

COMPREHENSIVE ANALYSIS OF INTERNAL TRANSPORT OF PATIENTS TO DIAGNOSTIC TESTS

JERNEJ JEREB,¹ HILDA MAZE,² ROMAN PAREŽNIK² &
BRIGITA GAJŠEK¹

¹ University of Maribor, Faculty of Logistics, Celje, Slovenia.

E-mail: jernej.jereb@student.um.si, brigita.gajsek@um.si

² College of nursing in Celje, Celje, Slovenia.

E-mail: hilda.maze@guest.arnes.si, roman.pareznik@gmail.com

Abstract The subject of the study was a hospital with about 700 beds and 2.000 employees, where more than 30.000 patients are treated annually. More than half of the employees are employed in the field of nursing. The hospital has recently faced a shortage of nursing staff, resulting from both increased needs and the departure of employees due to unfavorable working conditions. The hospital is trying to deal with this problem from time, employee, and patient perspectives. We have analyzed the structure of time spent at work and care for employees' health while not forgetting about the patient's well-being, dignity, and safety. We focused on transporting patients for diagnostic tests to the diagnostic rooms. We found that the greatest potential lies in improving the software support to the entire internal transport process.

Keywords::

hospital,
transport,
ergonomics,
time,
dignity.

1 Introduction

With a growing ageing population and workforce trend, there is an increasing challenge for the quality and sufficiency of health care services (Ilmarinen, 2006). The pressure on hospitals is increasing in terms of a more significant number of patients, who are also elderly on average. At the same time, it is becoming increasingly difficult to retain employees and acquire new employees.

Hospitals are an extremely dynamic and live system, within which as much as 46% of all costs come from logistics-related activities. Hospital internal transport is required to provide diagnostic services in medical treatment that cannot be performed in different hospital departments but only on specialized diagnostic departments, which offer services for all other departments. In most hospitals, transportation is poorly managed and coordinated. This increases the cost of hospital care because, for example, the patients do not come to the examinations on time, not forgetting the patient's discomfort. (Hanne, Melo & Nickel, 2009)

With a growing ageing population and workforce trend, there is an increasing challenge for the quality and sufficiency of health care services (Ilmarinen, 2006). Hospitals face many problems, such as the lack of workforce and high incidence of work-related injuries, which eventually affect the efficiency of patient transfer in hospitals (Daynard et al., 2001; Hendrich and Lee, 2005; Dutta et al., 2012). Work-related musculoskeletal disorders (WMSDs) are prevalent among nurses (Schibye et al., 2001; De Castro, 2004; Weiner et al., 2017). Recent statistics showed that nursing assistants were one of the seven occupations with the highest occurrences of nonfatal injuries and illnesses in the U.S. (Bureau of Labor Statistics, 2013) and was listed as a high-risk occupation for overexertion injuries (Putz-Anderson et al., 1997). Specifically, in 2013, WMSDs related cases in both nursing assistants and registered nurses combined had the highest incidence rate out of all occupations at 142 cases per 10,000 full-time workers, compared to a national average of 38 per 10,000 in the U.S. (Bureau of Labor Statistics, 2013). In the long run, WMSDs grow to be a larger concern as injuries such as lower back pain develops into a chronic disease that affects quality of work life, mental and physical health (Marras & Karwowski, 2006), with subsequent economic costs borne by healthcare organizations (Katz, 2006).

On the one hand, we have hospital staff who break down under the burden of the difficulty of supporting patients during patient movements and transports. On the other hand, we have patients who want to maintain their dignity through the process. Maze (2017) stated that "Illness reduces a persons' ability to maintain dignity and privacy, even though they want to have it right at a time when they are helpless and sick. Patients are supposed to be independent arbiters of meeting their needs, which means that nurses are supposed to meet their expressed needs in the process of medical treatment." When renovating and improving processes, it is crucial to maintain and improve the level of the dignity of patients.

Another important aspect is the planning of transport processes. Planning must provide sufficient time for the safe implementation of patient movements and their transports, including activities to ensure patient dignity. On the other hand, time windows must be planned so that there are no waits, which make the process costly and, at the same time, lower the level of quality of execution for the patient. Planning processes are based on exchanging necessary information, which must be done rationally so as not to take too much of the available time for administration purposes. Today, information and communication solutions are available for this purpose, slowly displacing telephone conversations and filling out paper forms.

In theory, there is no such holistic approach to renewing processes in hospitals, which gives our contribution original value. In the chapter theoretical background, we describe scientific findings of planning of internal transport of patients to diagnostic tests, dignity, and technical aspect of transport implementation. The methodology is original because it describes how someone should approach holistically to renew processes in a hospital environment. Results report measured values and observed facts from practical work in a sample hospital. In the discussion, we analyse the results and answer research questions. We conclude the paper with a proposition for further research work.

2 Theoretical background

In the chapter theoretical background, we describe scientific findings of planning of internal transport of patients to diagnostic tests, dignity, and technical aspect of transport implementation. In this way, we gain an insight into the latest state of research and at the same time try to present in one chapter a holistic view of the process of internal transport of patients in the hospital from several aspects.

2.1 The planning of internal transport of patients to diagnostic tests

Diagnostic tests are among the most frequently visited hospital services by both inpatients and outpatients. Trained employees usually escort patients with limited mobility to the required diagnostic tests from and back to hospital departments. Internal transport of patients is carried out with wheelchairs, beds, or gurneys (Hanne, et al., 2009).

The organisation and planning of the internal transport of patients is one of the logistical activities carried out daily in the hospitals. Nevertheless, the impact of these logistical activities on hospital costs and the quality of health care is important (Hanne, et al., 2009).

In most cases, hospitals have the Central Patient Transport Department (PTD), which is responsible for coordinating, organising and carrying out the internal patient transport. The main task of this section is the dispatch service, which receives requests for the transportations of patients (Hanne, et al., 2009).

The request for patient transport is usually made by the hospital department ordering transport by calling the PTD dispatcher and telling them necessary information about the patient, point of origin and destination, and other important transport requirements. The dispatcher's decisions are usually based on his experiences and feelings. The bulk of communication between stakeholders in the process of ordering transportation is made over a telephone line, which is more difficult due to the occupancy during the peak morning hours. Almost all operations in PTD are paper-based. Most hospitals do not use any electronic system, which could process the orders. Therefore, it is impossible to create and manage the records of the completed transportations and it is not possible to measure the quality of service.

There are also delays in transport in hospitals, which reduces the equipment and staff efficiency and increases the patients' waiting times (Hanne, et al., 2009).

2.2 Dignity

The word dignity comes from Latin *Dignitas*, which means worthy. Dignity is an integral part of patient care. Caregivers are responsible for maintaining and respecting the patient's dignity. This is their ethical responsibility (Edlund, Lindwall, Von Post in Lindström, 2013).

Several different interpretations are existing, which describe the concept of dignity. Therefore, this concept is used in different contexts. Dignity is a concept that can only apply to a human being and indicates the entity of body, soul, and spirit. Here we talk about absolute and relative human dignity. The values of absolute dignity are holiness, priceless, duty, freedom of decision, and service. These values are absolute, endless, and impossible to deny. Relative dignity is a reflection of absolute dignity, but the source of values of relative dignity is culture, and these values are regulated hierarchically. Cultural norms thus influence the expression and respect for the dignity of another (Edlund, et al., 2013).

Chochinov (2007) mentions the A, B, C, D model of maintaining dignity in patient care. The letter A represents an attitude. Here the author emphasizes that the medical staff must consider their attitude towards patients and possible prejudices and assumptions that could jeopardize the objective treatment of the patient by them. B represents behavior. When nurses and physicians are aware of their impact on patients' perceived dignity, it makes sense to direct their behavior to preserve the dignity of the person. This also includes small gestures, such as asking a person for his feeling, how they are today, straightening a pillow or blanket, noticing if a person has a greeting card on the table, and asking the patient about it. So, it is important to give the patient personalized attention. Although some procedures are routine for us, but not for the patient, it is important to try to make the procedure or event as stress-free as possible by noticing the patient's insecurity or fear and encouraging or extra explaining what will happen and for what purpose. This means that with additional information, we also reduce the level of stress that the patient experiences. C represents compassion, which refers to the awareness of suffering and the desire to reduce that suffering. This could be shown as a gentle squeeze of the patient's

palm, a look, non-verbal communication, or words. And finally, the D as dialogue. Dialogue with the patient, where we get acquainted with various aspects of the patient's life that can help us better understand his condition (Chochinov, 2007).

In a study conducted by Oosterveld-Vlug, et al. (2013), 30 home residents in four nursing homes were interviewed. The list of questions that served as the basis for the interviews contained questions such as: "What are those important factors for dignity in your opinion?" and "How does staying in such an institution affect your dignity?" At the end of the study, they emphasized the importance of the attitude of caregivers and the healthy person towards the patients and pointed out the importance of the way they handle various tasks and thus can have an impact on undermining or respecting patients' dignity. They noted that the disease has an impact on three domains through which it can undermine patient dignity. These domains refer to the individual self, that is, to the patient's subjective perceptions of who he is as a person; then to the relational self, which refers to reciprocal relation to important loved ones, and to the social self, where the patient is conceived as a social being who enters into interactions with the wider society (Oosterveld-Vlug, et al., 2013).

2.3 The technical aspect of transport implementation

In the paper, internal transport of patients to diagnostic tests involving the patient's physical movement to the means of transport, if necessary, was observed. The moving path of the patient is decided by a specific medical process (Lv & Guo, 2013). In addition to the path, it is necessary to determine the means of transport before the start of the route and plan and correctly move the patient to the means of transport. Not all patients are able to get out of bed independently and travel on their own. Their medical condition may require movement to the means of transport and transportation in a sitting or lying position. These activities can be stressful and exhausting for the patient, but they can also be a reason for the deteriorating health of employees. Manual lifting and transfer activities are the job tasks most frequently associated with back injuries in nursing personnel (Caska et al., 1998; Leighton & Reilly, 1995; Owen et al., 1992 and many others). Wheelchair or bed pushing during patient transfer is one of the most physically demanding and yet everyday tasks in the hospital setting (Guo et al., 2017; Ando et al. 2000; Daniell et al., 2014). Moving hospital beds has been listed as one of the riskiest physical tasks that may lead to

injuries that require employees' absence from work (Ando et al., 2000; Hill-Rom, 2009; Wiggermann, 2017; Zhou and Wiggermann, 2017). Tools and aids for moving patients to and from beds and individual means of transport also differ in staffing needs. For example, bed pushing can be more demanding in terms of the need for human resources than wheelchair pushing because it can require two persons - one pushing behind and one steering in front.

Factors contributing to patient discomfort and employees back injuries during lifting and transfer tasks might be organizational (time pressure to perform the task, lack of available lifting aids, and lack of personnel to assist with the lift), environmental (space restrictions, inconvenient or inaccessible lifting equipment or transfer devices, and poor condition of such devices), or personal (history of bad experiences at patients and previous back injury or recurrent back injury at employees) (Haiduven, 2003). In this chapter, we focus primarily on environmental factors. The theory emphasizes the importance of the choice and properties of the relocation aids and the means of transport to (1) enable the patient to move, (2) make the patient satisfied with the service, (3) maintain the health and satisfaction of the employees and (4) rationally use employees' time.

Several scientific papers confirm the impact of the use of lifting assistance devices on the reduction of morbidity among nurses. For example, Retsas and Pinikahana (1999) recorded that the rate of manual handling injuries among Intensive Care Units (ICU) nurses was unacceptably high (52.2%), as was back injury (71.4% of all injuries). In order to reduce manual handling injuries, they suggested that employers should provide lifting assistance devices; design workplaces to minimise the need for ICU nurses to twist, bend and/or lift items from the floor; introduce regular equipment maintenance procedures; provide adequate staffing to assist with lifting patients; implement processes that facilitate more detailed statistics on manual handling activities and outcomes. Vieira and coauthors (2006) proposed lifting devices, biomechanical training, bigger rooms, adequate set-up, and additional staff. Advice on the use of lifting equipment/devices/aids is quite common in the scientific literature.

In the field of transport, the scientific literature investigates employees' workload during the transport of patients by different means of transport. Cowell and Shuttleworth (1998) proposed that thorough needs and risk assessment should be undertaken before purchasing equipment. This guideline is followed by several scientific papers investigating the effects of using different means of transport on employees and patients. For example, Guo with coauthors (2017) researched the use of robotic hospital bed mover. Research is interesting because powered bed movers have been increasingly introduced to hospitals to reduce physiological strains on users and reduce the workforce. The Battery Powered Bed Mover, operated by one person, showed either an equivalent or reduced muscle activity required as compared to all other modes operated by two persons. This could potentially increase workforce efficiency in bed moving two-fold, freeing up many resources and significantly improving hospital operation efficiency. This type of means of transport has been considered for use in the hospital under investigation.

3 Methodology

The study started with a literature review of four topics: time study methods, the dignity of patients, technical aspect of transport implementation, and ergonomics view on staff performing patient relocation. The most important findings are presented in the first chapter.

To make a snapshot of the existing situation, we used observation and measurement methods based on pre-prepared observation sheets. Between 15. and 19. June 2020, we observed the transport of patients from six departments to various diagnostics. The observation was announced in advance. We analyzed process execution and the types and mode of transport from calling for examinations, escort, orderliness for patients, transfer, and the quality and scope of communication with the patient during transport. A minority of information was reviewed and approved by the hospital employees. They had the opportunity to contribute their ideas and proposals.

A.S.M.E. process chart (A.S.M.E. Special Committee on Standardization of Therbligs, 1947) was used for time study. It was used for recording names of performed activities, their type (operation, transportation, inspection, delay, storage, work with information), their duration, distance traveled and type of adding added

value (adding value for patient / no added value for the patient but obligatory to be performed / not obligatory operation). Times were measured with a clock on a smartphone while monitoring live transport performance.

The findings of the existing situation connected with patients' dignity, the technical aspect of transport implementation, and the ergonomics view on staff performing patient relocation were collected based on a pre-prepared list of things to observe and questions for the staff and the patients to be asked. We were additionally informed based on the analysis of the documents received by the hospital. We took a look at the means of transport used in the hospital to transport patients. Using the comparative method, we compared their technical characteristics with the technical characteristics of the means of transport, which could mean an improvement for the hospital.

Our research questions were:

- RQ1: How much of the time transport employees spend during transportation on activities that add value to the patient?
- If this time is significantly low, we are also interested in answering the question RQ2: Is there a way to improve the proportion of time spent by transport employees on activities that add value to the patient?
- RQ3: Is adequately taken care of the dignity of patients?
- RQ4: Can we propose a means of transport that would mean improvement in terms of maintaining employee health and increasing productivity?

4 Results

The results are collected according to three separate chapters, just as they were collected according to three separate methodological procedures.

4.1 Internal transportation of patients

While observing the process (figure 1), we found that the activities in the internal transport process always take place in the same order. This process includes patient appointments, scheduling of patient appointments, organisation of the transport, patient transferring, radiological examination, and patient reception in the hospital ward after the examination.

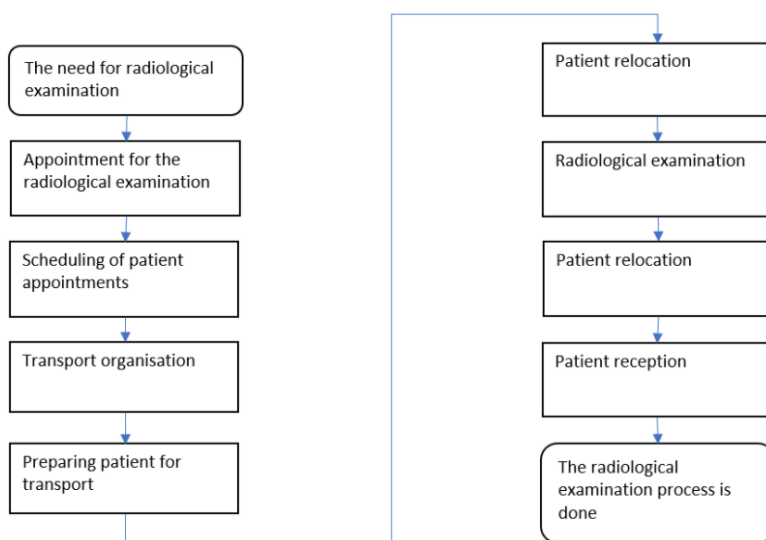


Figure 1: Flowchart of the internal transport to and from the radiological examination

Source: Own

The ward doctor defines the patient's radiological examination, which must be executed in the hospital's IT system, where he picks the appropriate diagnostic test. The schedule of diagnostic tests is then created by the radiological engineer, who sees the requests for diagnostic tests created by doctors in care wards. After the schedule of diagnostic tests is created, department nurses are informed about it. They can see which patients need to be prepared for the transport and when. They can see this information in the hospital IT system. Department nurses also inform radiological engineers if the patient overlaps the investigations or other activities. If they do, the radiological engineer needs to reschedule the patient. Transport nurses have no direct access to this IT system; therefore, they do not have up-to-date information. They are informed about scheduled shifts by phone.

The transport nurse missed the diagnostic test room and took the patient to the wrong one in one case. The transport time has extended for 3 min, which represents 18 % of the whole transport time.

Table 1 presents the observed times while accompanying patients on diagnostics.

Table 1: Measured times

Source: own

All time units are in [min]	1	2	3	4	5	6	7	8	9	10	11	12
Hospital ward	Ward 1	Ward 2	Ward 2	Ward 3	Ward 3	Ward 3	Ward 3	Ward 3	Ward 4	Ward 5	Ward 5	Ward 5
Radiological examination	Diagnostic room 1	Diagnostic room 2	Diagnostic room 1	Diagnostic room 2	Diagnostic room 2	Diagnostic room 3	Diagnostic room 3	Diagnostic room 3	Diagnostic room 2	Diagnostic room 2	Diagnostic room 2	Diagnostic room 2
Mean of transport	Wheelchair	Bed	Bed	Bed	Bed	Bed	Bed	Bed	Wheelchair	Wheelchair	Bed	Bed
Preparation of patient	5.13	1	0.67	0.42	0.45	0	1.53	1.16	0.42	0	3	7.3
Transport	1.75	2.15	1.92	9.35	6.83	9.4	8.71	8.8	6.6	5.75	5.33	6.54
Waiting on the elevator	0.75	0.67	0.25	3.97	2.75	1.4	0.79	4.66	0	3	5.33	2.33
Waiting on the examination	10.75	3.3	6.5	0.35	0.17	1.06	0	4.01	4.81	1.17	0.5	2.1
No business activity	0	0	0	0	0	0	0.25	0	0	0	0	0
Radiological examination duration	9.34	2	5.25	3.72	3.5	4.92	7.34	7.57	7.11	8	2.6	2.25
Alltogether	27.72	9.12	14.59	17.81	13.70	16.78	18.62	26.20	19.05	17.92	16.76	20.52

Duration of radiological examinations

On average, the duration of radiological examination was 5,3 min long. The most extended examination was 9.34 minutes long (45 %).

Waiting time in hospital wards

In 10 cases out of 12, transport workers had to wait because patients have not been prepared for the transport. Transport workers waited 1.75 minutes on average due to patient preparation.

Two times, it also happened that transport workers came to the hospital ward and no patient was waiting for them. The patient had other tests or other activities to attend, but transport workers were not informed about them. In one case, the transport worker had to wait 7.3 minutes and spent 36 % of the transport process waiting for the patient to finish his physiotherapy. In table 2, preparation times are shown for two different means of transport, bed, and wheelchair. As shown in the table 2, the average patient preparation time is longer when moving the patient with a wheelchair. But the maximum preparation time measured during the investigation was longer in the case of transport with bed (7.3 min).

Table 2: Measured times

Source: own

Mean of transport	Average preparation time [min]	MIN preparation time [min]	MAX preparation time [min]
Bed	1.73	0	7.3
Wheelchair	1.85	0	5.13

Transport

Transport lasted on average 6.9 minutes. The longest transport time was 9.4 minutes long and represented 56 % of the whole transport process.

Waiting time in front of the elevators

On average, the waiting time in front of the two elevators was 2.16 min long. The elevator stops at each level even if nobody is waiting for it. The longest waiting time in front of the elevator lasted 5.33 minutes and represented 32 % of the patient transfer process. In one case, we did not wait for the elevator.

Waiting time before examination in front of diagnostic rooms

The longest time of waiting on examination in front of diagnostic room was 10.75 minutes, representing 45 % of the whole process. We did not wait only once. On average, the waiting time in front of the diagnostic room was 2.89 minutes or 16 % of the transport process.

Table 3: Measured waiting times in front of diagnostic rooms

Source: own

Diagnostic room	Average waiting time [min]	MAX waiting time [min]	MIN waiting time [min]
Diagnostic room 1	8.63	10.75	6.50
Diagnostic room 2	1.77	4.81	0.17
Diagnostic room 3	1.69	4.01	0

Examination duration

Average diagnostic times were calculated for three diagnostic rooms, table 4.

Table 4: Average diagnostic times in different diagnostic rooms

Source: own

Examination	Average examination duration [min]
Diagnostic room 1	7.30
Diagnostic room 2	4.17
Diagnostic room 3	6.61

4.2 Dignity

Considering the physical appearance, including the size of patient pajamas, covering with a blanket, their hairstyle, tidiness, we found that only one out of 15 patients was wearing visibly too large pajamas. In the other 14 cases, the appearance of patients was appropriate. The communication between patients and hospital medical staff was presented in 8 cases. 6 patients did not communicate with the nurses. Three patients were visibly upset and emotionally unstable. Other patients were in a good or neutral mood with a stable emotion.

4.3 Means of transport

Transport workers for transporting patients who can move in a sitting position use ordinary and electric wheelchairs. The choice depends on the availability of the wheelchair and the condition of the patient. Patients who need to be transported in a lenticular position use movable beds, classic on pushing, adjusting the height and inclinations of the bed can be disabled/mechanical/electrical.

Transport with a wheelchair did not cause significant problems for employees. A slightly increased effort was reported, compared to monitoring a patient walking independently.

Employees put the most effort into moving the movable beds, which requires pushing, cornering or softer turns, braking, and occasionally carrying equipment. The transport of a patient with a movable bed is always performed by two employees, a department nurse, and a transport worker.

All modes of transport are reasonably fast. Moving the patient faster would reduce his comfort and sense of security. The need for a nurse to participate in transport is sometimes not needed. Especially when there is no need for special medical knowledge, the patient is conscious, does not need additional medical care on the way, the risk of medical complications on the way is not expected. In Slovenia, we record a significant shortage of nurses (Trampuž Kajzersberger, 2020). Two employees to move the movable beds are also needed in terms of strenuous pushing and steering. The opportunity for improvement is not so much in faster transports as in the reduced need for accompanying staff in a case of transport with a movable bed.

5 Discussion

5.1 Potential for maintaining the achieved level of patient dignity

In the results, we can see that most hospital staff talk with their patients and pay attention to them, and most of the patients are being well cared for. Even though the results do not show a worrying picture, we must be aware that the hospital staff knew when the research would be done. Therefore, this could impact their behavior. Furthermore, we think that a carefully planned intervention is important to ensure that healthcare professionals are educated about the patient's rights and their dignity. They should also be educated about their contribution to maintaining or destroying patients' dignity and about aspects of dignity. Thus, we propose an education or a training workshop, which would be organized for staff who take care of patient transport as well as nurses and transport nurses. The training workshop would be conducted in groups of up to 25 individuals. A smaller group would be easier to provide feedback and participation of the workshop participants and thus increase the workshop's success, as participants would feel included and reduce the likelihood of negative moods. Each workshop would last 45 minutes. This workshop will present possible problems, which may arise, as well as the theoretical guidelines in practice, which could help hospital staff to maintain patients' dignity at a high level.

5.2 Potential for improved productivity by upgrading IT support

During our research, we came to a possible solution which includes upgrading of IT system. As described above, the communication between stakeholders (doctor, radiological engineer, department nurse, patient transport department) is mainly based on telephone calls. To improve the information flow, the IT system is needed to be upgraded so that each stakeholder needs access to the hospital IT system. A few new tasks also need to be implemented for stakeholders, which could help create the whole flow of the patient smoothly and effectively.

In the proposed flow of the process, the doctor orders the examination according to the following procedure. First, the doctor selects the patient and the required examination. Secondly, he/she could also select the mean of transport for the transport of the patient and at the same time insert/select the telephone number of the department where the patient is.

When the patient request is completed, it becomes visible to the radiological engineer. After the radiological engineer receives several orders, he/she lists them in the hospital's IT system. He/she also needs information about the telephone number of care wards or workstations, and he/she should also have information about the patient's colonization.

In case of overlapping the patient's activities, a nurse in the department needs to call the radiological engineer to change the schedule. A nurse must follow changes in the schedules. Nurses in the care ward also need to prepare the patient for transport on time before the transport nurse arrives at the department. For this activity nurse in the care ward must know the name and surname of the patient, patient room number (entered in the system), outpatient examination, mean of transport, time of the examination, and other additional preparations (fasting, venous canal, completed questionnaires and consents).

Due to frequent delays in patient preparation, we propose that each department establishes responsibly or a nurse in charge of preparing patients for transports on time.

The necessary information should be easily accessible via the TV screens in the nurse's room, including name and surname of the patient (or initials), patient room number, examination clinic, mean of transport, the time by which the patient must be ready for transport.

The patient transport department should, after placing the patient on the examination schedule, have access to the following data to initiate transport:

- name and surname of the patient,
- date and time of the investigation (time window from-to),
- type of transport,
- patient ward,
- examination clinic,
- telephone number of work units,
- location of the transport nurse (long-term goal).

These data would be available to the patient transport department or its dispatcher in the hospital's IT system. With this data, the dispatcher can arrange transport between transport nurses. Scheduling would be optimal if the dispatcher had insight into the locations of the transporters. Hospital IT-related applications could provide their location data. When the dispatcher in the patient transport department receives a new transport request, he/she could use auxiliary applications to send a "call", which assigns the task to the nearest transporter, the most suitable transport. The transporter had a few minutes to "accept" the assigned task on his smartphone. Confirmation of accepting tasks would be followed by receipt of data for the execution of the patient's transport: name and surname, time of the beginning of the patient's examination, duration of the examination, type of transport, patient department, examination clinic. Prior to the use of this information, the transporter could travel to the ward where the patient is located on time, depending on the time of the examination (taking into account the time taken to the ward + the time of transport from the ward to the examination clinic). Ideally, the patient should be ready in the hallway at least 15 minutes before the examination. With the help of the name and surname on his bracelets or elsewhere in a hidden place, I would make sure he was really the right patient. He would then mark on his mobile phone in the app that the patient was "taken over" on the ward. This would be important information for the radiology engineer to see that the patient will arrive for the

examination on his computer. The transporter would then transport the patient to the diagnostic room informed by the dispatcher, so there should be no mistake in taking the patient to the wrong diagnostic room.

4.3 Potential of Battery Powered Bed Mover implication

The need for the escort of a nurse in transports with a movable bed could be eliminated in many cases by introducing Battery Powered Bed Mover (Guo et al., 2018). By its use, many bed transfers could be done by just one employee, especially in cases where the patient's medical condition allows transport only by the transport worker. The purpose of this device is not to speed up transport but to reduce the physical exertion of employees and the need for an additional employee. Although instead of two, the transport would be done by one person, the employee would spend less energy, perform the work more easily and efficiently, and suffer less pain and potential work-related injuries. Daniell with coauthors (2014) confirmed that a powered bed mover reduces the level of muscular strain required to move a hospital bed. Maintaining a more upright posture can result in a load-reducing effect on the body, with spinal flexion in the sagittal plane identified as a risk factor for lower back injuries (Punnett et al., 1991; Waters et al., 1993). As a result, the possibility of sick leave would be reduced.

A hospital with probably 100 to 150 beds would require no more than two of these units (Beran, 2014). The cost of a Battery Powered Bed Mover with the capacity to move hospital beds weighing up to 500 kg is between 18.000 and 22.000 EUR. Almost all models on the market are compact and easy to maneuver in tight corridors, have an ergonomic design, are quiet to operate with non-marking tires, and are compatible with most standard beds. The hospital will recover this cost in less than a year (Beran, 2014). The cost of purchasing the device is almost the same as one nurse's average gross personal income. When calculating Return on Investment (ROI), there is not just the workforce cost of hiring a nurse to escort patients; the cost of treating nurses when they get hurt must also be taken into account.

4.4 Answers to research questions

RQ1: How much of the time transport employees spend during transportation on activities that add value to the patient?

Transport employees spend on average 9.4 minutes for the transport of the patient to the diagnostic room and back to the care ward. Their primary job is to transport the patient. This transport adds value to the process of diagnostic examination from the aspect of transport employees. Waiting on a patient on the care ward, waiting in front of the elevator or diagnostic room does not add value and can reach from 10 to 80 % of the whole trip from a care ward to the diagnostic room and back to the starting point.

RQ2: Is there a way to improve the proportion of time spent by transport employees on activities that add value to the patient?

The transport of patients represents, on average, 56 % of the whole transport process. We do not recommend increasing the speed of transport to ensure safe and comfortable transferring of patients. The solution could be improved planning and monitoring of the current situation. Each delay must be as soon as possible incorporated in the revised plan and sent to transport workers.

RQ3: Is adequately taken care of the dignity of patients?

The results do not show a worrying picture, but the number of observed patients was small. Besides that, the employees in the hospital knew when and how the research would be done. This could also affect their behaviour. In general, we can say that patients are adequately cared for. By educating and establishing the transfer of good practices among employees, the already good motivation of employees to care for the dignity of patients could be further improved.

RQ4: Can we propose a means of transport that would mean improvement in terms of maintaining employee health and increasing productivity?

Yes. We propose a Battery Powered Bed Mover. ROI is expected in less than a year. We will relieve the burden on nurses, reduce sick leave, increase patient comfort and increase the productivity of transport staff.

5 Conclusion

The research work enabled the students to have their first contact with the planning and implementation of research methods in the real environment of the hospital. A methodology has been developed to address the process of transporting patients to specialist examinations comprehensively. The patient aspect was also taken into account. Although time is not the most important indicator of the efficiency of processes in a hospital, improved planning and monitoring of the implementation of the process could bring the process times very close to optimal. We also believe that relieved staff would be more motivated to maintain patient dignity. Relief would be possible in transferring information from the use of the telephone to the internal information system. However, a variety of technical aids could relieve nurses of the burden of reducing the need to participate in the transfer of patients and their monitoring/transportation to specialist examinations.

An important shortcoming of the study is the small number of transports observed due to the coincidence of the study with the time of Covid 19 spread. The opportunity for future studies is in a larger sample and further search for synergies between individual aspects of the treatment of patient transport to specialist examinations in the hospital environment.

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