LEAN: 4W & 1H OF LEAN IN MEDICAL FACILITIES

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Abstract: *The academic literature offers many examples of firms which have achieved significant improvement via lean management implementation. These firms usually apply well-defined lean tools. The impact of its implementation is well established in the literature, which means they can use it as a guidebook. The essence of lean management is the creation of a culture that encourages learning and thus continuous process improvement through simplifying and standardizing the way work is performed and systematically attacking problems as they occur. This paper is divided into two parts. The first part summarizes available relevant materials about lean healthcare and its methods, applications, results (academic or practitioner literature, case studies, etc.) and creates a complex study of this very current topic. The second part introduces the results of a survey focused on medical staffs´ knowledge of lean methods which was carried out in 2013 in various Czech medical facilities. Both parts point out the ergonomic principles in lean healthcare and its benefits.*

Keywords: *Lean management, Lean healthcare, Lean methods, Ergonomics principles, Medical errors.*

JEL Classification: *I15, P46, J32, O14.*

Introduction

Without any doubts, lean philosophy leads to reduce disruptions, process variability and wasting. On the other hand it can increase productivity and efficiency. Before implementing of this philosophy, it is necessary to ensure that all involved staff is aware of lean principles, history and purposes. Employees who go along with lean philosophy are the key for its successful implementation.

For the reasons stated above, the first part of this paper introduces from five perspectives; the WHEN and WHERE, WHAT, HOW and WHY. The perspectives "WHEN and WHERE" briefly describe the beginnings of lean in manufacturing and also in healthcare and its origin. The part "WHAT" defines the essence of lean as a pure process simplifying and waste reduction; describes the most important and usable lean tools and methods. The pure knowledge of lean methods, techniques and approaches is not sufficient. It is necessary to know how the lean practices work and which its results are. The last part called "WHY" offers main reasons for implementing lean philosophy to both industry and healthcare. In terms of manufacturing, lean generally leads to reducing waste and increasing productivity. Whereas in healthcare lean can remove unnecessary procedures, but first of all, it can eliminate disruptions which may cause fatal consequences.

1 4W & 1 H of LEAN

1.1 The WHEN and WHERE of Lean

In 1990 James Womak published a comparative study of American, Europe and Japanese automotive production systems in which he used the phrase "lean manufacturing" but not its meaning. Lean manufacturing or industry engineering is strongly

connected with TPS (Toyota Production System), but it is deeper rooted. TPS was developed from Henry Ford´s production system, and Henry Ford developed F. W. Taylor´s scientific management of manufacturing – thus "lean" has its beginnings at the turn of the twentieth century [2, 14].

Lean had its beginnings on the production floor at Toyota Production System, then migrated to other enterprises and these days is more and more producing benefits in services, including healthcare [8].

The precise date of the first application of lean in healthcare is uncertain. In 1995 Heinbuch offered a lean solution in a particular case of just in time method. His work was dealing with physical inventory reduction in hospitals. A similar application regarding implementing lean approaches in healthcare was made by Jacobs and Pelfrey in 1995. Speculations about the potential use of lean in healthcare were put forth by the NHS Modernisation Agency in 2001. Bushell and Shelest described a pilot implementation of lean in a mid-sized hospital in the U.S.A. – this work was focused on patient flow improvement. Other similar publications of positive results of lean implementation in the area of medical facilities increased the interest about the topic Evidence presented in the literature indicates that lean has been embraced across the public services, including healthcare since 2005 [1, 10].

1.2 The WHAT of LEAN

Literature on lean is generally divided into two categories, which are nevertheless strongly linked: the definition of tools and practices and the lean implementation – research and case studies. These research and case studies address the specific lean methods, tools and approaches that result in the highest performance [9].

The lean tools are mostly grouped according to their impact on functional areas of the company (e.g., Just-in-Time, Total Quality Management, Total Productive Maintenance, SMED, Pull System, Kaizen, Ergonomics, etc.). Pure process simplifying and waste reduction is considered the essence of lean. Actually, Womack and Jones encourage lean companies to identify all wasting activities and eliminate them, because wasteful activities are those that do not add value from a customer perspective. However lean is not only concerned with waste elimination and cost reduction. Hines point out that in fact there are two ways to increase customer value, by reducing waste and thus the cost of products or services; or by increasing the value-adding activities without increasing the cost of goods or services [10].

As a customer (patient, in the case of lean healthcare) "buys" only value added activities, it is extremely important to define lean value stream, which provides increased value to a customer in a more efficient and cost-effective manner. Value adding time in hospital means diagnostic time (collecting and analyzing clinical information), active care time (clinical interventions), passive care time (under observations, no interventions) and positive wasting time (patient's condition is likely to improve without interventions). Non-value adding time is superfluous time (not needed diagnostics, observations or interventions), administrative time, passive wasting time (no change in patient´s condition is expected) and negative wasting time (patient´s condition is likely to deteriorate). Many authors argue that lean is not rocket science; it is basically only waste reduction in all processes [6].

1.2.1 Wastes in Healthcare

The eight wastes targeted by lean manufacturing, all of which can apply to healthcare:

1. **Overproduction** – making more of something than the next process needs. This waste shows up most commonly in batching work. In medical facilities it can include tests, paperwork or claims [8, 11]. Thaiichi Ohno, who is considered the father of the Toyota Production System (TPS), said that "in a period of low economic growth, overproduction is a crime." [2]
2. **Inventory –** as the major cost to healthcare is for carrying inventory or supplies, it is the most important kind of wasting from the hospital perspective. In this case it is necessary to find inspiration in lean manufacturing when the overall cost of delivery is considered to define ideal shipment and its frequency.
3. **Motion** – the easiest way to consider what this type of wasting means is walking or any other body movements. A lot of walking waste originates from poor layout design or a lack of optimal working conditions. In the field of hospitals or any other medical facilities it should be, more than elsewhere, body movements linked with patient manipulation which can cause a musculoskeletal disorder.
4. **Transportation -** in manufacturing this appears as moving parts around. In healthcare this kind of waste shows up when moving patients, tests, materials and information around.
5. **Over processing –** it means doing more than customers require. From the point of view of a patient, it could be multiple claim forms.
6. **Defects –** the second most important type of wasting in lean healthcare. Defects, corrections, adjustments or inaccurate information may cause many problems. For example, an incorrect label on a blood tube can cause irreversible errors in a process.
7. **Waiting –** in any form, waiting is a waste. It can be, e.g., waiting in an emergency room for an available bed, waiting for equipment to arrive from another department, waiting for a doctor, nurse or operating room, test results or information.
8. **Under-utilizing staff** - inadequate using of knowledge, skills, education and creativity which employees possess is a serious waste. It is important to highlight that the people closest to the work know it best; they are experts and they just have to be trained in problem solving and lean techniques but they also have to share their knowledge and experiences [8, 11, 13].

1.3 The HOW of LEAN

A pressing issue for researchers but also for practitioners is explaining "how" implementing lean practices leads to improvement. Many authors argue that the pure knowledge of lean methods, techniques and approaches is not sufficient. It is necessary to combine doing work with learning to do work better –it is really important to continuously monitor the work results, make it immediately apparent when results contrary to expectations are occurring – mainly in the case of lean healthcare [9].

It is not easy to implement lean; nevertheless the most difficult issue is to control it and to continuously improve it. According to the Dennis, lean production is not only a set of techniques; it should become a path that must be approached with spirit of humility and lifelong learning. Irving Layton´s motto says: "They dance best who dance with desire." The author believes that intensity is the soul of lean production and team members are its heart [2].

1.4 The WHY of LEAN

The main reason for implementing lean methods is the fact that lean leads to less disruptions and therefore to higher stability. According to Dennis, "STABILITY" is the main object of the lean. Archimedes motto: "Give me a place to stand, and I can move the earth", explains the importance of stability either in the production factors (man, machine, material, method) in the case of production or in other areas. Dennis argues that the stability starts with visual management, 5S workplace organization and TPM (Total Productive Maintenance). All of them support standardization and provide point-of-use information that eases decision making [2].

Implementation of lean in healthcare, particularly in hospitals, should remove duplicate processes and unnecessary procedures and also eliminate disruptions which may cause fatal consequences [10].

One of the most common examples of medical disruption is adverse drug reaction, which can be caused, e.g., by incorrect drugs application. Lazarou et al. analyzed records for prescribed medications for 33 million U.S. hospital admissions in 1994. It discovered 2.2 million serious injuries due to prescribed drugs; 2.1% of in-patients experienced a serious adverse drug reaction, 4.7% of all hospital admissions were due to a serious adverse drug reaction, and fatal adverse drug reactions occurred in 0.19% of in-patients and 0.13% of admissions. The authors estimated that 106,000 deaths occur annually due to adverse drug reactions [3, 7].

A five-country survey published in the Journal of Health Affairs found that 18 – 28 % of people who were recently ill had suffered from a medical drug error in the previous two years. The breakdown by country showed the percentages of those suffering a medical or drug error were 18 % on Britain, 23 % in Australia and in New Zealand, 25 % in Canada, and 28 % in the USA. In the USA more people died in each year from medical errors in hospitals than those dying from road traffic accidents, breast cancer or even AIDS [12].

Although lean is increasingly prevalent in healthcare, there is only little evidence of a full implementation of lean to the level achieved by Toyota. The literature suggests that healthcare organizations are implementing lean by using simple tools on small projects. In the UK, Radnor analyzed the annual reports 2007/2008 of 152 acute hospitals for evidence of lean led improvement activities. In the sample, 80 hospitals cite the applications of lean principles (e.g., process mapping, 5S, etc.), only 5 hospitals attested to the adoption of lean principles as part of the culture of the organization [10].

It is necessary to wise up that the center of all activities in medical facilities are patients – their safety, comfort and time, the aim of medical staff (doctors, nurses, etc.) is doing maximum to gain this objectives, for example by using ergonomic principles. Ergonomics is other very useful tool of lean. The ergonomic principles are commonly used in all types of industries, rarely in services, including medical facilities. Many authors argue that the implementation of its principles helps to prevent disruptions in medical processes by reduction of staff exhaustion and increase of patients comfort. Ergonomics is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance. Ergonomists contribute to the design and evaluation of tasks, jobs, products, environments and systems in order to make them compatible with the needs, abilities and limitations of people [5].

The most recent US Department of Labor (DOL) summary statistics indicate that nursing aides, orderlies and attendants, along with two other occupations (truck drivers and non - construction laborers), account for one out of five musculoskeletal disorders (MSDs) reported nationally in 2001. The American Hospital Association has stated that work-related MSDs account for the largest proportion of Workers Compensation costs in hospitals and long-term nursing home facilities nationwide. In addition, the American Nurses Association reports that ergonomic injuries occur in nurses at a rate that is twice that found in the general working population [4].

The negative consequences of poor working environment in hospitals with respect to ergonomic principles are globally very serious problem. The survey presented in the second part of this paper analyses application of ergonomic principles in chosen Czech medical facilities and its impact on medical staff.

2 Survey: Application of Ergonomic principles, MSD´s Symptoms

The aim of the second part of this paper is the analysis of the current situation of medical staff´s knowledge of lean method in representative Czech hospitals, focusing on ergonomics.

In order to find out what is Czech medical staff´s knowledge of lean healthcare philosophy and tools was created a questionnare survey to evaluate the knowledge, working attitude, behaviors of participants and working environment in several Czech hospitals.

The survey was divided in two parts: overall interest of the hospitals staff in lean methods and ergonomic principles using in healthcare environment and their inpact on medical staff.

Main object of this part is find out the work environment of medical staff, which could directly affect the staff´s performance and patients comfort and rehabilitation conditions. The basic question were:

- Is MSD´s experience influenced by job position /doctors/nurses/paramedical staff/?
- Is MSD´s experience influenced by length of practice of participants?
- Is there any influence of length of practice on frequency of MSD´s symptoms occurency?
- Is there any difference in type of MSD´s symptoms and medical care sought for MSD´s?

The quantitative portion of this study comes from a survey of employees (doctors, nurses and paramedical staff) in various not-for-profit hospitals across the Czech Republic. The survey started in October 2013 and was executed online via survio.com.

Until now we collected a total of 279 completed surveys. Surveys were distributed to doctors, nurses and paramedical staff in selected state hospitals across the Czech republic (total of 12 hospitals). The collected data was statistically proved using different statistic methods, mostly by ANOVA.

The basic characteristics are displayed below.

Tab. 1: The basic characteristic of a sample

		Frequency (n)	Percent (%)
Gender	Female	42	15,05%
	Male	237	84,95%
Age	18 - 29 years	87	31,18%
	30 - 49 years	129	46,24%
	50 and more	63	22,58%
Practice	Less than 5 years	60	21,51%
	5 - 10 years	66	23,66%
	10 and more	153	54,84%
Position	Doctor	42	15,05%
	Nurse	174	62,37%
	Paramedical staff	63	22,58%
MSD´s experienced in the past	Experienced	215	77,89 %
	Not experienced	64	22,11 %
MSD´s frequency	Constantly	47	16,84 %
	Weekly	87	31,18 %
	Monthly	134	48,02 %
	Infrequently	11	3,96 %
Medical care sought for MSD´s	Yes	84	30,11 %
	No	195	69,89%
MSD´s symptoms	pain	175	62,72%
	edema	8	2,86%
	tingling	20	7,16 %
	cramps	76	27,26 %

Source: [15]

2.1 Results

According to the results, almost three – quarters of respondents are affected by the musculoskeletal disorders (MSD´s). The main reason of this result should be e.g. poor-designed workplaces or hard and time-consuming manipulation with patients without any ergonomic devices. Based on the results, 93 % of medical staff affected by MSD´s got a sick note.

In US, MSDs account for $1 of every $3 spent on workers compensation and affect 1,8 million workers each year. Many experts believe this numbers to be under-reported. Compared to other private industry sectors, the medical, economic, and social costs of work-related musculoskeletal disorders or ergonomic injuries in the healthcare environment are particularly serious and warrant special consideration. [4].

In the table below is displayed the influence of job position on MSD´s experience.

Tab. 2: ANOVA Job position vs. MSD´s experience

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	49,54839	1	49,54839	113,6253	0,000000000000000000057537	3,89249
Within Groups	80,23656	184	0,436068			
Total	129,7849	185				

Source: [15]

According to the results, job position does not have an influence on MSD´s experience. There is not difference between job position and inclination to MSD´s.

Tab. 3: ANOVA Length of practise vs. MSD´s experience

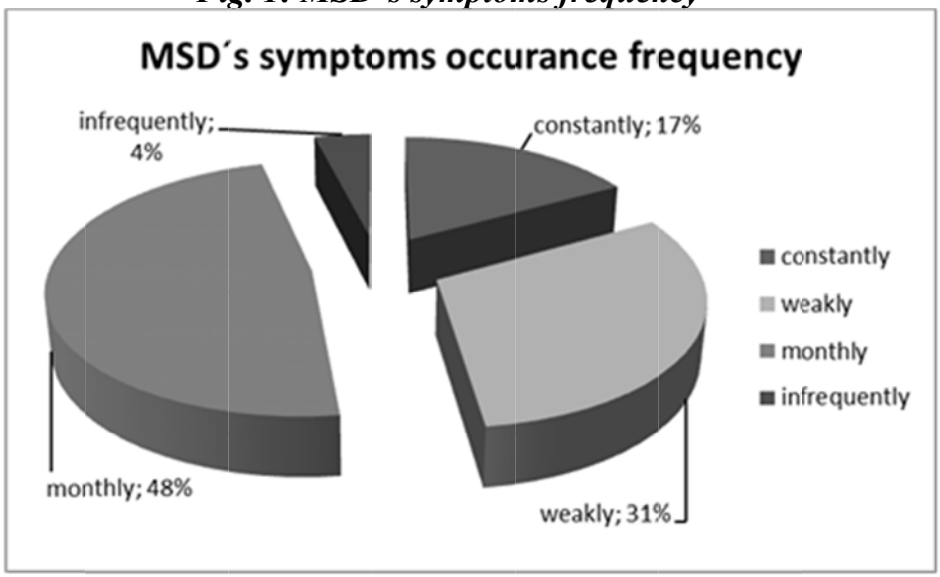
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0,263441	1	0,263441	0,313796	0,576041188	3,892494
Within Groups	154,4731	184	0,839528			
Total	154,7366	185				

Source: [15]

Regarding the MSD´s symptoms occurrence, we decided to analyze an influence of length of participants´ practice on MSD´s experience. As can be seen in the table above, length of practice has an impact on it. P-value is moving to 1, it means very strong correlation between proved factors.

Graph below shows us that the 17 % of respondents has the symptoms of MSDs constantly, almost 50 % weakly and 30 % monthly. Apparently, these physical problems are caused by high staff´s exertion. It is evident that each mistake made in healthcare services can cause fatal consequences. Therefore it is inevitable to take up appropriate actions – in our case to start up with applying the lean healthcare principals, especially ergonomics. In order to find out the influenc of length of practice on frequency of MSD´s symptoms occurance we carried out other ANOVA testing.

Fig. 1: MSD´s symptoms frequency



Source: [15]

Tab. 4: ANOVA Length of practise vs. frequency of MSD´s experience

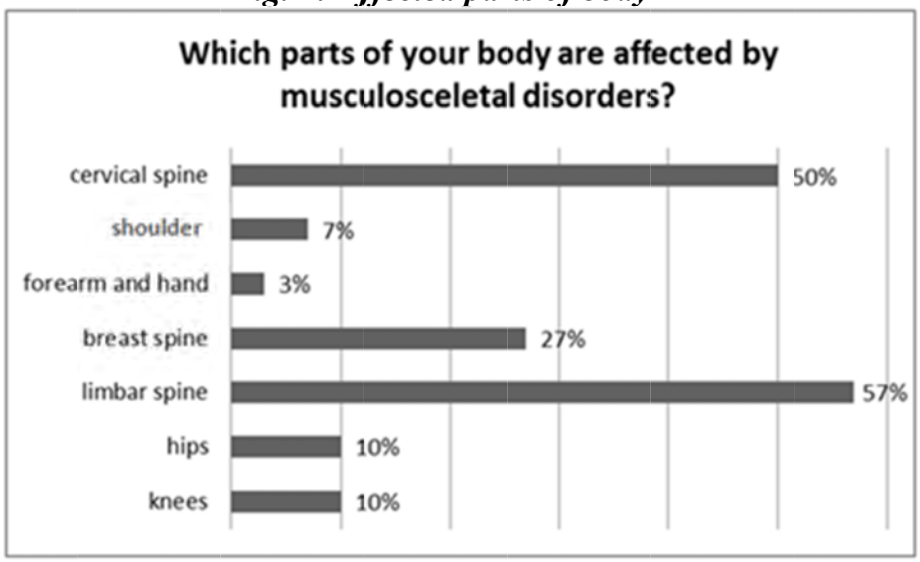
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	9,94086	1	9,94086	19,22993	0,000019	3,892494
Within Groups	95,11828	184	0,516947			
Total	105,0591	185				

Source: [15]

According to the results, length of participants´ practice does not have an influence on frequency of MSD´s experience. It could mean that there are other important factors which is necessary to prove. It could be wide spectrum of factors, eg. workplaces conditions, demography, social background, lifestyle, etc.

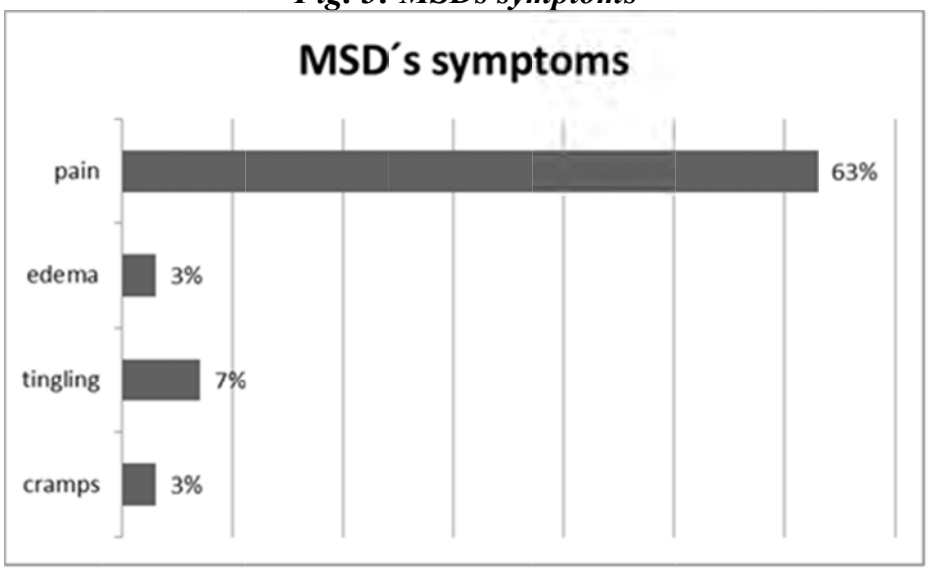
The respondents also indicated parts of their body which are affected by MSD´s. Apparently, as can be seen in the graph below, the most affected is the backbone; concretely lumbar, cervical and breast spine. Based on the results, the majority of MSD´s symptoms, exactly 63%, are accompanied by pain.

Fig. 2: Affected parts of body



Source: [15]

Fig. 3: MSDs symptoms



Source: [15]

In the table below is seen the relation between type of MSD´s symptoms and medical care sought for MSD´s. P-value is 0,8027. It means very strong influence between these factors. It is evident that there are some symptoms which occurenccy needs the medical care and others that do not need it. The most common symptoms and its occurency is displayed in the graph below. As a serious one we could consider eg. edema or tingling of affected parts of body.

Tab. 5: ANOVA Type MSD´s symptoms experienced vs. medical care sought

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0,048387	1	0,048387	0,062566	0,802764	3,892494
Within Groups	142,3011	184	0,773375			
Total	142,3495	185				

Source: [15]

3 Discussion

Healthcare sector is very specific area, but also methods of industrial engineering, including ergonomics, can be applied both in production and in the non-manufacturing sector. This is evidenced by numerous international studies dealing with these problems.

Czech health care facilities are almost untouched as regards the lean healthcare. The crucial point is consciousness that the benefits of the implementation of some chosen methods of lean healthcare can have a very positive effect on economic indicators, which could be a good argument at a time when some Czech facility is on the verge of bankruptcy. The results of my work could be a basis for an appeal to the management of healthcare facilities that took a step toward lean healthcare decided to implement lean tools, especially applying of ergonomic principles (ergonomic tools, training, audits). Through the application of ergonomic principles the occurrence of occupational diseases would be eliminate. The occupational diseases carries double cost - the cost of refund of wages for inability to work and cost of often very prolonged treatment.

Last but not least the uncomfortable working conditions lead to medical disruption, both due to exhaustion of the medical staff, and because of the negative impact on the patient himself.

Conclusion

This paper introduced the WHEN, WHAT, HOW and WHY of lean in both industry and healthcare. In order to emphasize the importance of lean methods, tools and approaches were reviewed some international statistics related to medical disruptions, as the goal of lean methods is to eliminate errors and to increase procedural stability. This paper presented results of our own survey, focused on ergonomics in Czech hospitals. The results alerted to the poor work environment in medical facilities which can be a reason for musculoskeletal disorders, claimed by 73 % of participants. Undoubtedly, it should indirectly influent patient´s comfort and safety.

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