support Module: Support is provided for controlling and operating multiple AGVs for vertical movement, integration of essential elevators for vertical movement via the Elevator Interface System (EIS) and Elevator Manager System (EMS), and for charging/storing AGVs via the Automatic Battery Charge (ABC) module. Each system is designed for both integrated operation and individual module operation.

- Expansion Progress (Gradual Expansion, Pilot Hospital Application ⇒ Expansion to Partner Hospitals)
  - After starting with two pilot wards in July 2021, service was added to nine additional wards in May 2022, to five more wards in September 2022 and to another seven wards in December 2022, expanding the implementation to a total of 23 wards in the main building. In 2023, we expand to the Cancer Hospital wards, and in 2024, we plan to further expand to the Annex Building wards, pending the renovation schedule.

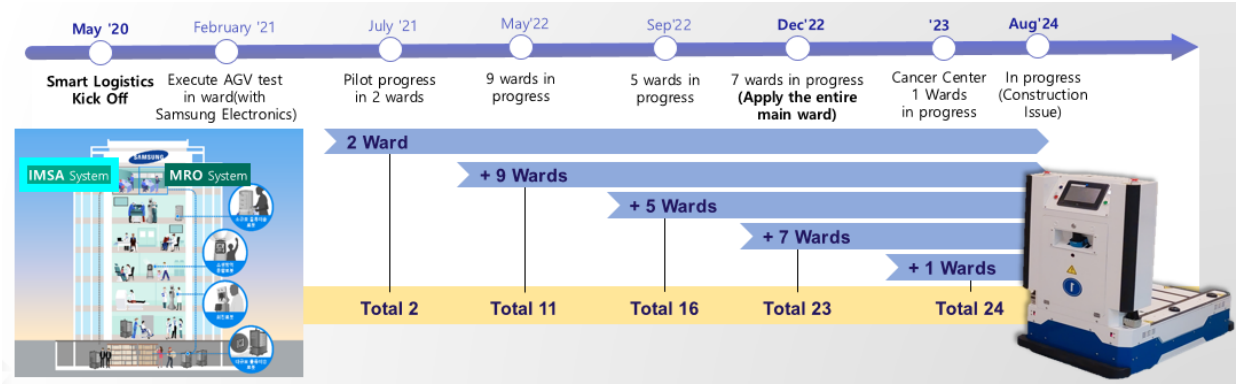


Figure 24. Step-by-step plan for diffusion of Smart Logistics

- Measures for improving logistics and consulting services are planned for two hospitals that are part of the SMC system: Gangbuk Samsung Hospital and Samsung Changwon Hospital.
- Educational content will be developed for partner hospitals, allowing application of the five modules according to hospital size and requirements.
- An application will be developed to expand the model globally for use by overseas hospitals.

Improving Adherence to the Standard of Care

- Results
  - We have established an advanced logistics system based on an intelligent logistics system, thereby moving away from the manual-based method for securing safety stock that involved the requisition of excessive material.
    - Outcome: We have eliminated billing tasks through standard quantity prediction and have established a regular delivery system.
  - By improving inefficient manual inventory-management tasks and reducing the burden of inspection and inventory management at clinical sites, we have enhanced medical care quality, thereby creating an environment more conducive to patient care.
    - Outcome: Reduction in non-essential tasks has allowed nurses to focus on patient care, improving patient satisfaction and experience.
  - Previously, patient discomfort and infection/safety risks existed due to congestion caused by daytime mail delivery. However, by implementing nighttime delivery, we have improved patient experience by reducing the opportunity to transmit infection, and have enhanced patient safety and convenience.
    - Outcome: Securing patient-centric daytime routes has improved patient satisfaction and has mitigated risks.
  - Although the absence of a smart logistics system in the healthcare industry has forced reliance on mail logistics systems, the establishment of the MOMS system has paved the way for the expansion of a leading model that can coexist within the medical ecosystem.
    - Outcome: The initial establishment of a smart logistics system and plans for domestic and international expansion are underway.

  Additional explanation:
  MOMS (**M**edical **O**bject **M**anagement **S**ystem) is an IT process that serves as an integrated smart logistics system. It provides functions such as automatic inventory management support, MAGIC Cart monitoring, and AGV operation. It is designed as a whole-system construction operation solution. Furthermore, MOMS offers a simulation function for AGV operation allowing the input of a map into the transportation algorithm module, which can display the optimal route in advance when routes are changed.

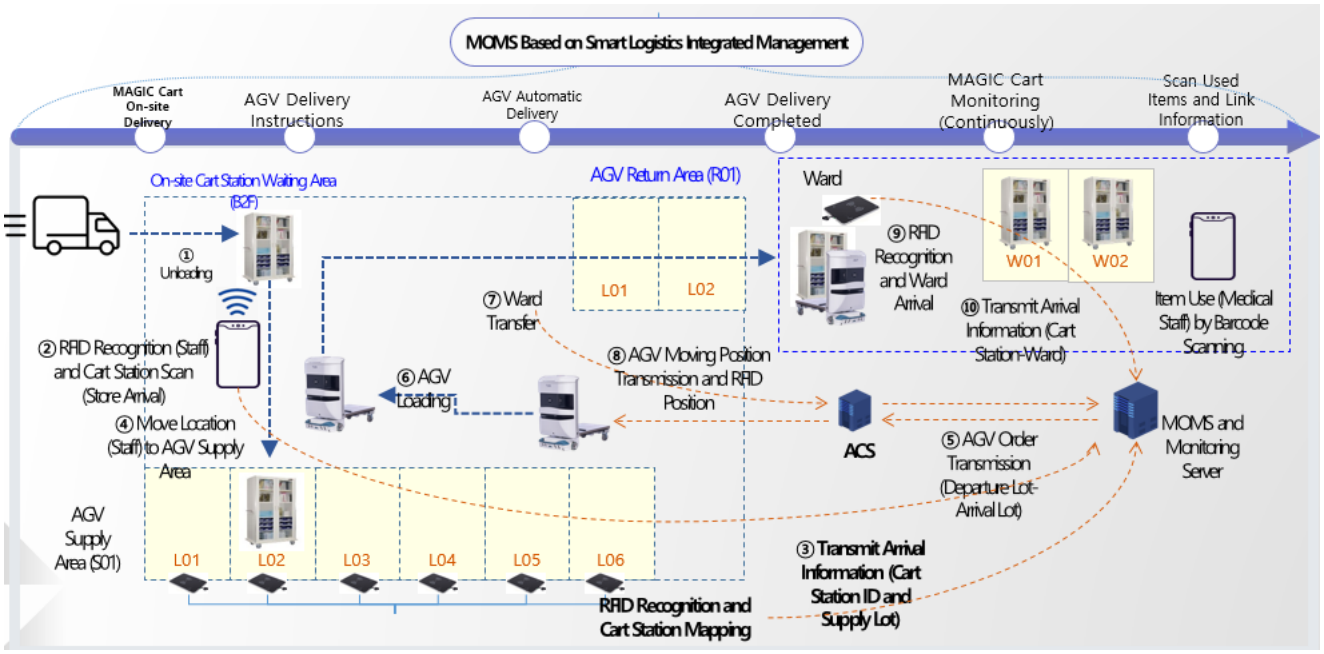


Figure 25. Medical Object Management System (MOMS) based on integrated smart logistics

Improving Patient Outcomes

- Outcome: Elimination of Billing Process
  - Explanation: Through the standard-quantity module, which calculates variation in the usage of medical supplies and IV fluids by day, we have eliminated the 30.5 minutes per day spent by nurses on inventory verification and quantity prediction tasks per ward.
    - Application of Standard-Quantity Module ⇒ Achieved "No Billing" Environment

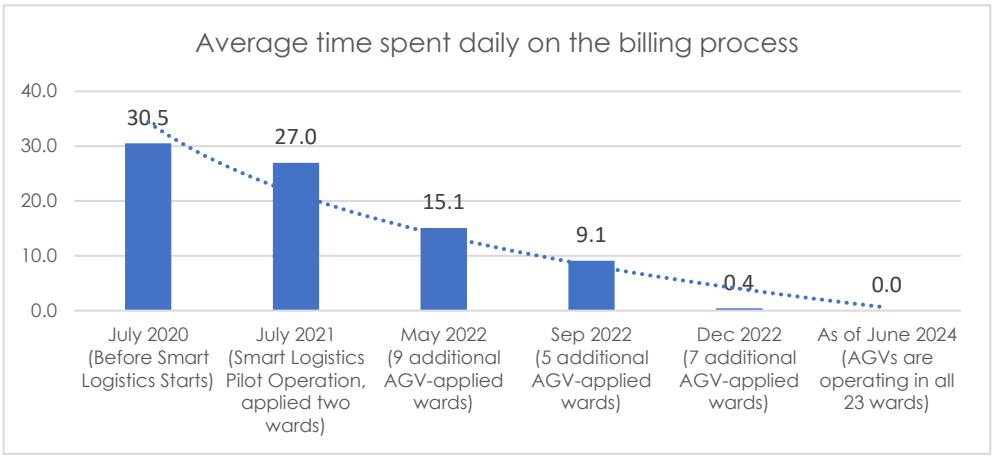


Figure 26. Change in average amount of time spent daily on the billing process, July 2020–June 2024

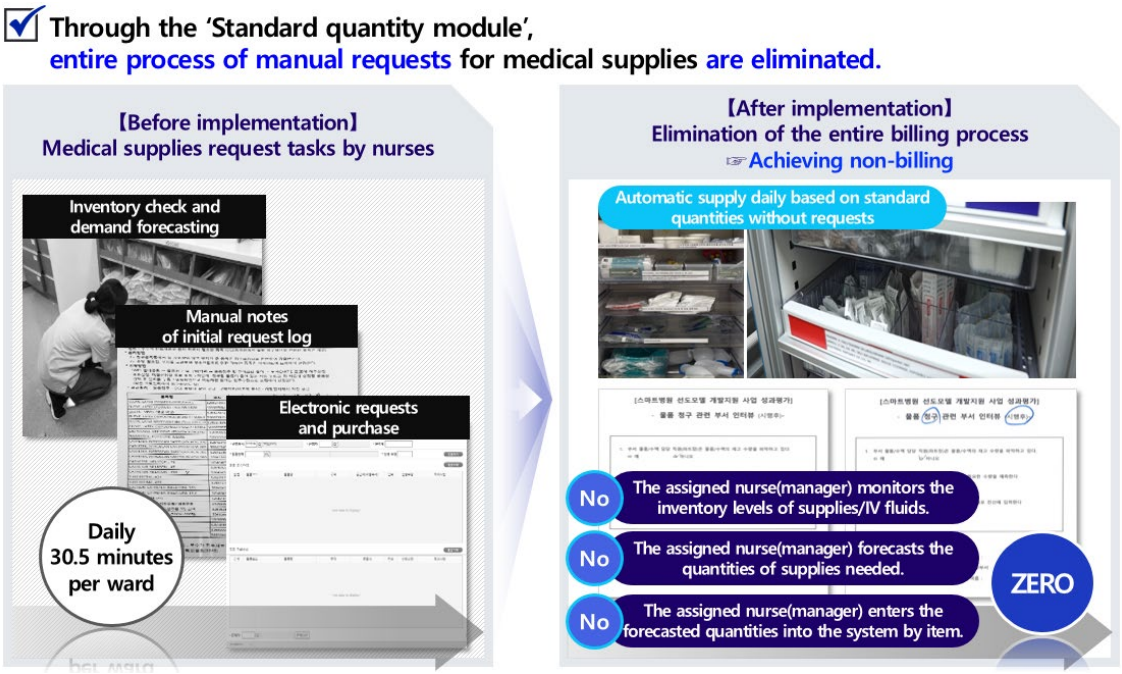


Figure 27. The Standard Quantity Model has eliminated the entire process of manually requesting medical supplies

- Outcome: Removal of Inspection Process
  - By implementing the Magic Cart, which loads items in standard quantities for delivery, we have eliminated the 29 minutes per day spent on inspection and item-organization tasks per ward.
    - Application of Magic Cart ⇒ Achieved "No Inspection" Environment

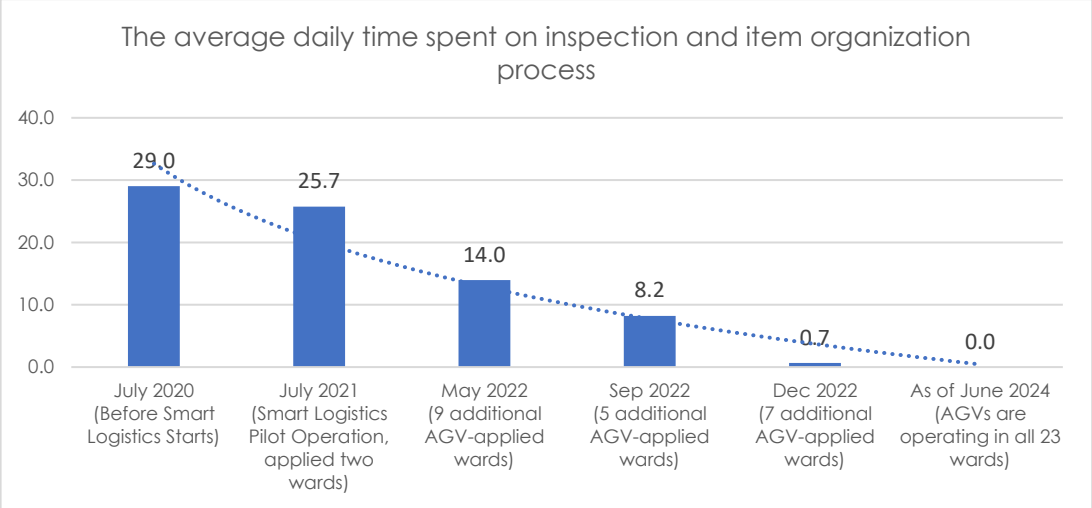


Figure 28. Average time spent daily on inspection and item-organization processes

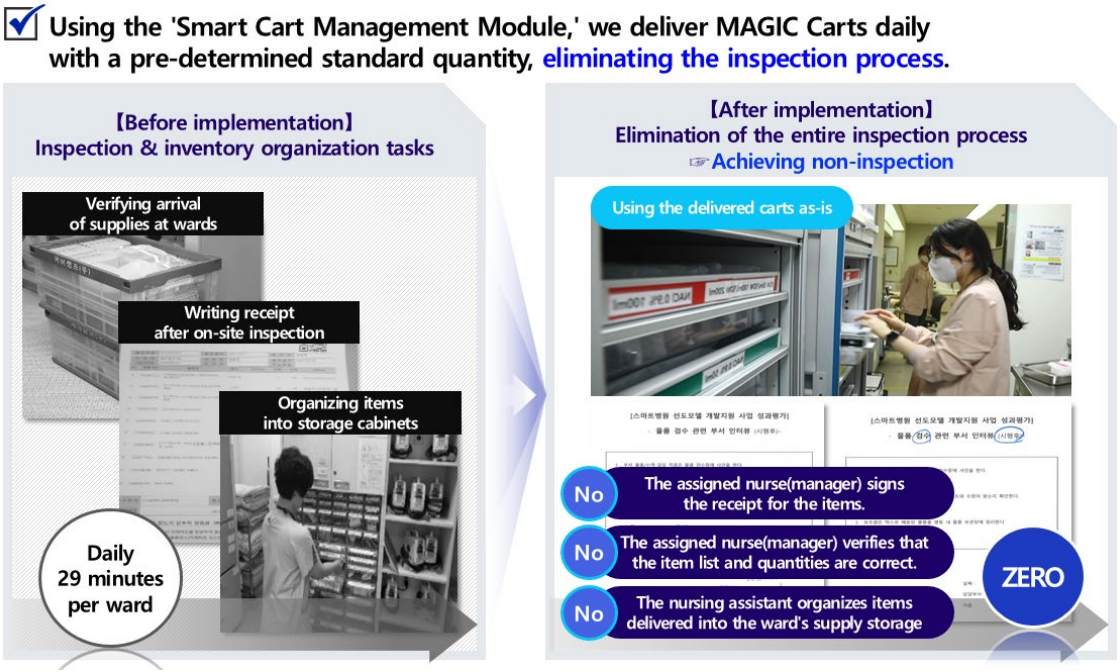


Figure 29. Removal of Inspection Process

- Outcome: Elimination of Inventory Management Process
  - Through the automatic inventory management module, which confirms items as the Magic cart is loaded and returned, we have eliminated the 6.7 minutes per day spent on inventory expiration management tasks per ward.
    - Application of Automatic Inventory Management Module ⇒ Achieved "No Inventory" Environment

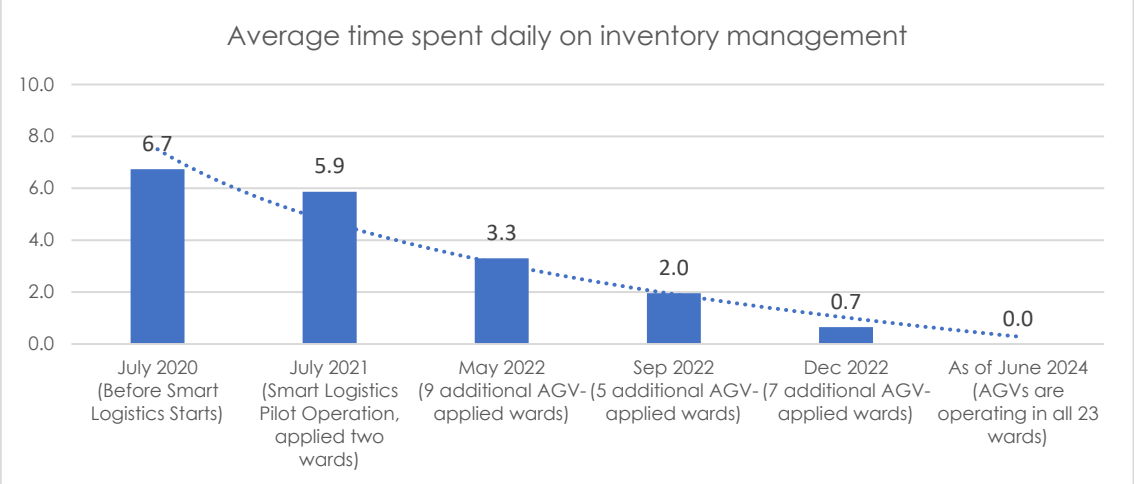


Figure 30. Average time spent daily on the inventory management process

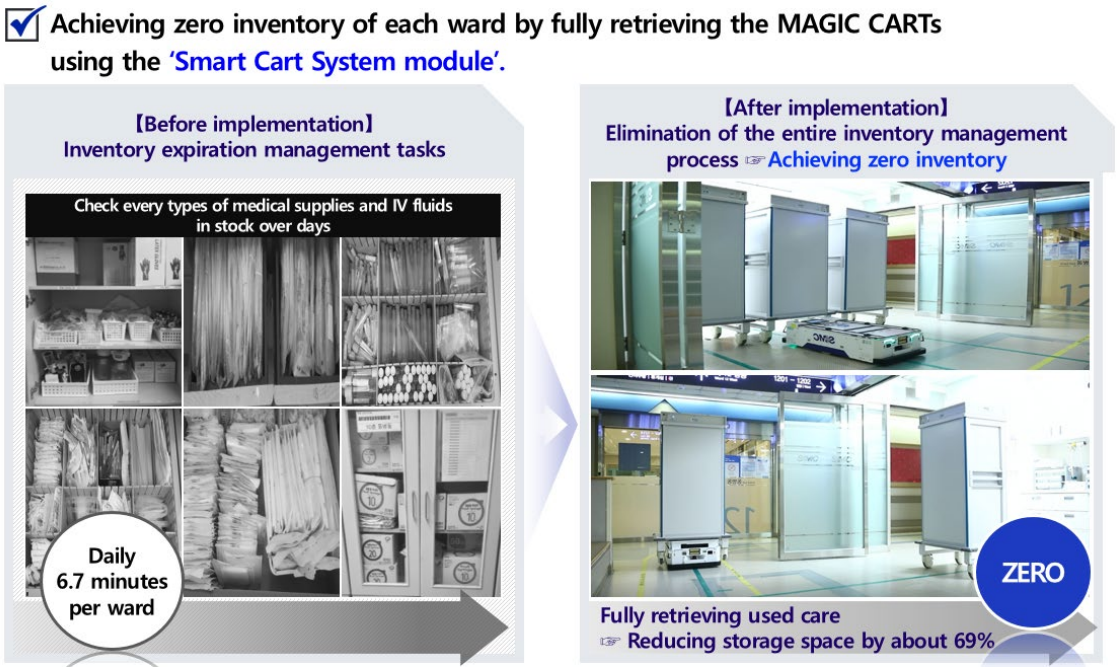


Figure 31. Elimination of Inventory Management Process

- Outcome: Automation
  - We have automated inventory management tasks by utilizing automated logistics delivery robots during nighttime and the automatic inventory management module for final quantity determination during loading and return.
    - Application of Automated Delivery Module + Automated Delivery Support Module + Automatic Inventory Management Module ⇒ Achieved "Automation"

- Outcome: Improvement in Daytime Congestion at Clinical Sites
  - Nighttime automated logistics delivery robots eliminate patient discomfort and infection/safety risks during daytime mail delivery due to overlapping patient paths, outpatient visits, and admissions/discharges.
    - Improvement in Daytime Congestion at Clinical Sites ⇒ Achieved "Improved Patient Satisfaction and Minimized Infection/Safety Risks"

Figure 32. AGVs automatically deliver, Improvement in daytime congestion at clinical sites

- Outcome: Cost Reduction through Standardization
  - Standardizing supply items reduces 85% of the inventory (from 350,319 to 51,987 items) and 87% of the inventory costs (from 460 million won to 60 million won).
    - Standardization of Supply Items ⇒ Achieved "Cost Reduction"

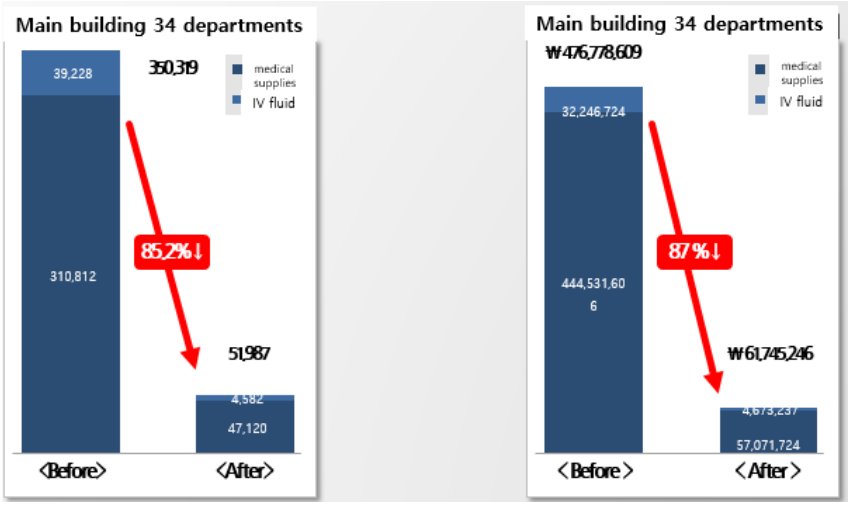


Figure 33. Reduced costs for medical supplies and IV fluid through standardization

- Outcome: Enhanced Space Utilization
  - As MAGIC Carts (5 units) are used as storage cabinets for medical supplies and IV fluids (22units), the storage space area has decreased by 71% compared to the previous setup.
    - Removal of Existing Storage Cabinets + Retrieval of All Used Carts ⇒ Achieved "Enhanced Space Utilization"

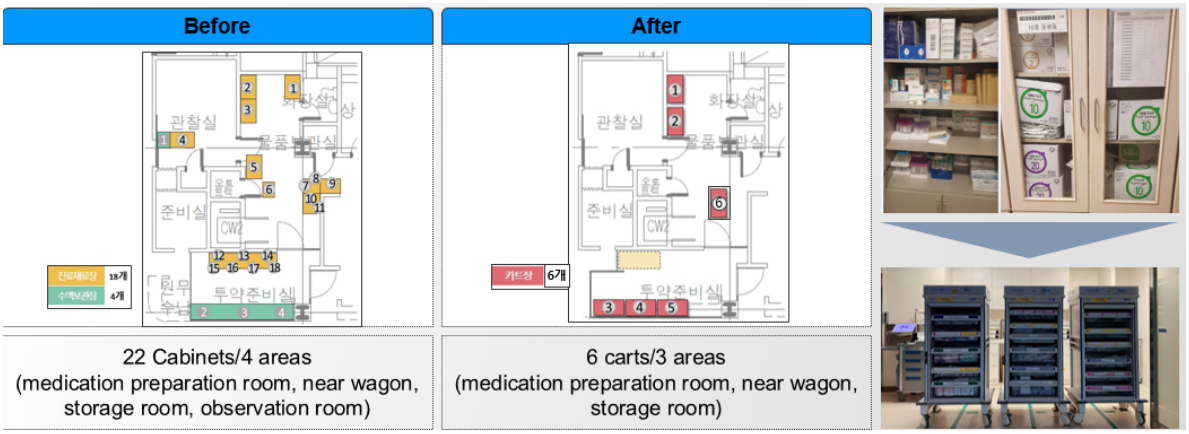
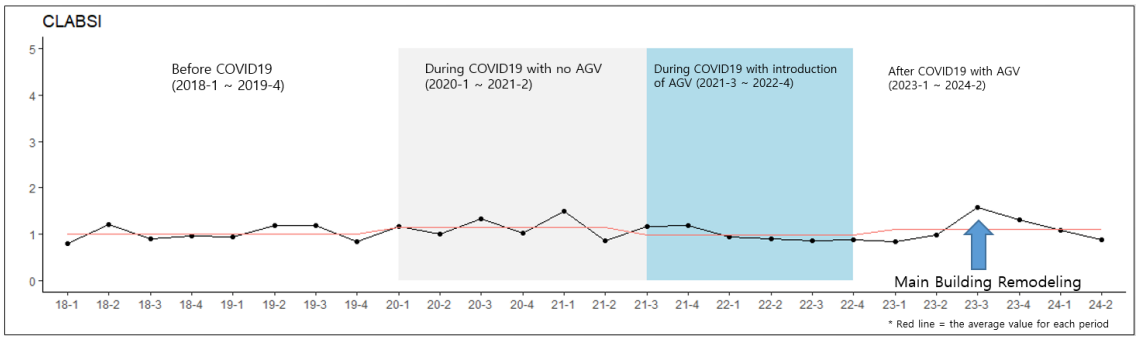


Figure 34. Storage space area has decreased by 71%

- Outcome: Patient Safety Outcomes
  - At Samsung Medical Center, after reviewing the definitions of the five metrics related to patient safety (CLABSI, CAUTI, SSI, CDI, and MRSA), we received expert opinions indicating that only CLABSI is significantly related to patient safety. As a result, we focused on the central line-associated bloodstream infection (**CLABSI**) metric.
  - The CLABSI metric has been improving since the introduction of the robot, but it temporarily increased in mid-2023 due to the suspension of robot delivery during the remodeling of the hospital's main building. Overall, robot logistics can be considered to have a positive impact on CLABSI.

(A) Central Line-Associated Bloodstream Infection (CLABSI) metric



(B) Nursing Workforce Deficit due to COVID-19 Quarantine

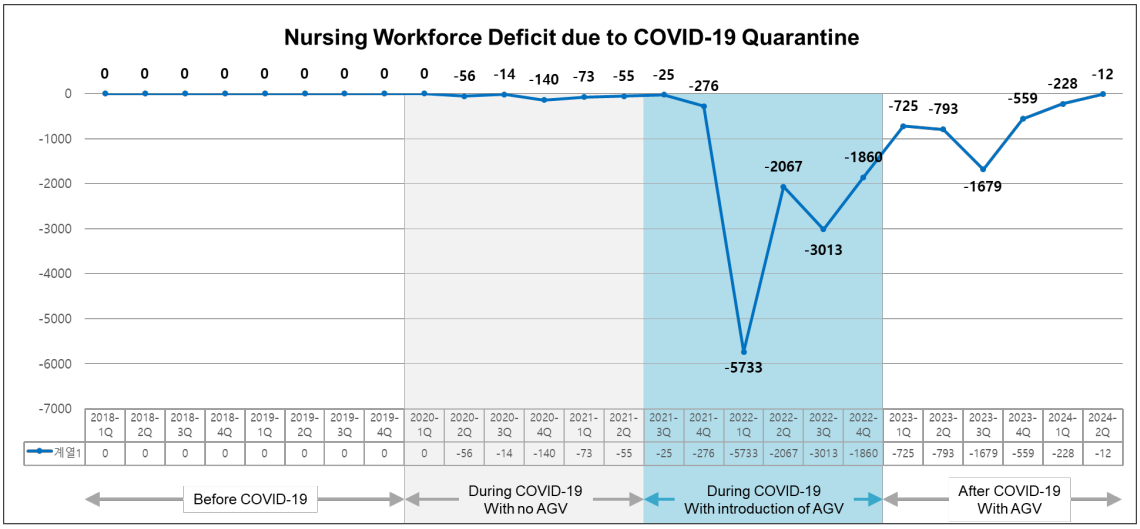


Figure 35. Chronological Metrics for CLABSI and Nursing Workforce Deficit due to COVID-19 Quarantine

- Figures 35 shows that SMC faced a significant shortage in nursing staff coverage due to the high number of nurses who were either confirmed to have COVID-19 or who were quarantined. Notably the graph figures represent only the count of confirmed cases. If the number of nurses who were quarantined due to close contact is also considered, the actual loss of staff was likely even higher.

- The period from Q4 2021 to Q4 2022, the peak of the COVID-19 pandemic, was particularly challenging. Typically, a significant loss of nursing staff would have a negative impact on hospital operations, but SMC was able to maintain normal patient care through the implementation of measures such as the AGV robot, which reduced nurses' workloads. As evidenced by the data, despite staffing restrictions, there was no decline in quality of care.

- In conclusion, Samsung Medical Center was able to demonstrate remarkable resilience during the COVID-19 period, successfully maintaining stable CLABSI rates despite staffing limitations. The implementation of robots led to improvements in the CLABSI indicator, although there was a temporary rise during the main building's renovation when robot delivery was suspended.

Accountability and Driving Resilient Care Redesign

- Management after Standardization
  - The smart logistics system involves a weekly report issued to users based on data. The standard quantity is regularly reset every three months according to recommendations to ensure a sufficient supply quantity and cycle per day. The quantity can also be modified by the medical department.
  -

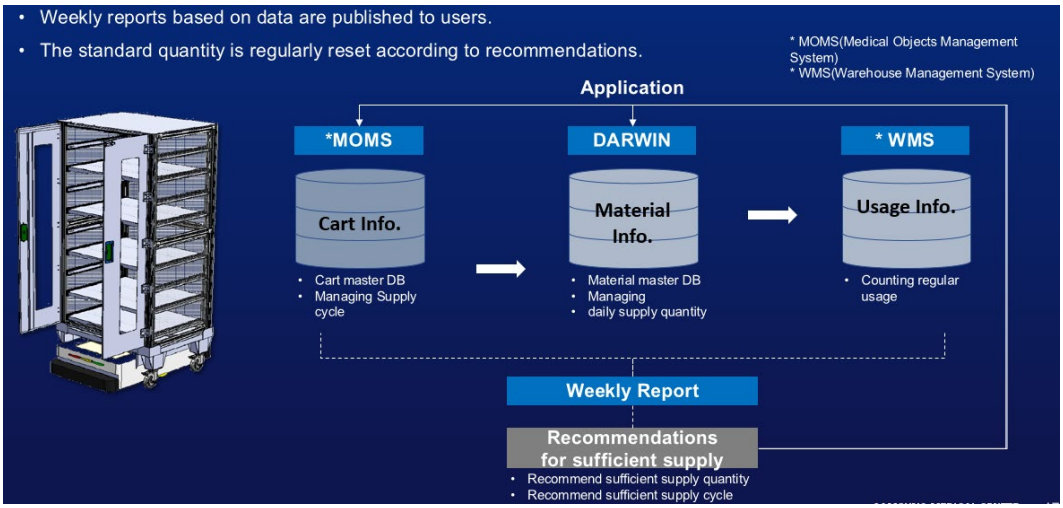


Figure 3635. Management after standardization (process)

  - The screen shown in Figure37 displays the user's view of the standard quantity and can be accessed directly from the department while viewing the weekly usage report. This allows users to view and manage information about the standard quantity in real-time.

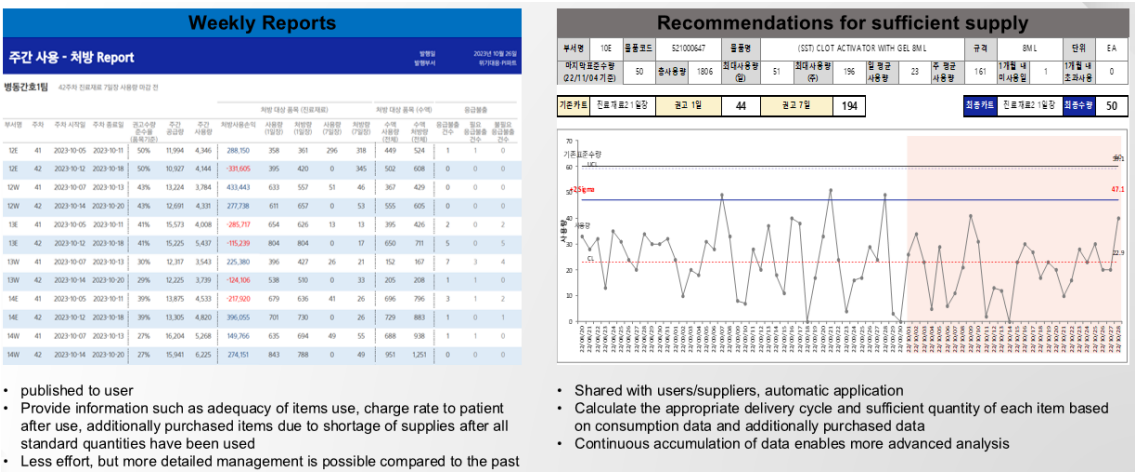


Figure 37. Management after standardization (report)

- For the supply of clinical materials to the wards, a standard-quantity module is used to determine the items and quantities required for each ward, and to establish a standard amount for the supply cycle. Based on real-time data, the algorithm delivers the necessary amount every day or every seven days. The department can adjust the standard quantity temporarily, if needed, and the additional requested quantity is applied. In case of emergency, the emergency withdrawal system provides additional supplies, and borrowing is also possible. This smart logistics system manages quantities based on these three patterns (Fig 38).

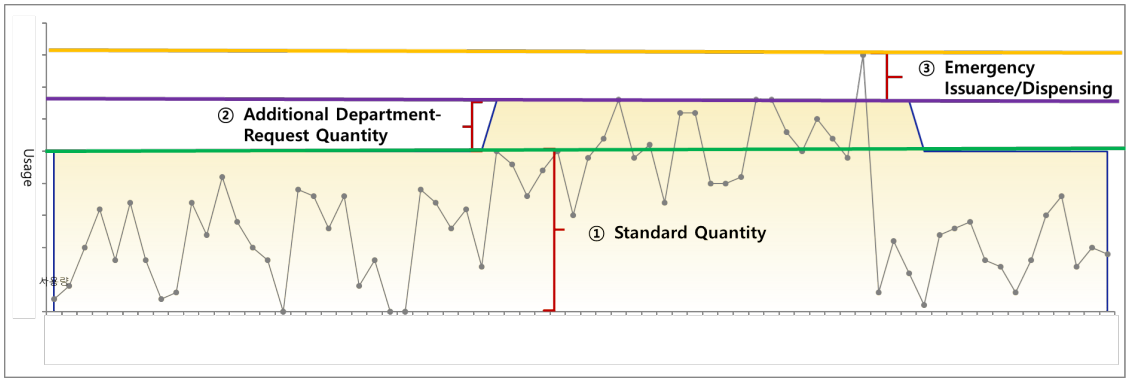


Figure 38. Three management patterns that determine quantities supplied

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HIMSS Global Conference Audience Guidance (This will not be published)

Topic Guidance Check three which apply to this case study

Clinically Integrated Supply Chain

Innovation, Entrepreneurship, and Venture Investment

Process Improvement, Workflow, and Change Management