

SUSTAINABLE HOSPITALS

Hospital Logistics

WHITE PAPER



About this white paper

This white paper presents the Danish concept of Hospital Logistics and ground-breaking solutions that contribute to making Danish hospitals more efficient and improve patient safety and treatment quality. It is part of a series of white papers that show how Danish solutions can contribute to increase efficiency in healthcare while empowering patients and staff.

Danish healthcare innovation is not exclusive for the Danes: many years of global presence show that our healthcare products and solutions create value internationally. Danish ideas and products are used every day in hospitals, medical clinics, ambulances, and nursing homes across the world.

We hope to inspire you and would like to invite you to Denmark to learn more about the Danish healthcare system.

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Executive summary

- Healthcare systems around the world are challenged by an increased share of elderly citizens and chronically ill patients as well as more expensive forms of treatment.
- These factors are causing a significant demand pull in terms of treatment needs as well as expectations, which accentuate the need for our healthcare systems to work smarter on all levels. Therefore, hospitals need to consider means to increase efficiency and productivity in order to be able to treat more patients without increasing costs.

For more than a decade, Danish hospitals and companies have worked together on improving logistics in hospitals. The overall aim has been the creation of just-in-time solutions in order to optimize coordination and efficiency and reduce the patients' length of stay. In Denmark, the focus on hospital logistics has played an important role in achieving a 30 pct. increase in hospital productivity since 2003. This white paper demonstrates the possibilities for hospital logistics within different areas of hospital services and needs, including supply logistics, clinical logistics, sterile goods and sample logistics.

'Just-in-time' logistics

At the New Aarhus University Hospital, a fine-meshed IT system will enable real-time localization of people and equipment right down to room level.

At Aalborg University Hospital, the introduction of a similar and new solution has resulted in a close to 20 pct. efficiency increase.

Danish solutions for just-in-time logistics include systems for locating and tracking staff and equipment, solutions for automating basic and repetitive tasks, as well as solutions for guiding patients around the hospital, all of which help avoid delays and peak times in the hospital process.

Sample logistics

At Hospital of Southern Jutland in Aabenraa, the number of patients has increased by 13

pct., but with the new sample logistics solution, the hospital has managed to cope and even reduce the average length of stay.

Intelligent solutions for handling samples help hospitals reduce their sample turn-around-time and subsequently speed up patient diagnostics. Fully automated laboratories improve sample flow by handling and sorting all blood samples without any manual handling, thereby minimizing the risk of errors and freeing up time for value-adding tasks such as patient related work.

Sterile goods and sample logistics

The Capital Region in Denmark will centralize all handling of sterile goods at two departments at Rigshospitalet and Herlev Hospital.

With fully automated handling of sterile equipment, the two centers will improve hygiene and reduce the risk of infections. At the same time the budget for purchasing and storing sterile equipment will be reduced because of the just-in-time solution.

The future

Integrated logistics is the next step. Automatic delivery of medicine from the hospital pharmacy directly to the wards and just-in-time house-keeping, based on the hospital discharge system, is already a reality in Danish hospitals.

Storage space, which is built directly into the hospital walls, will prioritize short walking distances, large coherent clinical areas and patient related functions.

Denmark is in the process of building 16 new highly specialized hospitals that are all constructed as hospitals of the future, taking into account the changing role of hospitals in our future healthcare system. While optimal hospital logistics is important for all existing hospitals, it is vital for the new, large and specialized hospitals.

We hope that you will find this white paper both innovative and inspiring.



• Bent Hansen
President of the Danish Regions

"A safe and efficient supply chain makes up the backbone in a well-functioning Danish healthcare sector and is of vital importance to the hospitals' employees in order to provide the best possible treatment to the patients."

Foreword

"A safe and efficient supply chain makes up the backbone in a well-functioning Danish healthcare sector and is of vital importance to the hospitals' employees in order to provide the best possible treatment to the patients. Denmark has already come far in terms of optimizing the field of hospital logistics. Now, a historic billion-dollar investment in new hospital constructions in Denmark makes up a unique opportunity in the years to come to create an even more coherent supply chain to accommodate the future challenges facing the healthcare sector."

Bent Hansen, President of the Danish Regions

Denmark strives towards having the best healthcare system in the world. In order to secure and maintain this leading position, and to respond to the increasing pressure on

hospitals for providing even better services for fewer resources, Denmark is investing heavily in a new and modernized hospital infrastructure to create a sustainable and even better healthcare sector for the future.

"Denmark has already come far in terms of optimizing the field of hospital logistics."

The construction and modernization of 16 state and regional funded hospitals together with multiple regional hospital projects creates a need for changing the strategic approach to managing the supply chain including hospital logistics in order to fulfill the potential of the massive investment. Thus, rethinking a safe and efficient supply chain encompassing new as well as established

hospitals is an important agenda in the Danish healthcare system.

The overall ambition is to enhance coherence in the supply chain and improve the interaction between logistical and clinical processes by creating a foundation for hospital logistics upon which it will be possible to cooperate with the suppliers to further develop joint solutions both inside and outside hospitals and eventually across hospitals and administrative units. Ultimately, innovative solutions within hospital logistics and traceability support a successful operating supply chain in the healthcare sector. These solutions prove their potential to increase patient safety and release resources that can be applied in improving care and time spent with patients. And this is only the beginning.

Bent Hansen

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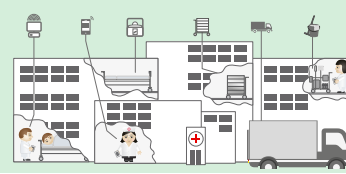
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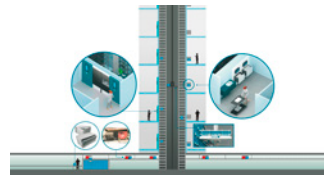
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High performance hospitals are essential for healthcare transformation

Healthcare systems around the world are challenged by an increased share of elderly citizens and chronically ill patients as well as more expensive forms of treatment.

More than a decade ago Denmark launched initiatives to address these challenges, where some of the first initiatives were to increase the quality of treatment and increase productivity at the Danish hospitals. This has led to an increase in hospital productivity by 30 pct. since 2003.

The 2007 structural reform of the public sector in Denmark laid the foundation for a new hospital structure and a new division of labor between primary healthcare and hospitals. Comprising 16 hospital construction projects,

the Super Hospital Programme is a cornerstone in the new Danish hospital structure where a number of small hospitals are merged into fewer, highly specialized hospitals.

The investment in new hospitals is planned to further increase hospital productivity. On top of the agreed 2 pct. annual increases in overall hospital productivity, the 16 Super Hospitals are required to meet an additional demand for efficiency gains of up to 8 pct.

For these highly advanced hospitals to succeed in constantly improving productivity, new processes and technology are required to enable just-in-time delivery of services and equipment and coordination between all specialties and thousands of patients and staff. This is key to some of the productivity gains that have already been achieved, but also to future

improvements and coordination in our future hospital structure.

The Danish hospitals have a great focus on organizational as well as technological development, and the combination of these areas of change offer a perfect opportunity for radical innovation in the field of hospital logistics.

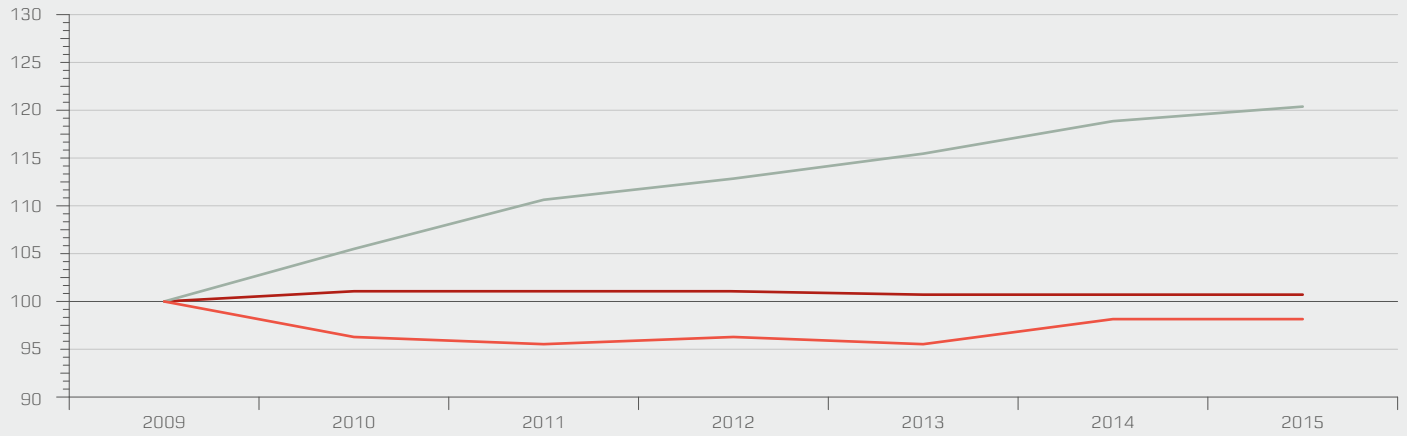
An efficient Danish healthcare sector

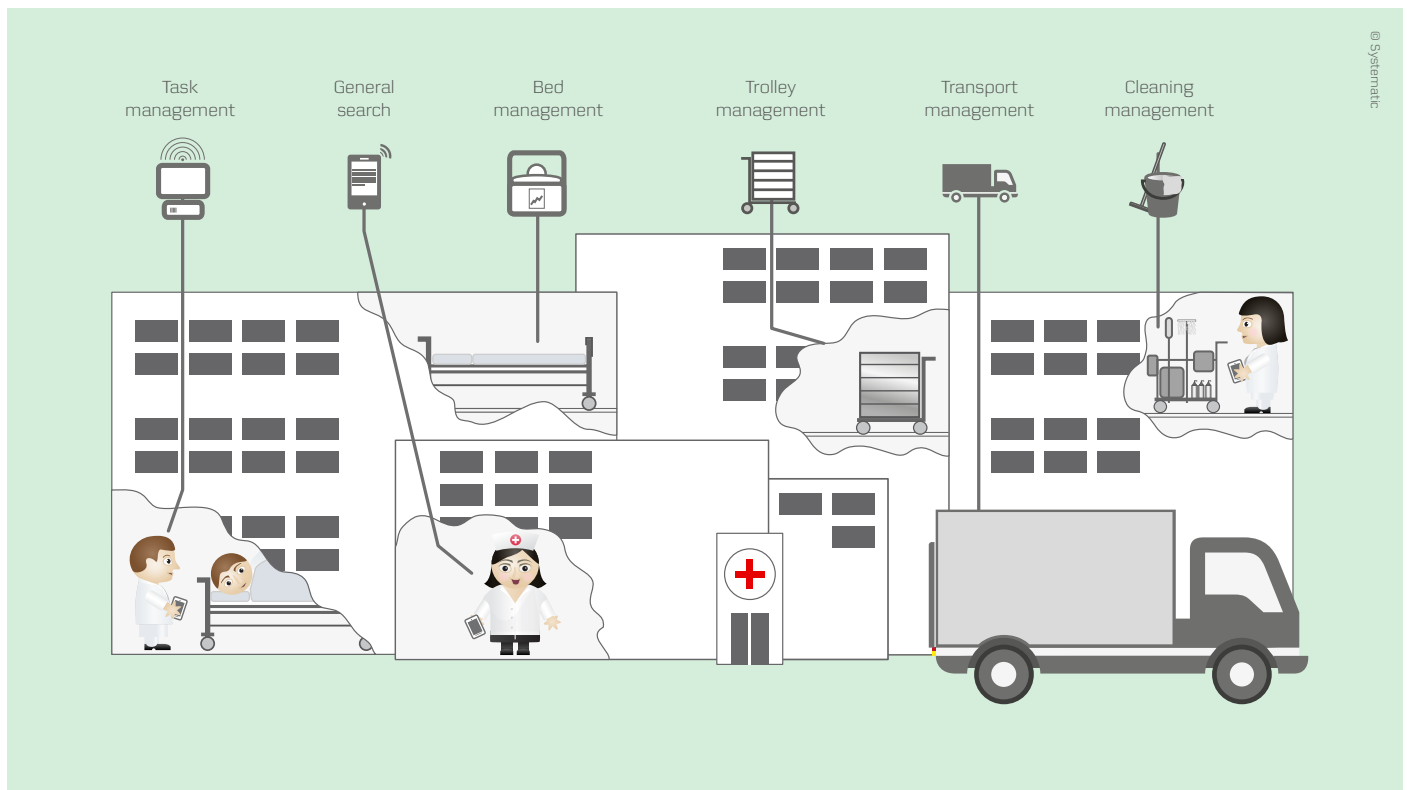
● Patient satisfaction

● Healthcare expenditures
(share of gross domestic product)

● Productivity of
Danish hospitals

Index 2009 = 100





Hospital Logistics – a 'just-in-time' concept for hospitals

A main purpose for establishing the Super Hospital Programme was the need for larger and technologically updated hospitals supporting accelerated treatment. In 2020, the average length of stay in Danish hospitals is expected to be less than three days, and the number of outpatient treatments is expected to have increased by 50 per cent since 2007. Just-in-time logistics will be a key enabler for accelerated treatment, allowing health personnel to be able to focus on their core task instead of searching for colleagues or equipment or waiting for lab results.

Several Danish companies are dealing internationally with complex logistical challenges. Experiences from other industries such as shipping and airport logistics are now being used to design the solutions for the future hospital logistics.

The national solution concept of the future is dealing with these logistical aims:

- Fast handling of samples for analyses
- Provision of services on time and without any errors
- Just-in-time delivery of equipment

The aims are obtained by the use of:

- Knowledge about the location of equipment, personnel and patients
- Transparent task management across the hospital

Service logistics

In ever larger and more complex hospitals, 1:1 communication systems like walkie-talkies and phones have become increasingly insufficient when it comes to service and staff logistics. Resource management in modern hospitals require a high level of transparency across departments, tasks and staff in all functions - from porters and lab technicians



Task Management

Generates transparency and gives basis for optimizations



Transport Management

Real-time overview helps the coordinator



General Search

Tracking of equipment and personnel



Trolley Management

Overview of trolleys across the hospital



Bed Management

Complete overview of all the hospital's beds and optimizes the flow



Cleaning Management

A complete view of all tasks that service assistants have to deal with

to nurses and doctors. Knowledge about the location of resources and transparent task management makes it possible to prioritize tasks based on criteria such as distance or importance, increasing the efficiency of service as well as clinical workflows. Moreover, by having the right information at hand, errors are minimized and quality is increased.

Where is the doctor and the nearest equipment?

Why disturb a colleague, if he or she is busy in an examination room? Then it is better to call a colleague who is available and not waste time searching and disturbing.

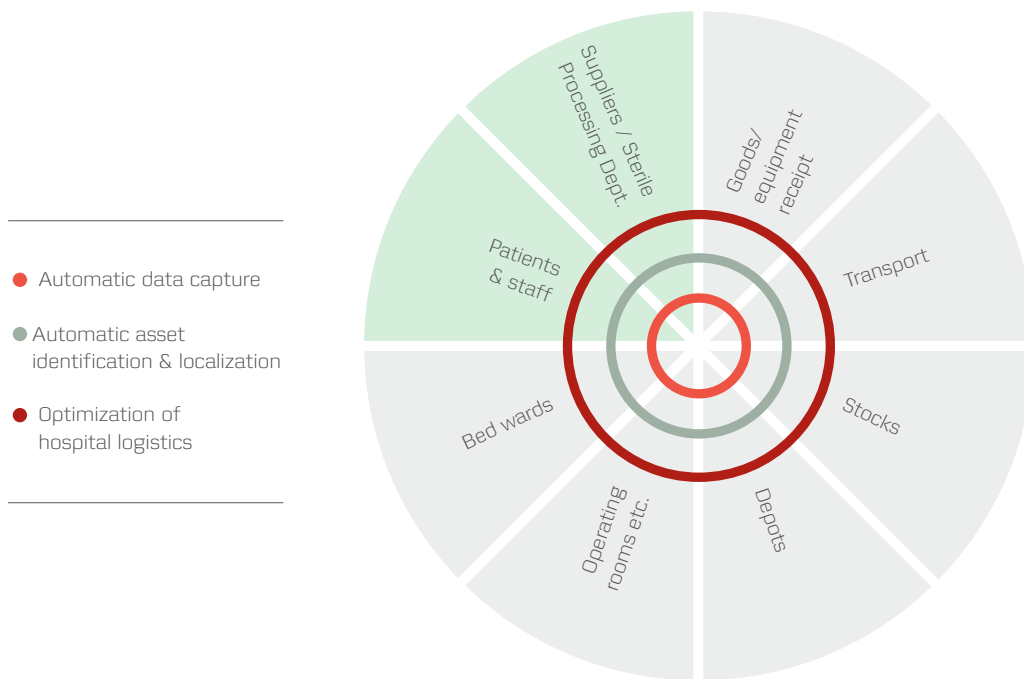
Why spend time looking for basic equipment, when a quick look at the phone can tell you exactly where the nearest equipment is?

Why run to the laboratory with samples, when they can be delivered automatically from the department directly to the laboratory?

These scenarios are ordinary situations that can be solved by systems for locating people and equipment, and solutions for automating basic tasks. More time will be available for patient related tasks. Several different technologies are useful in this regard and different applications can make use of that information.

Patient logistics

Tracking and locating systems are not only useful in terms of locating equipment or personnel. They can also play an important role in optimizing the patient flow by intelligently guiding the patients to the right location on time. By doing this, peak hours are avoided as clinical staff is not wasting time waiting for the next patient. From a patient perspective, such systems also prevent a stressful experience of being lost in a complex hospital environment.



Hospital Logistics at New Aarhus University Hospital

When the New Aarhus University Hospital is completed in 2019, it will be the largest hospital in Northern Europe, spanning approx. 500,000 m² and employing around 10,000 people. To achieve the productivity targets set for a hospital of this size, a Real Time Location System (RTLS) is necessary to support the logistics processes.

Optimal coordination and utilization of resources require careful planning. However, the constantly changing activities in the hospital make this sort of planning difficult. To overcome this challenge, a full real-time overview of the location of colleagues, patients, and equipment in the hospital enables the hospital personnel to locate their colleagues and needed equipment.

At the New Aarhus University Hospital, a fine-meshed IT system will enable real-time localization of people and equipment right down to room level. This visionary system is unique and has a standardized RTLS infrastructure supplied by Lyngsoe Systems and apps supplied by Systematic enabling in-app search

for equipment, bed management, trolley management, and transport logistics optimization between the region's hospital units.

"The Hospital Logistics solution enables us to optimize coordination and supply within the 500.000 m² of the new hospital."

"The Hospital Logistics solution enables us to optimize coordination and supply within the 500.000 m² of the new hospital. The just-in-time coordination is key for us in order to meet the efficiency objectives, which must be fulfilled by the new hospital." - Gert Sørensen, former CEO of Aarhus University Hospital.

The localization of equipment and beds is possible because everything is equipped with different intelligent tags such as paper thin radio frequency identification (RFID) labels, and plastic embedded tags. The advantage of using RFID tags is that it is a low-cost solution for tagging equipment, which

does not require batteries. Other tags with batteries are used for bed status management. Additional functions can be connected to the system, e.g. Wi-Fi technology for alerts or temperature monitoring

• A national reference architecture

A Danish national reference architecture has been established to simplify the integration between the RTLS system and applications in order to communicate and facilitate access to data. The reference architecture has the objective to be a common framework for localization and automatic identification. It is based on international standards (GS1) and ensures a loose coupling between applications and the underlying technology and infrastructure for localization and equipment identification.

The systems are thereby strengthened to ensure that they are able to handle future business demands and outside influences despite changes in the underlying technologies.



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The right patient at the right time at Aalborg University Hospital

The clinical staff at Aalborg University Hospital uses a Service Logistics solution to coordinate and prioritize the movement of patients from wards to operation rooms and treatments - and back to the wards.

The Service Logistics solution ensures fast and timely ordering of patient movements and equipment around the hospital as all service personnel have easy and mobile access to job lists. When an order is placed by the clinical staff to e.g. move a patient, the system ensures that the task is immediately displayed on the task list directly on the service personnel's mobile devices.

Similarly, the person who placed the order can follow the status and prepare the next steps because they know exactly when the patient will arrive.

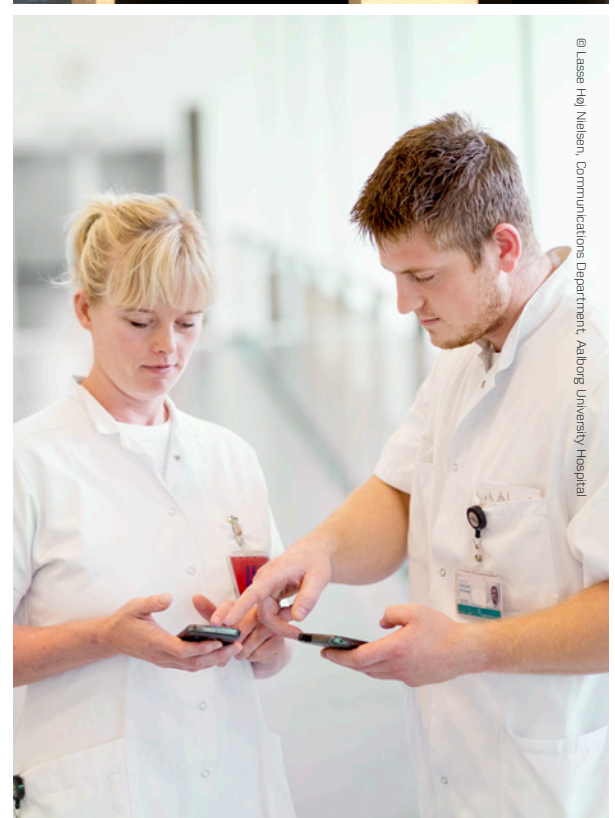
Through the use of real-time location tracking, the Service Logistics solution also knows where all service persons are in the hospital. The same tracking technology can

potentially show the status of all equipment. Hence, delays due to missing service personnel, equipment, or beds not being ready for a patient can be avoided, and the hospital achieves further savings on energy and resources.

The Service Logistics solution also collects valuable information about activities and tasks. The analytics functions of the solution assist management in using the data to further optimize future resource allocations and shifts.

The entire clinical staff at Aalborg University Hospital is using the Service Logistics solution on a daily basis and the introduction of the new solution has resulted in a close to 20 pct. efficiency increase.

Based on the positive experiences and benefits, Aalborg University Hospital plans to expand the use of the Service Logistics solution to support other clinical activities where optimized coordination and real-time information can accelerate the patient flow and increase efficiency.



© Lasse Høj Nielsen, Communications Department, Aalborg University Hospital



• A Flow Master at one of the new Joint Emergency departments using a Clinical Logistics solution to control the flow of patients.

Clinical Logistics – facilitating a structured patient flow

Careful planning of the daily clinical activities, often supported by advanced scheduling solutions, is a necessity in hospitals. However, with a dynamic and sometimes dramatically changing patient flow it is perhaps even more important that workflows and tools are in place to support the coordinating staff in making the proper adjustments to fit a new and more hectic reality.

Emergency care in Denmark was optimized during the period 2009 – 2012, where the concept of Joint Emergency Departments was implemented. Joint Emergency Departments are organized according to new principles, introducing one entry and one phone number, triage of all patients, a specialist at the door (instead of an unexperienced physician) and even with a specialist in the role

of flow master, who will ensure correct treatment and a fast flow of patients in the emergency department.

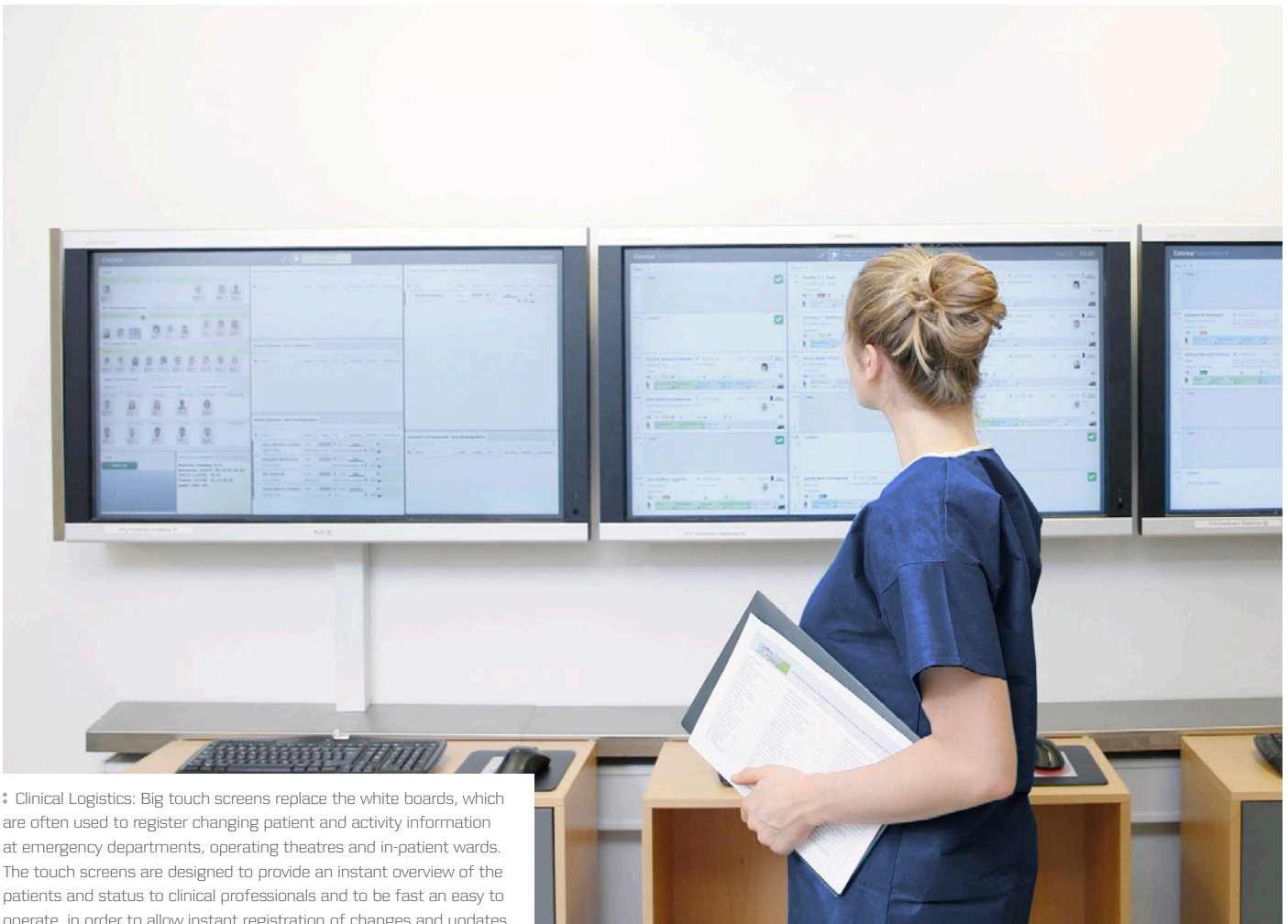
Overview, coordination and awareness of all patients is vital to the success of the new departments and to achieving the increase in patient flow and quality. Those needs are similar to challenges faced by Inpatient Wards, Recovery Units and Operation Theatres in Denmark, where a new concept was introduced a few years earlier – the concept of Clinical Logistics.

Clinical Logistics is a broad term for IT solutions that support the managing of patient and workflows in the hospital. Overview is key and is typically achieved by displaying in- and outbound patient flow data on large touchscreens and workstation monitors. Depend-

ing on the Clinical Logistics solution coordinators and Flowmasters can also overview additional information about the staff on-call and keep up to date with the planned patient treatments and surgery schedules in their own or across multiple departments.

“Depending on the Clinical Logistics solution coordinators and Flowmasters can also overview additional information about the staff on-call.”

However, it is the interactive tools inherent to most Clinical Logistic solutions that make the general concept truly unique. From a variety



• **Clinical Logistics:** Big touch screens replace the white boards, which are often used to register changing patient and activity information at emergency departments, operating theatres and in-patient wards. The touch screens are designed to provide an instant overview of the patients and status to clinical professionals and to be fast and easy to operate, in order to allow instant registration of changes and updates.

of platforms, including mobile devices, coordinators and healthcare professionals can update and adjust the patient information, treatment plans, and surgery schedules, and assign activity and patient responsibilities. Advanced solutions even allow users to order beds, cleaning and patient transports directly from the user interface to promote collaboration and ensure a better patient experience. Consequently, healthcare professionals are offered a single entry to a variety of tools that support the coordination of the daily tasks and thereby ensure a more structured patient flow.

The idea behind Clinical Logistics is that information, knowledge, and system updating should not be handled by a single individual or teams located far from the patients, but instead be carried out by the patient respon-

sible healthcare professionals, who are far better informed about the current situation in the departments.

"As communication and collaboration are at the core of most Clinical Logistics solutions the information is typically shared instantly across the entire system."

As communication and collaboration are at the core of most Clinical Logistics solutions the information is typically shared instantly across the entire system, alerting the clinical and supporting staff of the changes. In addition, integrations with third-party systems

such as ambulance systems, the Electronic Medical Record, booking systems, and patient administration systems, provide even more information from the Clinical Logistics system, limiting the need for multiple system sign-ins, and resulting in more efficient workflows.



• The new Joint Emergency Department at Odense University Hospital.

Improved efficiency in the Joint Emergency Department

Streamlined processes, clearly defined areas of responsibility, and an immediate overview of capacity and availabilities ensure a smoothly running Emergency Department that meets region-wide KPIs.

Since the inauguration of the new Emergency Department in 2012, Odense University Hospital (OUH) has been faced with a higher number of patients than expected and limited resources. However, through process identification, standardization and a better utilization of the existing Clinical Logistics solution, the Emergency Department has been able to reduce the patient waiting time, bring down employee sick leave, and improve the overall flow in the department with more efficient treatment planning.

There are many different ways to improve the workflow in an Emergency Department. In Odense, focus has been on optimizing the already existing work processes.

“There are many different ways to improve the workflow in an Emergency Department. In Odense, focus has been on optimizing the already existing work processes.”

Consequently, steps and responsibilities have been defined and communicated, the use of triage levels during visitation has been streamlined, and capacity conferences

have been initiated using patient and treatment data from the clinical logistics solution. As the clinical logistics system always offers real-time overviews of the current and near-future situation in the emergency and collaborating departments, utilizing this information to plan ahead has proven to make a considerable difference in ensuring efficiency and an optimized patient treatment. A major goal of trying to deal with overloads has been achieved and has thus led to a better experience for patients and employees alike.



Optimizing the patient flow across an entire region

Managing the patient flow is important when running a modern, efficient, and organized hospital today. However, managing the patient flow and sharing patient information across multiple hospitals in a region is what future hospitals require.

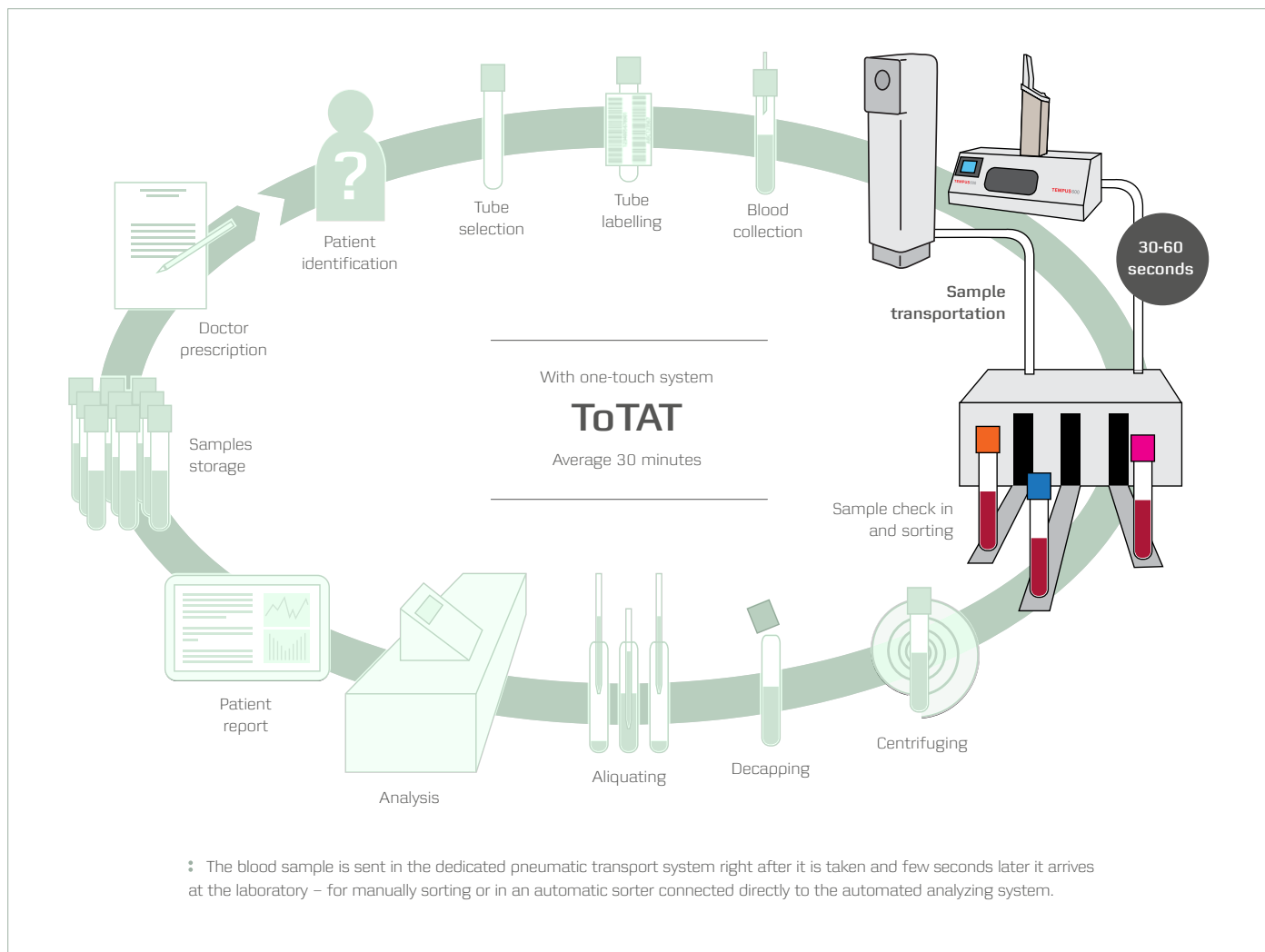
"Managing the patient flow is important when running a modern, efficient, and organized hospital today."

After a few years of running an efficient Clinical Logistics solution in a number of chosen departments, the Central Denmark Region decided to realize the full potential of professionalized patient flow management by gradually expand-

ing the solution to cover more and more departments across the nine hospital locations in the region. A decision that has enabled the region to realize their vision of a more transparent hospital flow with focus on quality, collaboration and a better utilization of resources.

This type of regional setup enables the connected hospitals to access patient information across organizational borders, provides tools for a consistent and streamlined patient treatment, and enables a better incident management with access to capacity information from multiple emergency departments. In addition, the hospitals can also ensure patient safety especially during transfers with clearly defined responsibilities and support each other with improved information and knowledge sharing in meeting regional expectations and established KPI's.





Accelerated patient flow through fast turn-around-time for blood samples

● The transportation time is a major factor in terms of overall efficiency of the blood sample analysis process. Most hospitals work with the concept of turn-around-time (TAT) when measuring their efficiency in processing blood samples. TAT defines the speed of the sample analysis in the laboratory and when this includes high efficient in vitro diagnostics equipment (IVD), the entire analysis process can be carefully measured and controlled.

The challenge is to measure and control the total turn-around-time (ToTAT). ToTAT is a

measuring standard that accounts for the entire process cycle of the blood samples, beginning when the blood sample is requisitioned to the analysis results are available. In today's hospitals, the ToTAT for blood samples can be up to 4-6 hours.

With dedicated and effective logistics systems, it is now possible to have blood samples delivered to the laboratory in seconds without damaging the blood quality. This can potentially reduce ToTAT to approximately 30 minutes.

The new and innovative sample logistics systems are based on pneumatic technology,

which, in combination with robot technology, ensures that blood samples are transported from the point of care to the laboratory in a matter of seconds. This process also ensures that a blood sample is untouched by hand from the moment it is dispensed at the point of care and until the test result is available.

With instant delivery of blood samples to the laboratory, hospitals are able to control ToTAT and subsequently bring it down to a minimum – thereby accelerating patient flow and freeing up resources for treatment.



⌋ Blood samples are easily sent and transported with Tempus600 Vita



⌋ Blood samples are landed in a bulk loader in a fully automatized laboratory



• Susan Boye Nørregaard,
Head of the Biochemistry and Immunological Department

© Bjørn Sørensen, Communications Team, Hospital of Southern Jutland

Fast sample response time at Hospital of Southern Jutland

In 2014, three hospitals merged to form the Hospital of Southern Jutland, and the Emergency Department for all three hospitals was centralized in Aabenraa. This resulted in new demands on the hospital as the number of patients increased and faster turn-around-times (TAT) on results of blood samples was needed. The ambition was to reduce response time to maximum one hour.

Fast transport of blood samples from the departments to the laboratory is a key factor in reducing the total turn-around-times (ToTAT). This challenge was handled by using a dedicated and automatic system for transporting blood samples and connecting the departments directly with the laboratory. The Tempus600 transport system delivers the blood samples directly in the laboratory in an even flow from the departments, which

eliminates manual handling of samples, ensures an even treatment of the samples and frees up resources for patient related tasks. The whole process is fully automated, monitored and IT-supported to ensure that the ToTAT does not exceed one hour.

"Previously, the staff walked from point A to B with the samples, and the process was characterized by manual handling."

"Previously, the staff walked from point A to B with the samples, and the process was characterized by manual handling. The dedicated transport system has resulted in a reduced amount of manual repetitive tasks and staff can stay on the department floors

taking care of the patients instead" – Susan Boye Nørregaard, Head of the Biochemistry and Immunological Department in Aabenraa.

Since the merging of the Hospital of Southern Jutland, the Biochemistry and Immunological Department in Aabenraa has experienced a 13 pct. increase in patient contacts, but with the focus on the ToTAT, the hospital has managed to reduce the average duration of hospital admittance in the Emergency Department.

In 2020, the new Hospital of Southern Jutland is established with an emergency hospital in Aabenraa, a specialized hospital in Sønderborg, and an outpatient clinic in Tønder. To be able to meet the future demands of handling an increasing amount of blood samples and to ensure rapid response time, the hospital plans to implement additional Tempus600 systems





• Incoming lab samples at North Zealand Hospital are automatically unpacked and distributed to the labs by a robot.

The fully automatic laboratory at North Zealand Hospital

● Innovative robot technology enables the North Zealand Hospital to improve workflow and logistics in the Department of Clinical Biochemistry. A new robot, Gibosort, automate the entire process from handling blood sample tubes, performing the analysis, and sending the test results back to the doctor. With this solution, no manual handling is involved from the moment a sample is taken and until the test result is available in the patients electronic record.

Several of the blood samples analyzed in the hospital laboratory come from the general practitioners. The samples are packaged in special boxes and transported to the hospital. Previously, a medical laboratory technician unpacked the transport boxes manually and prepared the tubes for the automatic analysis system. This process is now handled automatically by a robot. The automatic process reduces TAT for test results to approximately one hour.

General practitioners order the analysis electronically and download a requisition with a barcode. When the transport box with the samples arrives at the laboratory, the robot scans the barcodes and sends the samples with a pneumatic tube to the robotic laboratory where the analysis is performed.

"The amount of automation that Gibosort provides is definitely very interesting – and in our hospital, we see a great future potential for this kind of automation."

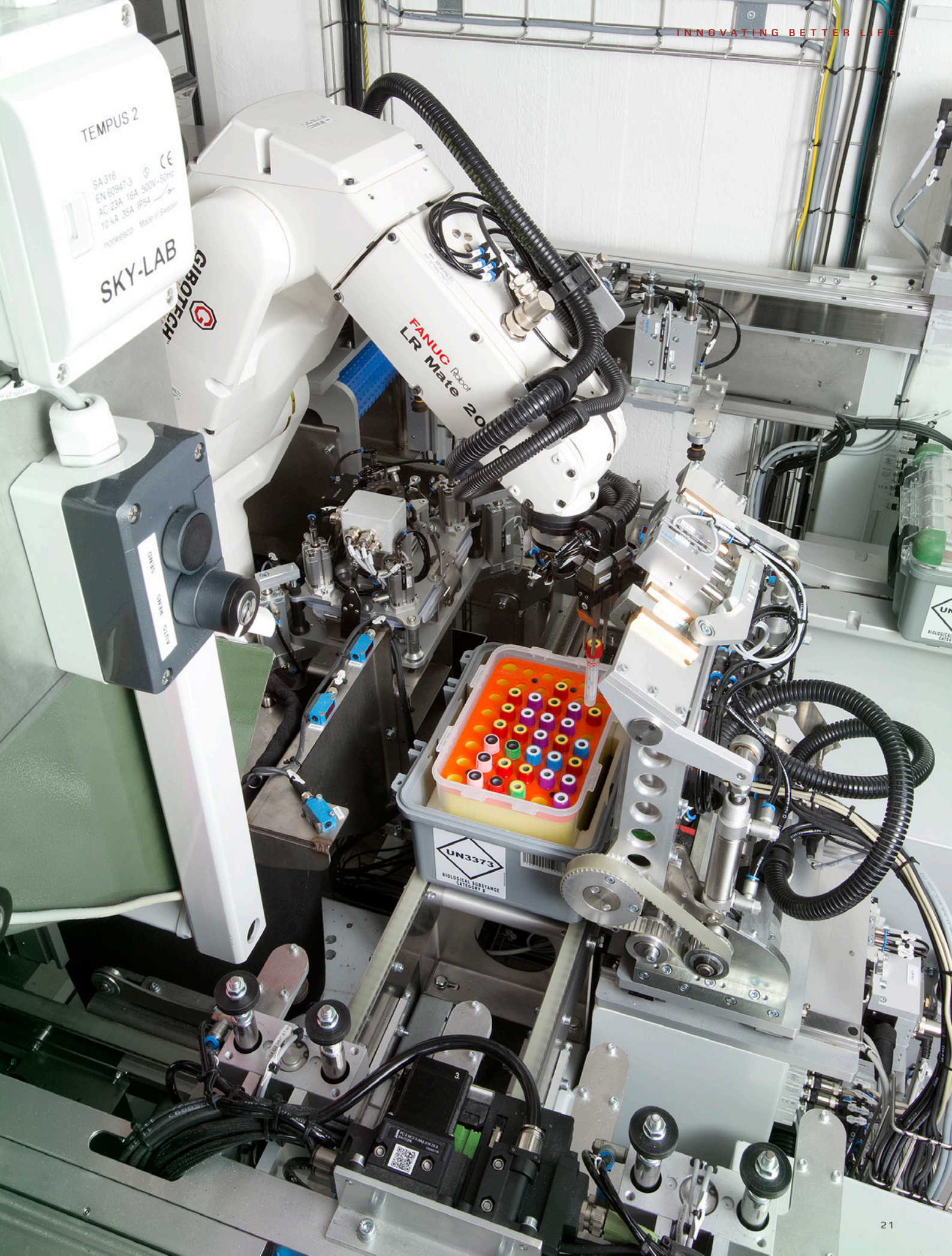
"The amount of automation that Gibosort provides is definitely very interesting – and in our hospital, we see a great future potential for this kind of automation. We are very inter-

ested in innovative and secure solutions that free up resources from administrative labor, which can instead be used on patient related tasks. The safety of our patients is increasing as we are automating the previously manual workflow. It creates more time for our medical laboratory technicians for value-adding tasks instead of sorting blood samples manually"

– Evy Ottesen, Head Laboratory Technologist from the Department of Clinical Biochemistry at North Zealand Hospital.

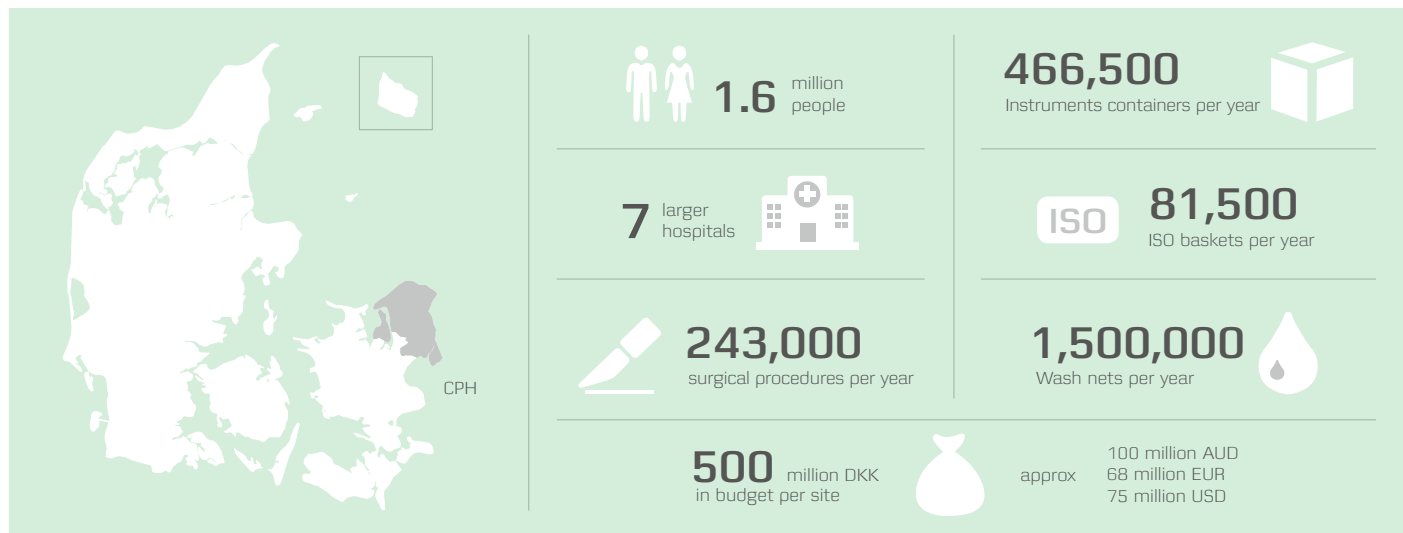
Faster TAT for lab results and faster responses to general practitioners help speed up patient diagnostics, treatment and patient satisfaction.

The system is the first robotized system of its kind installed at a hospital. The system is designed in close collaboration between the North Zealand Hospital and Gibocare.



Automating healthcare with the latest robotic technology

Capital Region of Denmark - Key Figures



Central Sterile Service Departments – efficient and high quality handling of sterile equipment

In the Capital Region of Denmark, the Central Sterile Service Departments (CSSD) for all hospitals in the region will be centralized at two departments in Herlev and at Rigshospitalet respectively. The purpose of centralizing the regional CSSDs is to collect sterile goods from hospitals in the region and process these in fully automated high-performing facilities. The benefits of centralizing the CSSD processes and storage of surgical instruments in the regional facilities are to increase the availability of surgical instruments and to increase the quality of CSSD processes and documentation to a consistently high level with less manual interactions. Furthermore, the automated handling also improves hygiene and reduces the risk of infections.

The two regional CSSDs are fully automatic and use industrial robots to handle manual and repetitive tasks to eliminate manual handling and minimize the risk of errors. The two facilities have identical processes and run repetitive operations in a well-proven concept known from IT data centers. If one CSSD is affected by contamination, fire, flooding, power outage or other incidents, the other CSSD can immediately take over its operations. Both CSSDs are managed by

common control and tracking systems and they are able to handle sterile goods for all hospitals in the region, while they are connected to certain groups of hospitals.

An increased turnaround of surgical instruments is expected with less instruments sitting dormant in local hospital department stocks. Instruments needed for acute cases will still be available from small local on-hand stock for fast response, but the majority of instruments will be in daily circulation through the regional CSSDs.

To make the concept of the regional CSSDs work well, it has to ensure that instruments are available for stakeholders in hospitals whenever needed. Trust in the concept is built and maintained by providing accurate and real-time location and tracking information on the whereabouts of instruments, not just inside the CSSD processes, but also on the logistic trail between the CSSD and hospital departments.

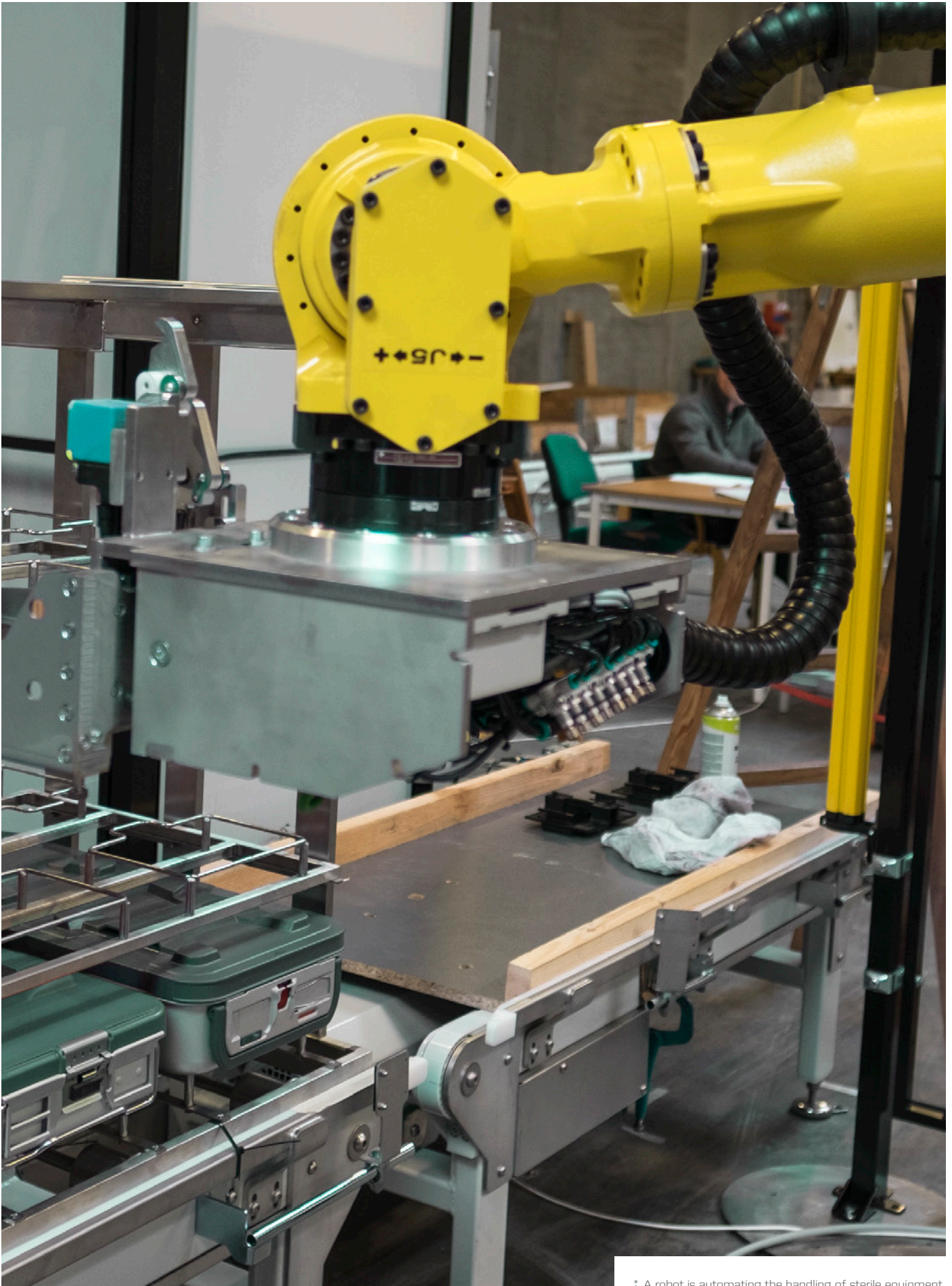
This information is provided by RFID (radio-frequency identification) and barcode technology. Instruments and equipment are carefully registered and a sophisticated database tracks and monitors instruments that enters and leaves the automated warehouse

and keeps a tally on every single shelf space. Since every product needed at the hospitals and the location of each instrument inside the warehouse is registered in the database, an optimized route can be provided for restocks.

Once instruments leave the warehouse, they can be accurately tracked on their way between the CSSD and hospital departments. The sterile goods tracking solution provides objective tracking information that represents the real logistics flow of instruments and is unedited by any stakeholder. Arrival times for instruments can be predicted based on the tracking information and hospital departments can be notified upon arrival of instruments.

The objective tracking information is also a valid input for optimization of logistics processes as it reveals any delays, bottlenecks and performance deviations in the sterile goods flow.

Detailed and specific registration of instruments and equipment can also provide data to increase patient safety through patient related tracing. This way, patients can be identified later, if they need re-treatment due to problems with certain series of equipment or supplies.



⌘ A robot is automating the handling of sterile equipment.



Fully automatic Central Sterile Service Department at Rigshospitalet

As the first hospital in Europe, Rigshospitalet in Copenhagen will implement industrial robots to empty trolleys with sterile goods in the Central Sterile Service Department (CSSD). Gibocare will supply the solution, which automatically removes instrument containers and transport boxes from trolleys.

An internal transport system of automated guided vehicles (AGVs) eliminates all manual moving of containers around the department, and containers and instruments are automatically transported through the entire process of wash and sterilization.

When the containers arrive to the CSSD, they are guided to the manual work stations in the washing area for unpacking.

If transport boxes are empty upon arrival, they are automatically placed in a wash rack for washing.

When the instruments have been examined and pre-washed by operators, they are placed in a wire basket and a wash rack for washing. After washing, the instruments are transported to the work stations in the packaging area where they are prepared for sterilization and placed in an instrument container.

Mini AGVs deliver the containers to a robot cell that loads and unloads the autoclave automatically.

After sterilization, the instrument containers are brought to the automated warehouse.

The automated warehouse at the CSSD at Rigshospitalet holds 12,000 units. When a surgery is planned at a hospital in the region, data from the hospital surgery booking system is transferred to the CSSD warehouse management system. One or more containers and transport boxes are then allocated to the specific surgery, released from the storage, loaded in a trolley for sterile goods and transported to the hospital. In this way, only surgery specific trolleys are delivered to the hospitals, which reduce waste and unnecessary storage of seldom used equipment at hospitals.

CSSD and OR Asset Tracking

ICON DESCRIPTION:

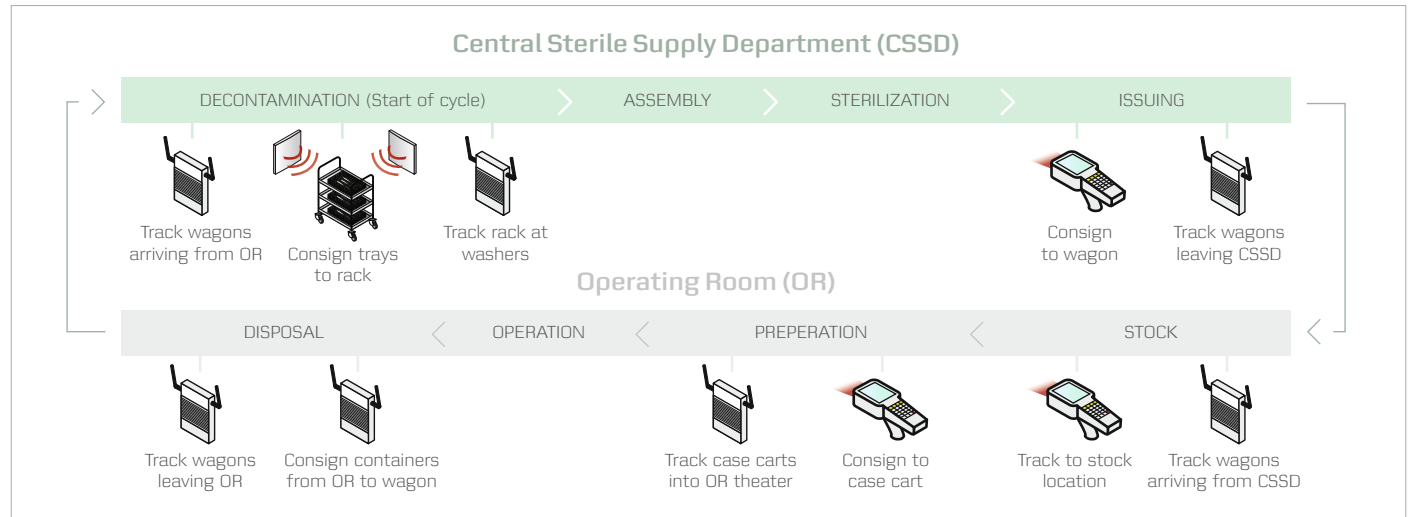
Consignment
Portal



Hospital
Reader



Hand-held
Terminal



Sterile goods Tracking at Herlev Hospital

Lyngsoe System provides sterile goods tracking at Herlev Hospital with a tracking solution based on RFID and barcode technology that automatically records the whereabouts of instruments in the circular flow between the regional Central Sterile Service Department (CSSD) and hospital departments.

All transport racks, wash racks, and sterilization racks are equipped with high temperature resistant RAIN RFID tags and barcodes. The solution tracks all instruments and equipment through the decontamination and assembly process to the automated storage and issuing area, where trolleys for specific operations are loaded onto transport wagons.

The solution tracks the transport wagons all the way from the CSSD exit to arrival at the hospital departments and back to the CSSD. RFID readers automatically record the progress of each trolley to arrival at the operating room.

In the operating room, the use of instruments is recorded by the CSSD management system to complete the sterile goods tracking.

All sterile goods tracking information is presented in standard GS1 data format that can be exchanged among stakeholders and hospital applications. Standard GRAI (Global Returnable Asset Identifier) codes are used for all trays, containers, racks, and transport wagons. GLN (Global Location Number)

codes are used for all tracking locations. The standard data format enables seamless data analysis across the logistics flow between the regional CSSDs and hospital departments.



• New OUH vision for supply logistics

The system handles all types of supplies and equipment. Hospital supplies, equipment, and resources are available where needed or in the immediate vicinity. Ideally everything needed is delivered just in time and everything that might be needed just in case is within range.

Intelligent and integrated hospital logistics

● **The New Odense University Hospital (New OUH), which will be ready by 2025, is constructed with an ambitious vision for the hospital supply logistics: The new logistic solution will drastically reduce the hospital's operating costs and reduce the physical layout of the hospital and thereby ensure large clinical areas with short walking distances and a floorplan that prioritizes clinical and patient related functions.**

"Hospital Logistics is intelligent when the overall logistics system allows clinicians to ensure efficient, smooth and safe patient progress. Thus, intelligent hospital logistics is IT-supported logistics. The planning of logistics is carefully coordinated with operations in the new hospital with emphasis on patient flow and architecture. In this way, it is possible to ensure that the construction of the new hospital is based on the requirements for future patient flow." – Lars Pilekjær, Project Manager, New OUH in 2017.

The New Odense University Hospital plans to implement a new storage concept, which eliminates the need for decentralized depots by integrating storage space in the walls of

the new hospital. The concept is based on a network of conveyor belts and lifts that connects central production support functions such as pharmacy, laboratories, Central Sterile Service Departments, depots, stock delivery, and kitchen with automated storage shafts at each department. The shafts are located for every 25 meters in the building and this physical network is combined with a small fleet of Automated Guided Vehicles (AGVs) as well as a pneumatic tube system.

"Hospital Logistics is intelligent when the overall logistics system allows clinicians to ensure efficient, smooth and safe patient progress."

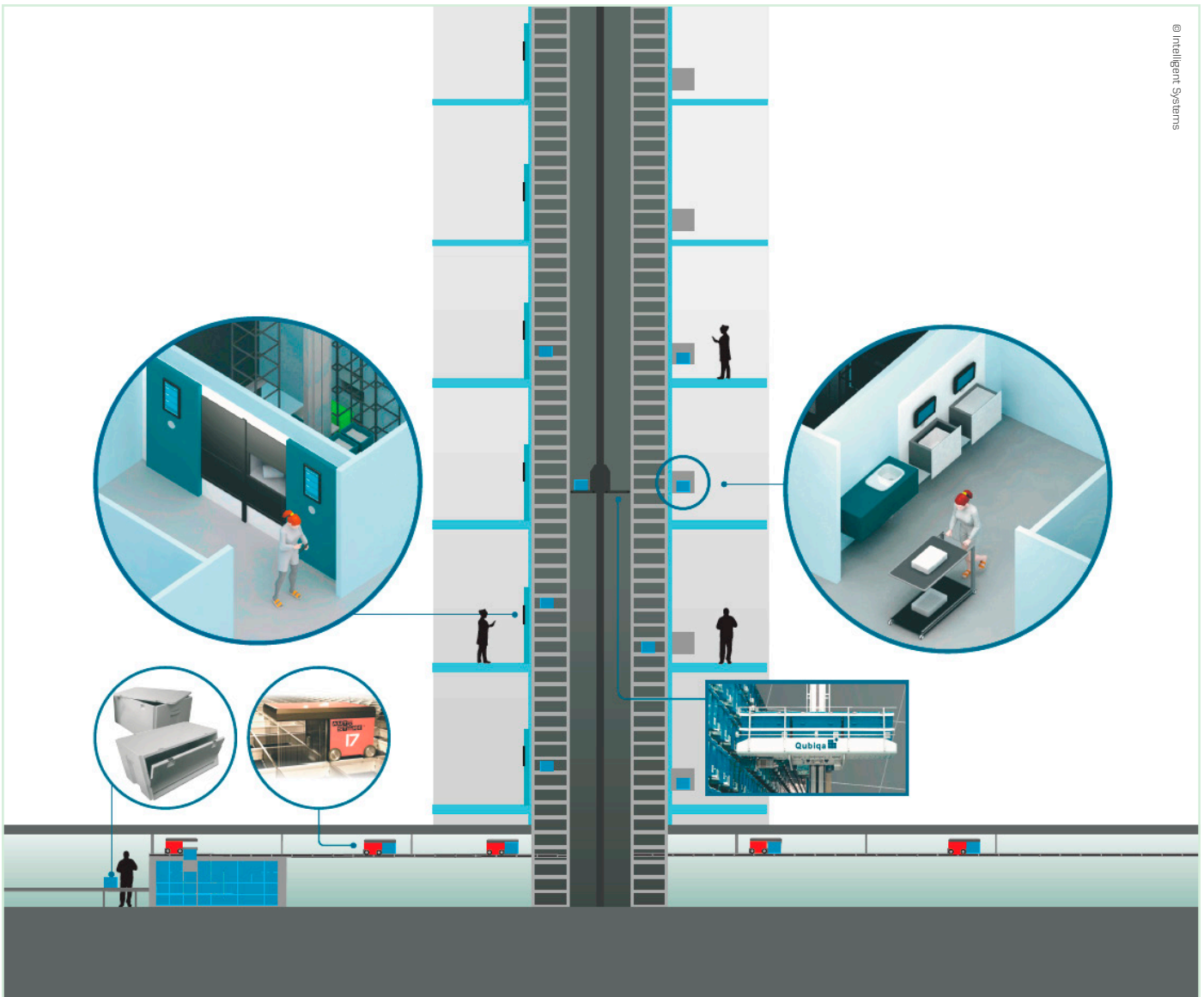
This fully automated storage solution can make just-in-time supply a reality in the new hospital because hospital staff can make orders on their tablet for immediate pick-up at the nearest storage shaft. It is expected that frequently used or frequently ordered items will arrive within a minute and items

seldom used on the ward can be delivered from other parts of the hospital within 5 minutes.

The system can address up to 90 pct. of the internal logistics tasks. Supplies, goods, and equipment no longer take up expensive storage space on every ward in the hospital; instead supplies will be available throughout the hospital from any ward when and where they are needed. Staff no longer has to keep inventory on the ward and manage storage facilities. Time spend retrieving, ordering, transporting, and handling supplies can be reduced considerably, which give staff more time to focus on patient related tasks.

The new concept is expected to reduce stock levels because the complete storage content will be accessible across the hospital - allowing supplies to be shared between departments and wards.

Short and easy access to supplies outlets is expected to shorten walking distances for the clinical staff.



: New OUH logistics and supply system

Makes supplies available throughout the hospital from any department **when they are needed and where they are needed**.

Significantly reduces risk of cross-contamination and infections by separating clean from unclean, encapsulating materials during transport and storage and restricting access to storage space.

Reduces time and resources spend finding, ordering, transporting, and handling supplies by automating logistics and allowing clinical staff to focus on patient related tasks.

Improves working environment by reducing need for manual lifting and handling of supplies.

Can be used for almost all types of supplies that can fit in the transport boxes – replaces the need for several transport and storage systems with **one shared transport and storage system**.

Reduces storage space needed by utilizing the full building and floor height for storage.

Reduces waste by providing an always up-to-date inventory of all stored supplies and allowing older supplies to be used before they reach expiration date.

Is **reliable, redundant** and **robust** in its design supporting hospital operations and emergency procedures..

Reduces stock by making the complete storage contents accessible from any department allowing supplies to be shared safely between departments.



AGV takes over distribution of chemo therapy

Two years ago, the Oncology Department at the Hospital of Southern Jutland in Sønderborg had to relocate. From being situated directly above and in direct connection to the laboratory that administers the chemo therapies, the department relocated two tower blocks away and three stories up from the laboratory. Transport needs increased since delivery times for chemo therapies went from 15 seconds to over 10 minutes.

To overcome the increased transportation times, the Hospital Pharmacy opted to try a MiR100 based Automated Guided Vehicle (AGV) solution from Mobile Industrial Robots to transport medicine back and forth. This frees up staff to focus on patient related work instead.

The AGV, dubbed 'Ejnar' by hospital staff, safely navigates through the complicated

hospital environment of beds and patient traffic and is even capable of taking the elevator on its own. If it gets stuck, it automatically sends a text to department staff who can reroute or remote control it via their smartphone. Once it reaches the department, it calls out for staff to let them know. The medicine is carried in drawers, which are accessed by code to avoid the use of keys.

Ejnar has become an integrated part of the hospital environment and it is not uncommon to hear patients yell out "Hi Ejnar!" at the AGV or even talking to it when it passes in the hallways.

Financially, the ROI (Return of Investment) of the AGV was no more than eight months.

The first AGVs in hospitals were typically used to transport goods through basement corridors but with the positive ROI and experience

of using AGVs to also distribute medicine directly to patient areas, the Hospital of Southern Jutland expects to expand with more of this type of AGV in the future.





Always a clean bed

Housekeeping in hospitals is a critical function, as focus on hygiene standards and their influence on infection control in the hospital environment increases. Housekeeping is also under constant pressure to reduce cost without compromising the standard of cleaning.

As patient flows in hospitals accelerate, the demand for more flexible cleaning standards and methods increases to ensure that hygiene standards are constantly met.

Systematic and Aalborg University Hospital are considering a new solution to support the hospital housekeeping. The solution is digital and transforms today's paper-based planning of cleaning tasks into a flexible real-time platform where cleaning tasks are scheduled and executed in close collaboration with the departments of the hospital.

The solution can potentially make the cleaning of rooms dependent on discharge messages from the patient administration system and is the first step towards just-in-time cleaning. This means that the service department moves from procedures of very little flexibility to procedures based on organic and dynamic workflows.

The system uses machine learning to predict the daily workload and thereby the status of the different cleaning plans. This supports the management in re-allocating resources throughout the day to optimize the cleaning efforts across the hospital. The result is better cleaning at a lower cost because it is possible to focus on critical cleaning tasks and postpone non-critical cleaning tasks and at the same time keep electronic documentation.

The project is one of the first to focus on housekeeping and provides the service department with modern digital support to optimize the overall hospital logistics.

partment with modern digital support to optimize the overall hospital logistics.

: Cleaning logistics includes:

- Registration of cleaning plans
- Grouping of tasks to support the organization forms that are specific to the hospital
- Smartphone-based viewing, updating and adding tasks
- Smartphone-based support for local collaboration and re-planning
- Monitoring of progress to support re-planning
- Real-time cleaning status to support best in class audit of cleaning quality

Innovative Hospital Logistics from Denmark

For more than 100 years, Denmark has been a world leader in logistics. Since the change from sail to steam powered transportation in the early 1800s, Danish companies have been driven by an innate desire to provide their products and services all over the world and consequently, they have perfected efficient logistics systems to be the world's best.

Globally renowned Danish companies like Maersk, Lego, and Vestas are world leading experts in complex logistics services that carry a significant part of the world trade among continents, supply small colorful bricks for children all over the world, and commission the world's largest wind turbines, all in even the most remote parts of the world.

Danish logistics system solutions also play a vital role in supporting the logistics in a large part of the world's airports and Danish logistics system providers measure and ensure visibility and quality in 80 pct. of the largest homogeneous supply chain in the world – the postal logistics systems.

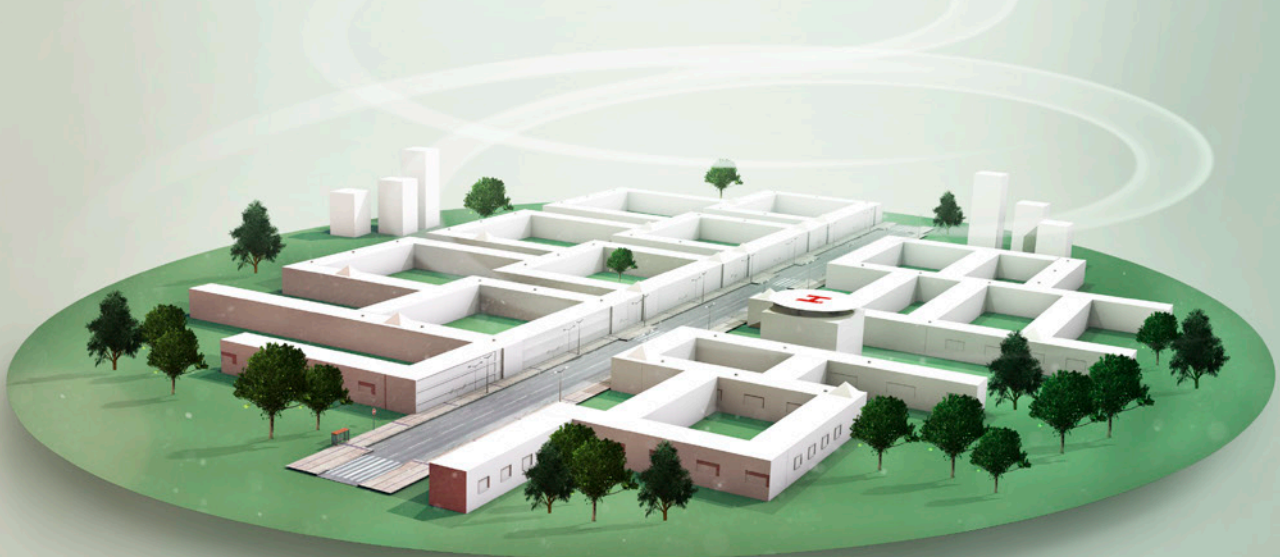
When this international logistics experience and know-how from other industries is matched with a healthcare sector that is known for a century long focus on

public-private cooperation, unique things happen and new concepts are created.

The central driving force behind the innovation is the need to transform Danish healthcare and to re-define the role of our hospitals in our future healthcare system. The transformation began almost a decade ago with the structural reform of the public sector in Denmark. The reform created a need for solutions and concepts that optimize hospital efficiency and a logistics set-up that enables very large and highly specialized hospitals to operate with maximum efficiency.

Through this perfect storm of needs for new solutions, know-how from other industries, and a tradition for public-private innovation, the concept of Hospital Logistics that we have presented in this white paper, became a reality. But it is not only a concept. In this white paper, we have also presented cases and experiences from hospitals, where these new solutions are implemented.

Contact Healthcare DENMARK if you want more information about hospital logistics or if you want to follow the next level of innovation within this concept. You can also request a delegation visit on the Healthcare DENMARK homepage if you want to visit Denmark and the hospitals presented in this white paper.

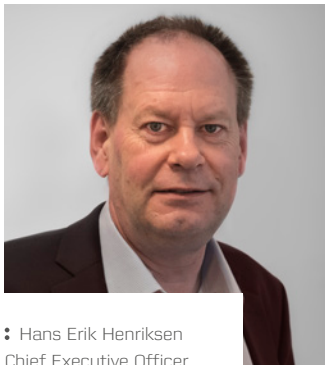


• Hospital Logistics create just-in-time solutions everywhere in the hospital and this is achieved by combining a wide range of know-how and technology with in-depth clinical insight and expertise.

Danish strongholds are based on the world leading position that Danish companies have achieved in other industries like postal and airport logistics and the Danish tradition for close public-private innovation.

About Healthcare DENMARK

Healthcare DENMARK is the international gateway to Danish healthcare expertise and innovation. Our aim as a non-profit public-private partnership is to internationally benchmark Danish best practices within healthcare.



• Hans Erik Henriksen
Chief Executive Officer

The goal of Healthcare DENMARK is not to sell or promote any specific products or solutions, but to communicate the strongholds of Danish healthcare. We do this by attracting health politicians, decision-makers, and journalists to experi-

ence Danish healthcare solutions in practice and meet the people behind. Our network is an extensive pool of public sector, private companies, and other actors in the area of healthcare – all dedicated to providing excellent and efficient healthcare as well as sharing best practices across borders and professions.

"In Denmark our focus on putting the patient first – combined with efforts to improve efficiency and quality – has resulted in a wide array of innovative solutions. I sincerely believe Danish solutions and expertise can have a positive impact on global health." - Her Royal Highness Crown Princess Mary of Denmark

If you would like to learn more about our world-renowned healthcare, we can assist you with tailoring a visiting program, setting up



• HRH Crown Princess Mary of Denmark
patron of Healthcare DENMARK

meetings, and arranging access to otherwise off-limits areas and people within both the public and private sectors, as well as assist you with local accommodation and transportation.

Healthcare DENMARK has a national and political mandate to provide this service to politicians, relevant top and management level professionals, and journalists working with healthcare.

Backing this public-private initiative is a partner group of both public and private key actors within Danish healthcare, including the Ministry of Health, the Ministry of Foreign Affairs of Denmark, the Ministry of Industry, Business & Financial Affairs, Danish Regions, Region of Southern Denmark, the Confederation of Danish Industry, the Confederation of Danish Enterprise, Falck, KMD, Systematic, OpenTeleHealth, Copenhagen Healthtech Cluster, Public Intelligence, and Vendlet.

Her Royal Highness Mary, Crown Princess of Denmark is patron of Healthcare DENMARK.

Visit www.healthcaredenmark.dk to learn more about some of the world's best and most innovative healthcare providers and companies or to request meetings with the stakeholders who are future-proofing healthcare sectors around the world.



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