Supply chain: Inventory management

(In Health care)

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# Definition and scope

Inventory management in the healthcare sector refers to the systematic process of ordering, storing, and utilizing medical supplies, pharmaceuticals, and equipment to ensure that hospitals and healthcare providers can deliver continuous and safe patient care. It plays a vital role in balancing supply and demand, reducing shortages, and minimizing wastage of expensive or perishable items such as medicines, vaccines, and surgical tools. Globally, healthcare inventory management is a key focus area, representing nearly 30% of hospital operating costs, according to the World Health Organization (WHO). Efficient systems ensure timely access to life-saving materials while preventing overstocking that leads to financial losses and expiration of critical products.

# key challenges in health care inventory management:

1. **Demand Uncertainty and Forecasting:** Predicting the accurate demand for various medical supplies is difficult due to fluctuations in patient inflow, emergencies, and seasonal diseases, leading to either overstocking or stockouts.
2. **Complexity and Diversity of Inventory:** Healthcare facilities manage a wide range of inventory items—from pharmaceuticals and surgical tools to implants and consumables—each with different storage and handling requirements.
3. **Regulatory Compliance:** Inventory management must comply with strict healthcare regulations about expiration dates, storage conditions, and traceability, adding complexity to inventory processes.
4. **Cost Management:** Balancing the need for ready availability of critical supplies with budget constraints necessitates efficient inventory control to avoid waste and reduce holding costs.
5. **Supply Chain Disruptions:** Delays and disruptions caused by suppliers, transportation issues, and global events can significantly impact inventory availability and hospital operations.
6. **Integration of Technology Systems:** Legacy systems and lack of integration between procurement, inventory, and clinical systems hinder real-time visibility and efficient inventory management.
7. **Inventory Waste and Expiry:** Managing expiration dates to minimize waste without causing shortages is a persistent challenge given the perishable nature of many healthcare products.

# Business models involved in health care inventory management:

1. **Just-in-Time (JIT) Inventory:** Supplies are ordered and delivered precisely when needed to minimize excess stock and reduce waste. This model relies on strong supplier relationships and real-time monitoring to meet patient care demands without overstocking.​
2. **Periodic Inventory Management:** Inventory counts occur at fixed intervals (daily, weekly, monthly). While simple, it risks inaccuracies and stockouts due to less frequent updates.​
3. **Perpetual Inventory Management:** Continuous tracking of inventory using digital tools like barcoding or RFID; inventory records update in real-time with usage, reception, and transfers. This supports better accuracy and faster decision-making.​
4. **Consignment Inventory:** Suppliers place high-value items on-site but healthcare organizations pay only for what is used. This reduces upfront capital expenditure and risk of obsolescence, commonly used for expensive surgical or diagnostic equipment.​
5. **Centralized Digital Platforms:** Integrating inventory data with procurement, clinical, and finance systems provides transparency and control over stock. Centralization improves forecasting, reduces stockouts, and streamlines workflows.​
6. **Automated Reordering and Alerts:** Using software to automatically trigger reorders when inventory hits preset thresholds enhances efficiency and reduces human error.​
7. **ERP-Integrated Models:** Enterprise Resource Planning systems like NetSuite streamline healthcare inventory management with real-time tracking, replenishment, and reporting that connect inventory with financial and supply chain management.​

# Emerging Technologies in Inventory Management and Their Impact on Accuracy :

**\*Warehouse Management Systems (WMS)\***

These platforms coordinate receiving, put-away, picking, and cycle counting through structured workflows. By enforcing standardized handling and traceable transactions, a WMS reduces record discrepancies and enables stronger alignment between physical stock and system quantities.

**\*Order Management Systems (OMS)\***

OMS solutions consolidate demand signals from multiple channels into a unified view. This prevents fragmented orders and incomplete allocation insights, allowing more reliable planning for replenishment. With tighter control over inbound and outbound flows, forecast stability improves.

**\*RFID and Barcoding Technologies\***

Item-level tracking increases identification accuracy during movement, scanning, or counting. Compared to manual entry, these technologies significantly reduce clerical variance, shorten audit time, and enhance data fidelity throughout the stock lifecycle.

**\*IoT-based Visibility Layers\***

Sensor-enabled storage environments monitor stock condition, motion, and availability. Real-time visibility reduces blind spots, improving the precision of stock counts and location accuracy within the warehouse network.

**\*Automation and Robotics\***

Automated picking, storage, and cycle counting reduce human error and deliver consistent operational discipline. Beyond speed, the principal value lies in record reliability, which directly strengthens forecast alignment and planning stability.

# Growth Outlook

The market size is expected to reach about $15 billion in 2025, with a CAGR of around 8% from 2025 to 2033, driven by growing adoption in developing economies and demand for better patient care.

AI in medical supplies and inventory management is forecasted to grow even faster at a CAGR of 22% from 2025 to 2034, emphasizing the transformative impact of AI technologies.​

Globally, the healthcare supply chain management market, including inventory management, is estimated to grow from $3.93 billion in 2025 to $9.53 billion by 2032, with a 13.5% CAGR due to cost pressures and demand for transparency.

# Major Trends

**AI Integration:** Increasing use of AI to optimize inventory levels, predict needs, and reduce waste is a key trend shaping inventory management.​

**Cloud-based Systems:** Cloud technology adoption is rapidly increasing to improve efficiency, cost savings, and operational resilience, with expectations that 70% of healthcare leaders will adopt cloud solutions by 2026.​

**IoT and Smart Inventory:** The use of IoT devices such as smart shelves, RFID tags, and sensors enables real-time inventory tracking and automated alerts.​

**Supply Chain Traceability:** Blockchain and other traceability technologies are emerging to ensure transparency and compliance.​

**Green and Sustainable Practices:** Growing focus on green logistics and reducing waste within supply chains.​

**Automation and Robotics:** Automated procurement, inventory robots, and specialized logistics like cold chain management and delivery drones are improving supply chain agility and reducing inefficiencies.​

## Main KPIs

# Efficiency KPIs

1. **Inventory Turnover Ratio**

Definition: This KPI measures how many times inventory is sold or used within a specific period, usually a year. In the medical context, it reflects how quickly hospitals or distributors are consuming medical supplies.

**Formula**:

{Inventory Turnover Ratio} = {Cost of Goods Sold (COGS)}/ {Average Inventory}}

In the healthcare sector, a ratio between 5 and 10 is generally considered healthy, depending on the product type (e.g., consumables vs. durable equipment).

Why It Matters:

A high turnover indicates efficient stock movement and lower holding costs, while a low turnover may suggest overstocking or slow-moving medical items. This KPI helps hospitals manage cash flow effectively and minimize wastage due to expired materials.

2. **Days of Inventory (DOI) / Days Inventory Outstanding (DIO)**

Definition:

This indicator calculates the average number of days items remain in inventory before being sold or used. It is the inverse of the inventory turnover ratio.

Formula:

{DIO} = {365}/ {Inventory Turnover Ratio}}

Hospitals and pharmaceutical distributors often target 30–60 days of inventory, depending on demand variability and supply reliability.

Why It Matters:

DIO directly affects liquidity and operational efficiency. Lower days indicate faster movement and better resource utilization, while higher days could signal inefficiencies or an increased risk of stock expiration in medical storage.

3. **Sell-Through Rate (STR)**

Definition:

This KPI measures the percentage of available stock sold or used within a given period, providing insight into demand fulfillment and inventory efficiency.

Formula:

{Sell-Through Rate} = {Units Sold}/ {Units Received} / times 100

An ideal range in medical supply chains is typically between 70% and 90%, ensuring product availability while minimizing excess stock.

Why It Matters:

A strong sell-through rate indicates effective demand forecasting and stock management. In healthcare, it helps reduce the likelihood of product expiration, enhances sustainability, and ensures continuous availability of essential medical items.

## Availability & Service KPIs

1. **Stock Availability (Available to Sell - ATS)**
   * Percentage of inventory available for immediate use.
   * Formula: Stock Availability=Available Inventory/Total Inventory Required×100
2. **Stock Replenishment Efficiency**
   * Measures how effectively stock is replenished to avoid stockouts.
   * Formula varies by system but generally: Replenishment Efficiency=Orders Replenished On Time /Total Replenishment Orders×100
3. **Backorder Rate**
   * Percentage of orders delayed due to stock unavailability.
   * Formula: Backorder Rate=Backordered Items /Total Items Ordered×100

**5.Order Fulfillment Rate (Fill Rate)**

* + Percentage of customer or department orders that are fulfilled completely from available stock.
  + Formula:   
    {Order Fulfillment Rate} = {Orders Filled Completely} / {Total Orders}} times 100

## Accuracy & Forecasting KPIs

1. **Inventory Accuracy**

\*Definition: \* The percentage alignment between recorded stock levels and actual physical stock.

\*Formula:\*

(Accurate system count ÷ physical count) × 100

\*Typical Benchmark:\* Often maintained above the mid-90% range in well-controlled facilities.

\*Why It Matters:\* Higher alignment reduces emergency orders, eliminates reconciliation delays, and stabilizes the base dataset used for forecasting. When record precision is weak, downstream KPIs deteriorate regardless of planning quality.

\*2. **Forecast Accuracy (MAPE / MAPE%)**\*

\*Definition:\* A measure of how closely planned demand matches actual consumption.

\*Formula:\*

|Actual – Forecast| ÷ Actual × 100

\*Typical Benchmark:\* Performance varies by industry, but continuous improvement is expected once data accuracy is stabilized.

\*Why It Matters:\* Forecast accuracy governs procurement timing, working capital posture, and service continuity. Poor alignment forces safety stocks higher and increases cost exposure, while consistent accuracy enables controlled stockholding.

\***3. Lead Time & Lead Time Variability\***

\*Definition:\* Lead time reflects the total duration between order placement and receipt, while variability assesses its fluctuation.

\*Formula (Variability):\* Standard deviation of lead times ÷ average lead time

\*Typical Benchmark:\* Stable operations maintain low variability even where total lead time is moderately long.

\*Why It Matters:\* Forecasting depends not only on quantity precision but also timing reliability. High unpredictability forces excess buffers, inflating holding cost and complicating replenishment cycles.

## Financial KPIs

1. **Gross Margin Return on Inventory (GMROI):**

Measures how much gross profit is generated per unit of inventory investment. In supply chain terms, it reflects how well stock decisions support profitability across sourcing, stocking, and sales.

The formula for Gross Margin Return on Inventory (GMROI) is:

GMROI=Gross Margin / Average Inventory

**2. Carrying Cost % of Inventory:**

Represents the total cost of holding inventory—including warehousing, insurance, depreciation, and capital cost—as a percentage of inventory value. High carrying costs signal inefficiencies in stock turnover or excess safety stock.

Carrying Cost % =( Average Inventory Value / Total Inventory Carrying Costs )×100

**3. Obsolete / Dead Stock :**

Tracks inventory that is no longer sellable due to age, damage, or demand shifts. This KPI is vital for supply chain managers to identify forecasting errors, slow-moving SKUs, and opportunities for liquidation or process improvement.

Obsolete Inventory % = ( Total Inventory Value / Value of Obsolete Inventory )×100

# Operational KPIs

**1. Order Cycle Time:**

This metric tracks the time from order placement to delivery. Shorter cycle times reflect efficient order processing and logistics coordination.

Order Cycle Time= ( Delivery Date−Order Date) / Total Number of Orders Shipped

**2. Perfect Order Rate:**

Measures the percentage of orders delivered on time, complete, and without errors. A high perfect order rate indicates strong execution across procurement, fulfillment, and customer service.

Perfect Order Rate=( Number of Perfect Orders / Total Number of Orders )×100