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## Review Article

### Fools' Gold - Lean management in the health sector

Bryan McIntosh<sup>a</sup>, Bruce Sheppy<sup>b</sup>, Ivan K. Cohen<sup>c</sup>

a: Faculty of Health, Life & Social Sciences, Edinburgh Napier University, Edinburgh, Scotland.

b: School of Health, BPP University, London, UK.

c: Finance and Economics, Richmond University, The American International University in London, London, UK.

#### Correspondence

Bryan McIntosh  
Richmond University  
Queen's Road  
Richmond-upon-Thames  
TW10 6JP  
England  
Email: bryan.mcintosh@richmond.ac.uk

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#### Abstract

**Purpose:** This paper provides a critical evaluation of the impact of lean practices in informing healthcare policy.

**Methods:** Review of primary and secondary literature.

**Results:** There has been considerable interest in the implementation of practices imported from manufacturing into healthcare as a solution to address rising healthcare spending and disappointing patient safety indicators. This encompasses a number of practices in Operations Management and Human Resource Management, including Just-in-Time (JIT), Total Quality Management (TQM), Total Productive Maintenance (TPM), employee empowerment, and extensive training. Used together there is great potential to improve overall firm competitiveness. However, despite widespread enthusiasm about the potential of lean management processes, evidence about its contribution to higher organisational performance remains inconsistent.

**Conclusion:** Our paper contributes to the organisational management literature in healthcare by showing that even though lean management in healthcare appears to have the potential to improve organisational performance; there remain problems with its application.

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#### Introduction

As a result of the triple pressures of rapidly improving and more costly technology, ageing populations and severe recessionary pressures on government finances, healthcare systems of the developed world, need to make long-term cost savings, whilst maintaining and enhancing the quality of essential services. The National Health Service (NHS) in the United Kingdom (UK), has the particular requirement for efficiency savings to enable reinvestment in quality that is estimated to be £21.1 billion by 2014 (Department of Health; Appleby *et al.*)[1,2]. This requires increased productivity of 6% per annum[3], yet the United Kingdom Office of National Statistics estimates that productivity actually fell by approximately 0.3% per annum over the period 1995–2008 (ONS)[4]. Productivity is highly variable within the NHS and even within individual healthcare providers (NHS Institute for Innovation and Improvement)[5]. Given these pressures, the

productivity of healthcare organizations is an incredibly salient topic. Consequently, 'lean' as a concept and lean management as a managerialist practice is a particularly pertinent and is explored with particular reference to the English health system. The NHS managerialist perspective is relevant to private sector management approaches because it is seen as a "third way" of delivering healthcare by creating quasi competitive internal markets that promote the adoption of private sector practice.

Lean philosophy and practice have been implemented in the health sector in the UK and internationally, 'Lean' has been promoted as an efficiency response in the face of rising public spending[6,7]. Several efficiency approaches have attracted particular interest, encompassing a number of Operations Management (OM) and Human Resource Management (HRM) practices, such as Just-in-Time (JIT), Total Quality Management (TQM), employee empowerment and extensive training[8,9] and it is their modification and adaption to health

systems that is of particular interest to health managers.

In the UK, the NHS Modernization Agency[5] proposed 10 High Impact measures to improve patient care, most of which were inspired by the TPS (Toyota Production System). These measures aim to improve patient flow across the whole NHS; manage variation in patient discharge; manage variation in the patient admission process; avoid unnecessary follow-ups for patients; optimizing patient flow through service bottlenecks). Jones and Mitchell[10] have promoted lean management as “essential to a strong, successful NHS” and publications such as the *NHS Lean Implementation Handbook* from the NHS Institute for Innovation and Improvement and “Lean thinking for the NHS” from the NHS Confederation[11] evidence this approach. Burgess *et al*[12] found that 53% of NHS hospitals cite the application of lean principles in their activity. In the US, Bigelow and Arndt[13] observed that between 10% and 75% of hospitals have adopted some form of TQM programme. However, despite widespread agreement about the potential of lean management, evidence that it is contributing to improved organizational performance is surprisingly limited. This issue is particularly important in the healthcare sector given the pressures to alleviate soaring costs spending in the Western world. Consequently, there is a need for a critical review of the evidence about the impact of lean practices in organizational performance and in particular to inform healthcare policy.

This paper is structured as follows. The first section revisits the origins of lean management, the second the pillars of its principles and core practices. The third section evaluates the evidence that manufacturers who have implemented lean practices have benefitted from a sustained competitive advantage relative to those who have maintained more traditional mass production systems. The fourth section addresses the transplant of lean management from manufacturing to healthcare, and reviews the evidence of its impact on performance. Fifthly, we consider the potential of lean management for healthcare. Our paper contributes to the organizational management literature in healthcare by showing that although lean management seems to have the potential to improve organizational performance it is far from a panacea against underperforming hospitals. In addition, it informs policy-making by suggesting that a progressive managerial philosophy has a stronger impact on healthcare performance than the adoption of practices from any particular managerial approach.

## Methods

The methodology applied within this paper was built upon critical review of the secondary literature. The systematic review provided an exhaustive summary of literature relevant to Lean Management in the health system.

The first step of the review was a thorough search of the literature for relevant publications. Publications were assigned an objective assessment of methodological quality using a rating system. The researchers kept a log of the search strings used. The search string yielded more than 200 references. Additional terms (keywords 3) were added to the string in order to focus the search more accurately. Next, the titles and the abstracts of the identified articles were checked against pre-determined criteria for eligibility and relevance. To ensure that the searches undertaken were consistent and comparable, the method applied involved keywords and phrases derived from the research topic. These were then placed into categories and assigned keyword numbers to allow their strategic combination according to researcher impressions from a preliminary literature trawl: keyword 1 words were to be paired with every keyword 2 word once. These were ‘lean’ and ‘healthcare’ respectively. The initial search returned a high number of references (that is, 100 or more), the second search was further refined by adding keyword 3 (‘outcomes’) to the search string[14]. Search logs were compared between researchers to ensure that the terms had been applied consistently[15]. This research was refined to 100 articles which directly addressed the topic under consideration.

The ‘critical’ review went beyond a simple analysis of the sources outlined. We considered the breadth of different pieces of work, the depth of the different pieces of work, the relevance of each piece of work to our specific question(s) or objective(s), and were the research methods adopted in one source more useful in answering our question(s). This review highlighted the paradigms, gaps, contradictions and inconsistencies within the literature, both within single pieces of work, and as a result of making comparisons between the works of the authors. We then prepared a grid, which stated the un-stated and invalid assumptions in arguments, distinguished facts from hypotheses, distinguished facts from opinions and distinguished an argument’s conclusions from the statements that support it. It recognises the nature of the evidence both of argument, relevance and validity of findings. Distinguished between relevant and irrelevant statements and evidence and identified logical fallacies[16].

We followed Cottrell’s[17] approach in assessing the quality of arguments and evidence, placing an emphasis on the variety and validity of the materials under examination. We also analysed the various parts of arguments; with the primary sources it was possible to critically comment upon the suitability of the research design, the effectiveness of the data collection process, the validity of the sample selection process and the appropriateness of the chosen research methodology to the subject being researched.

## Lean

“Lean” is a term popularised in the 1980s and 1990s to encompass a number of approaches to managing manufacturing companies that included an emphasis on systems producing exactly what the customer wants at the lowest cost and with no waste. The assumptions underlying lean is that organisations are made up of processes. Improvements made in a lean context should optimize a customer’s journey rather than optimising individual departments. This perspective, which is widely applied in organisations is referred to as the “process-based view” of organisations. Karlsson and Ahlstrom[18] and Rees and Rees *et al*[19] suggest that ‘leanness’ should be seen as an ideal to be pursued, not a system to be implemented. Thus a lean context might include any good practice of process/operations improvement that allows reduction of waste, improvement of flow and an improved concept of customer and process view.

Central to understanding lean is an understanding of systems. This is often labeled “systems thinking”. The usefulness of this concept is that it explains that changing one aspect of a system (e.g. procurement) affects other aspects (e.g. delivery). These interrelationships are often obscure and therefore any approach “improving” systems should ensure that changing one aspect (e.g. procurement) does indeed have the desired effect on (e.g.) delivery. “Lean thinking” therefore adds detail to a systems view of the world by encouraging managerial interest in the way work and information flows through the system, particularly where it flows freely and where there may be bottlenecks. This allows a focus on improvement efforts to those areas that will improve the whole system and avoid sub-optimal changes.

Drawing on these concepts “lean management” or “lean enterprise” is essentially an umbrella term for a number of key practices which aim at preserving value in business with less work. In one sense it is a form of efficiency, albeit based on the optimization of flow. The term “lean management” was first put forward by Krafcik[20], the concept being based on his experiences with the Toyota-GM joint venture in California. However, many of the underlying principles of lean management can be traced to earlier examples, such as Henry Ford’s original production line practices, which can be seen as a forerunner of just-in-time (JIT) manufacturing.

The successes of American manufacturing in the decades following World War II led to Japanese companies adopting management theories and practices from the United States and Europe[21]. Initially this involved just-in-time techniques, (JIT)

primarily due to a lack of resources necessary to maintain large inventories. The Ford mass production system, which had been adopted by many American, European and Japanese firms[22], built on the use of product-specific machines operated by semi-skilled workers specialising in short-cycle operations to produce high volumes of standardized goods at low cost[23,24]. A number of Japanese manufacturers, led by Toyota and Honda, adopted a critical and culturally conscious adaptation of the American mass production system [25], arguing that it was neither practical nor economically sustainable in the context of the slow economic growth that followed the early 1970s oil crisis[26].

In the 1970s and 1980s American car manufacturers were losing market share to Japanese corporations[27]. This led both managers and academics in the USA and Europe to turn their attentions to the Japanese style of management, with a view to improving business performance. Investigative trips were made to Japan, and books were written encouraging western companies to emulate the Japanese philosophy of management[21]. Among the most influential initial contributions were Ouchi's[28] and Pascale and Athos[29]. The Japanese paradigm of production (and hence competitiveness) became best known in the West through the reports of the International Motor Vehicle Program. Between 1985 and 1990 researchers at MIT benchmarked management practices from automobile assembly plants around the world with the aim of understanding how Japanese corporations, especially Toyota, were able to achieve higher productivity and quality, and at lower cost. The results were published in Womack, Jones & Roos'[8] best-seller. Japanese principles and management practices became aggregated using terms such as 'lean production', 'lean management', 'lean thinking', 'lean', 'Toyota production system' (TPS) or 'flexible mass production', in contrast to the traditional mass production system.

Advocates of lean management highlight the limitations of mass production, arguing that increasing market turbulence[30], global competition, and more sophisticated consumer tastes no longer allow companies to capture "market share and high profits by producing large volumes of a standardized product" [23,31]. The more flexible model of lean production, aiming to produce "many models in small numbers cheaply"[32] was increasingly viewed as the solution to replace "Fordism". Lean production was said to require half the resources of mass production, in terms of human effort, capital investment and manufacturing space, to produce the same volume in half the time and with half the defects[33]. The availability of new technologies, especially computing, also opened opportunities for improved control systems and organizational methods[34].

Lean management offers low cost, high quality manufacturing offering a wide variety of models and functions continuously improved through rapid product development cycles. This is built upon a few key pillars which we now discuss.

### **The pillars of lean management philosophy**

The idea of lean is attractively simple: that the organisation should be obsessively focused on the most effective means of producing value for their customers. Lean management has revolutionized production and the organization of work by acknowledging the strategic importance of two principles: continuous improvement (from the Japanese *Kaizen*) and respect for people[26]. The lean philosophy of management is grounded in five pillars:

I) **Organization of work:** In mass production, the aim of manufacturing high volumes of standardized products was underpinned by a 'metal mentality'[8], where the main concern of workers and engineers was to ensure the ongoing flow of production. It was therefore acceptable that a significant amount of defective products would be allowed to go through and be dealt with at the end of the line by numerous quality and re-work specialists. This system generated significant waste. In

contrast, the lean approach to production aims to reduce and eliminate all kinds of waste (from the Japanese *Muda*) by continuously improving and simplifying the productive process, emphasising 'getting it right first time', hence reducing the huge costs of repairing production errors (an issue of importance to healthcare where the costs to patients and the provider of poor quality provision is often high). Ohno[32], who with Kiichiro Toyoda, is credited with the development of the Toyota Production System (TPS), argued that most production could be performed by assembly workers on their own; specialists added very little value[8]. Ohno changed the production layout at Toyota from a functional to a cellular configuration, creating several independent production lines organized by families of products[35].

II) **Teams:** In contrast with mass production, where extreme division of labour means curtailed worker autonomy and decision-making[36], Ohno[32] organized workers into teams, replacing a foreman with a team leader. This enriched and empowered workers by giving them a number of tasks previously performed by a range of specialists. This included minor equipment repair, quality-checks, and the ability to stop the assembly line when major quality problems were detected. It asked workers to think of ways of more effectively organizing work. This new production model contributed to increasing product quality at Toyota by ensuring that defects were detected and dealt with as near the source as possible[37], consequently re-work was kept to a minimum[38].

III) **Relationships with employees:** While mass production assembly workers were treated as expendable, easily replaceable, and asked to limit their work to executing short-cycle operations carefully prepared by production engineers[8], Toyota sought to make full use of workers' capabilities, through employee participation and extensive training[39,40]. Involving both participatory human resource practices and new employment relationships, such practices were at the heart of waste reduction efforts. They facilitate the transfer of knowledge from workers to management and its subsequent incorporation in the production process[40]. In addition, to fully benefit from its investment in human capital, Toyota also implemented a new psychological contract based on the promise of lifetime employment, little discrimination between blue-collar and white-collar workers, career progression opportunities associated with seniority and skills, and bonus payments tied to company performance in exchange for employee commitment and active participation in the continuous improvement of the productive process[41-43].

IV) **Relationships with suppliers:** Managing the supply chain is a critical success factor as outsourcing accounts for over 50% of product cost among US industries[44]. Mass production companies obtained large savings by giving their suppliers precise product specifications and then playing them against each other in a bid for the lowest price[38]. In contrast, instead of focusing on price as the main criteria for supplier selection, Toyota established long-term partnerships with its suppliers that went beyond the commercial relation practiced in the West. Ohno[32] argued that suppliers played a decisive role in Toyota's success, and sought to work cooperatively with suppliers by sharing technology, knowledge and experience. Toyota integrated core suppliers in new product development teams and gave them freedom to develop parts that could work together with other product systems[8]. Core suppliers were also encouraged to work together and to learn from each other. Integrating suppliers in product development also proved decisive for the success of Toyota's just-in-time (JIT) delivery system[45].

V) **Relationships with customers:** Mass production manufacturing was primarily concerned with achieving high levels of automation, standardization and competitive prices through economies of scale. The system was focused on the productive process rather than on what the client expected. In

contrast Toyota developed a strong customer focus as part of its process of waste elimination and continuous improvement[46]. A core aspect of this was focusing only on those product features valued by customers, considering all other product characteristics as waste and therefore susceptible of elimination[47]. Moreover, by implementing a flexible production process, based on JIT inventory management and the contribution of empowered highly-skilled workers rather than on automation, Toyota was able to change product features quickly and at relatively low cost, and was therefore able to attend to the changing needs of customers in different market niches[48,8]. Another important aspect was the rapid redesign of products and processes after the initial introduction of a new product (products were tested in actual use rather than only under pre-production circumstances) with the result that much more information from users and producers could be assimilated and used to improve the product in a quick and systematic way. The lean philosophy of management was implemented in the West through the importation of a number of Japanese-inspired organizational innovations, including inventory management using just-in-time (JIT), product quality improvement through total quality management (TQM), total preventive management (TPM), and employee involvement in continuous improvement through quality circles (QC).

JIT inventory management was at the heart of continuous improvement at Toyota. It aimed to ensure that parts were delivered to the assembly line and products to the client at the exact moment they were needed[49]. JIT eliminated the need for large inventories and batch-and-queue systems, enabling a reduction in the size of lots, and keeping perfectly balanced production lines (*Kanban*). Implementation of JIT was extremely risky as any problems with supply meant that the assembly line would stop almost immediately[47]. However, this was also one of the strengths of the system, as it forced workers and engineers to anticipate problems before they occurred[20]. Establishing trust-based partnerships with suppliers through ensuring their direct involvement in product development and commitment to just-in-time delivery was therefore critical for the success of JIT. However some problems with JIT arose, including increased urban congestion, making travel time for parts less certain, and one-off events, such as earthquakes, causing major disruptions to supply chains.

TQM movement was widely adopted in Japan before the USA. TQM aims to continuously improve the quality of products and organizational processes through a focus on customer needs and the organization's ability to meet them[50,47]. Practices commonly associated with TQM include statistical process control, cross-functional product design, supplier management, customer focus and customer involvement[46].

Successful implementation of JIT and TQM was supported by TPM programmes and employee participation. TPM involved a set of planned maintenance interventions performed by operators aiming to avoid equipment breakdowns and disruptions in the production flow. Lean management also encompasses a set of participatory HRM practices. Among these, Quality Circles (QC) became the best known, and extensively implemented practice in the West[51]. Quality Circles increased employee involvement with their organizations through participation and were therefore considered to contribute to product quality and organizational effectiveness[52].

Lean management has been extensively implemented in American and European manufacturers[21]. In a 1992 survey of 694 American manufacturing firms, Osterman[53] found that practices such as teamwork, job rotation, Quality Circles and TQM had been implemented by 35% of organizations with more than 50 workers. A UK survey of the use of manufacturing practices among a sample of 564 firms with over 150 employees in 1996 found that TQM, JIT, supply-chain partnering, team-based working and integrated computer-based technology were adopted by over a third of organizations[54]. Four years later Wood *et al*[55] found that the implementation of lean practices had increased considerably, particularly TQM

and in relation to employee empowerment.

To be able to consider whether or not 'lean' can be considered a solution to addressing costs and waste in healthcare, we first examine the evidence of the impact of 'lean' in manufacturing performance.

### **Lean management and performance in manufacturing**

'Lean' offers a new paradigm of work organization, including trust-based relationships with employees, suppliers, and clients, and promised waste elimination, reduced costs, and improved product quality[8,20]. This occurs via the adoption of a number of operations and human resource management (OM, HRM) practices. These include JIT, TQM, TPM, cellular manufacturing, extensive cross-functional training and quality circles[49,56]. Despite enthusiasm for 'lean', research exploring the link between its adoption in manufacturing and subsequent performance has resulted in inconsistent findings.

Lean thinking has reached the USA and Europe in waves associated with the adoption of specific programmes and practices[26,57], creating a body of research analyzing the link between the implementation of single lean practices, namely TQM, JIT and employee participatory practices, and organizational performance. These streams of research have produced mixed results. For instance, Easton and Jarrell[58] compared the financial performance of 108 organizations that implemented TQM practices between 1981 and 1991 against a benchmark control of companies that did not implement such practices which were measured using both accounting variables and stock returns. They found that TQM-adopting firms had higher performance than those who did not implement formal practices of quality control. By contrast, using data from 339 manufacturing companies in the USA, Choi and Eboch[59] found that even though TQM practices were positively associated with customer satisfaction, their impact on plant performance was modest.

Research analyzing the impact of JIT on performance also produced mixed results. Kinney and Wempe[60] compared the financial performance of 201 JIT-adopting firms with matched non-adopters in the USA from a three-year pre-adoption period to a three-year post-adoption period. They found that JIT adopters significantly improved their profit margins compared to non-adopters. Similarly, in a study with 454 leading manufacturing corporations in the USA, White *et al*[61] found that firms benefitted from the implementation of JIT practices, even though not all forms of JIT led to productivity enhancements. By contrast, in a study of 55 manufacturing firms which adopted JIT between 1980 and 1990 in the USA, Hudson and Nanda[56] only found anecdotal evidence associating JIT positively with financial performance. Balakrishnan *et al*[62] also did not find consistent evidence of the financial benefits of JIT adoption among a sample of 46 manufacturers in the USA.

The strategic HRM literature also fails to offer consistent support for lean management. Cappelli and Neumark[63] evaluated the impact of participatory HR practices (autonomous teams, regular meetings to discuss work-related problems, teamwork training, job rotation, cross-training, pay-for-skill programmes, and profit-sharing) on organizational performance by comparing longitudinal data from 900 American companies in different sectors extracted from the National Employment Surveys of 1977 and 1997. Their evidence suggests that any financial advantages stemming from the adoption of high performance practices are somewhat offset by a clear increase in labour costs. By contrast, in a seminal study with a sample of 968 companies of different sizes and across different industries in the USA, Huseid[64] found consistent evidence of the role of high performance HRM practices, such as training, job design, and information sharing, on company productivity and profitability. Similar findings have been reported by Kato and Morishima[65] who investigated productivity and the impact of three sets of participatory employee practices-employee participation at the top level, employee participation at the grassroots level, and financial participation of employees using

panel data for Japanese firms. Their findings show that firms implementing these high-performance practices increased their productivity between 8% and 9% compared with non-adopters. Overall, research addressing the impact of specific lean practices on performance has produced mixed results and failed to provide a solid base upon which to advocate the case of lean management[47,66]. However, this literature is considered limited in its approach, as it does not address 'lean' holistically.

By contrast, several more recent studies have sought to overcome this limitation, e.g. by exploring whether the joint implementation of OM and HRM practices produces synergistic effects resulting in increased company performance. These results also demonstrate less than equivocal support for 'lean'. On the positive side, Flynn *et al*[46] in a study of 42 plants in three different industries in the USA, showed that operational performance is grounded on a foundation of overlapping practices associated with TQM and JIT. They found that while implementation of JIT and TQM practices in isolation has a positive impact on performance, joint implementation of both practices with 'common infrastructure practices' (e.g. information feedback, management support, supplier relationships, workforce management) yielded the most significant performance improvements. This was one of the first contributions showing that TQM and JIT practices interact: TQM improves JIT performance through reducing re-work time and process variance. Similarly, JIT practices reduce inventory and storage size and improve quality by reducing potential scrap and re-work.

Cua *et al*[47] examined the link between the integration of a larger number of lean practices and performance. Using a sample of 163 manufacturing companies in different countries, they showed that even though the implementation of TQM, JIT, TPM and HRM practices in isolation had a positive impact on specific operational performance indicators (cost efficiency, conform quality, on-time delivery, volume flexibility), joint implementation of OM and HRM practices is associated with overall firm performance improvements. Similar findings are reported by Shah and Ward[49]: a study of a sample of 1757 manufacturing firms in the USA showed that firm performance benefitted from the implementation of several lean practices. De Menezes *et al*[66] analyzed how joint implementation of seven OM and HRM practices influenced productivity among a large sample of British manufacturing companies over a 24-year period. Their findings indicate significant synergistic effects arise from the combined implementation of several 'lean' practices. Their study revealed that improved performance is not necessarily dependent on the implementation of a particular set of best practices, but depends more on the existence of an appropriate underlying managerial philosophy.

Not all studies looking at the integration of OM and HRM practices lend support to 'lean'. Birdi *et al*[67] conducted a longitudinal study of a sample of 308 manufacturing companies in the UK between 1982 and 2002 analysing the individual and collective impact of 4 OM (TQM; JIT; AMT; supply-chain partnering) and 3 HRM practices (empowerment; extensive training; team-based work) on productivity. Their findings indicate that performance benefitted from the implementation of empowerment and extensive training, although none of the OM practices in isolation contributed to productivity. However, they also found evidence of synergies between all 7 practices, although this seems to be due to the effect of supply-chain partnering and HRM practices. Other contributions conclude that the integration of lean practices has no effect on performance. Thus, Patterson *et al*[68] examined the impact of the adoption of integrated manufacturing (encompassing advanced manufacturing technology, JIT and TQM) and empowerment (job enrichment and skill enhancement) on organizational productivity and profitability among a sample of 80 manufacturing companies in the UK. They found that only advanced manufacturing technology (AMT) and empowerment are significantly associated with improved firm performance. They also found no significant interactions between lean

practices, concluding, "there is no convincing evidence to support the widely held view that integrated manufacturing and empowerment practices act synergistically to affect company performance"[68].

The extensive research on lean management to-date has been unable to offer clear-cut evidence that its implementation provides a sustainable competitive advantage. The lack of consistent results can be attributed to conceptual issues as well as important differences in research design. The first difficulty stems from the lack of agreement about the conceptual boundaries of each programme. This is reflected, for instance, in the operationalization of lean practices across studies. A number of contributions have operationalized lean practices using a single practice[63,67,69], whereas others have considered bundles of practices[46,47,50,68,70,71]. But there is no agreement about the practices pertaining to each programme. For instance, Fullerton *et al*[70] consider that JIT encompasses ten core practices (focused factory; group technology; reduced setup times; total productive maintenance; multi-function employees; uniform workload; *kanban*; JIT purchasing; total quality control; and quality circles). Their operationalization therefore considers that JIT includes quality improvement, maintenance and HRM practices. By contrast, other contributors have chosen to focus on more programme-specific practices. Thus, Snell and Dean[72] consider that JIT encompasses only five practices, assessing the degree to which firms seek to reduce inventories, lead times, the number of suppliers, the size of deliveries, and the total number of parts. Such disparity in the operationalization of lean practices creates additional difficulties in assessing which practices and programmes are significantly associated with performance. Some contributions have sought to address this issue by identifying the practices more consistently associated with each programme in the literature and proposing more useful operationalizations of lean management[46,47,49].

A second issue contributing to disparity in research results is the way performance has been assessed. Studies have measured performance as productivity[67,73], financial results[64,69] or operational improvements[46,47]. This creates difficulties in assessing the usefulness of lean management as some practices have a differential impact on distinct facets of performance. For instance, some OM practices seem to have a positive impact on operational performance, although this is not always reflected in productivity and financial results[63,68]. Some studies have assessed performance based on managers' perceptions[27,61], whereas others have measured the impact of lean practices using more objective productivity and financial data [74,75].

Finally, a third factor contributing to disparity in results is the research design adopted. Most studies rely on cross-sectional data[27,50,71] and therefore are limited in the sense that the time for the implementation of practices and any improvements in performance may be long and yet is often not taken into account. Kato and Morishima[65] found that it takes about seven years before firms can experience the full productivity effect from the implementation of employee participatory practices in Japan. There are fewer longitudinal studies assessing the impact of lean practices on performance. Some of the most important contributions are the studies conducted by Birdi *et al*[66] and De Menezes *et al*[67], although their support for lean management is less than clear-cut.

Overall, research exploring the possible advantages from the adoption of lean manufacturing has produced mixed evidence. This contrasts with the generalised enthusiasm with which managers, consultants and academics have welcomed it. Nevertheless, lean management has crossed the boundaries of industry and is being applied extensively in healthcare. The next section examines the use of lean practices in healthcare and reviews the evidence of its impact on performance.

### **Lean in the health sector**

'Codified' lean is the approach that has been adapted widely to service and health sector organisations in the UK and abroad.

The most successful of these adaptations seem to occur when service organisations seek to manage the series of steps that produce value as a whole, rather than in bits or silos. This “systems” approach has implications across the organisation, not least the measurement of productivity at the system level rather than by unit, which focuses management effort on global rather than local efficiencies. For lean to work, it requires a culture that supports continuous improvement and the consequent reduction of cost and headcount from systems.

Service characteristics are not an excuse for avoiding manufacturing methodologies as a means of efficiency gains. Some studies argue that any organisation can gain substantial benefits including improved quality, reduction in costs and increase responsiveness from at least some new practices[54]. Indeed supermarkets have been adopting lean techniques for improving the flow of customers for many years and there are strong benefits that can be gained from implementing Lean whatever the size or sector of the organization[76,77].

As with manufacturing, considerable research has been conducted on lean management within the healthcare sector. Continuous quality improvement programmes in healthcare and their impact on performance in the USA became prominent in the early 1990s[13], and later in Europe[78]. Although there are a large number of enthusiastic contributions proposing guidelines for the implementation of quality practices[79,80] and documenting case studies of successful implementation of quality improvement measures in healthcare[81-83], there is limited rigorous research assessing whether, and by how much, implementation of TQM in hospitals leads to higher performance. This is particularly the case for Europe. In the USA a number of studies have examined the impact of TQM practices on hospital performance. Douglas and Judge[84] revealed that the implementation of seven TQM practices (management team involvement; adoption of a quality philosophy; TQM-oriented training; focus on the customer; continuous improvement processes; management by fact; and use of TQM methods) in a sample of 229 hospitals had a significant positive impact on financial performance.

By contrast, analysing data from a sample of 61 hospitals, Shortell *et al*[85] reported the implementation of TQM philosophies and practices was not significantly linked to improved financial performance. Nonetheless, positive links to perceived patient outcomes, shorter length of stay and charges were found. Weiner *et al*[86] found mixed evidence about the impact of TQM programmes on performance using data from a sample of 1784 community hospitals. Alexander *et al*[87] suggest that a positive link exists between the intensity of implementation of quality improvement practices and lower costs per case. However, contrary to expectations, the extent of implementation of quality improvement practices was found to be negatively associated with patient safety indicators, such as post-operative complications and failure to rescue[88]. They also found that the involvement of hospital staff and managers' in quality improvement efforts had a positive impact on clinical performance, although this is not always replicated throughout medical and nursing care[89].

A number of other contributions from the strategic HRM literature, not necessarily called ‘lean’, suggest a positive link between high performance work practices and performance in healthcare. For instance, in a study among a sample of over 500 nurses from a large academic health centre in Canada, Kollberg and Dahlgard[95] found that empowerment was positively associated with perceived productivity and self-rated effectiveness. Kolberg *et al*[36] also explored the correlation and consequences of perceived psychological empowerment among a group of 612 healthcare professionals and managers in an American hospital. Their findings suggest that empowerment perceptions were associated with job satisfaction and work productivity/effectiveness, as well as a lower propensity to leave the organization. Harmon *et al*[96], drawing on data from 146 Veterans Health Administration centres in the USA, also show that high involvement work systems (HIWS: encompassing practices including performance-based rewards,

empowerment and teamwork) were strongly associated with higher employee satisfaction and financial performance. Despite the costs associated with HIWS, Health Administration centers implementing these sets of practices benefited from average annual savings of \$1.2 million. Wysocki[97] emphasised that hospitals are not factories, neither do doctors, nurses and other hospital staff think of themselves as akin to assembly-line workers, nor their patients as a product ‘under construction’. There is a clash between the culture of efficiency and the culture of caring, with doctors sceptical of the former; nor do they want to be told how to do things. In the UK, West *et al*[98,99] conducted studies using samples of acute Hospital Trusts showing positive links between progressive HRM practices (e.g. performance appraisal, training, teamwork and employee participation) and lower mortality rates.

There is a paucity of European evidence assessing the link between TQM implementation and performance in healthcare. In one of the few contributions, Kunst and Lemmink[90] explored the link between quality management, customer satisfaction and business performance using the criteria of the European Quality Award among a sample of 227 hospitals in Spain, the Netherlands and the UK. Their findings suggest a positive link between progress in TQM and perceived service quality by patients. However, the perceptions of patients' quality of experience and TQM implementations are only modestly associated with performance, as measured by occupation rate and financial results.

The most significant “Lean” contributions, highlighting the link between participatory HRM practices and performance in healthcare, stem from the American TQM literature. In particular, three studies conducted by Gowen III *et al*[91], emphasized the importance of leadership, empowerment and teamwork in enhancing operational and financial performance in hospitals. The first, using data from a survey of over 200 hospitals shows that a transformational leadership style is an effective catalyst of a patient safety chain[92]. Their findings suggest that leadership based on charisma and inspiration at the highest levels of the organization is associated with the creation of a culture of safety and the adoption of patient safety measures that are positively reflected in patient safety outcomes: e.g. reductions in the frequency, severity, and impact of errors, as well as increased understanding and awareness of errors.

Gowen III *et al*[93] explored the impact of strategic HRM on performance above and beyond the adoption of continuous quality improvement practices. The first, conducted among a sample of 587 hospital quality and risk directors, found that the implementation of both HRM and quality practices were linked with improved organizational performance. However, the findings found that quality management processes were more strongly associated with fewer healthcare errors and error reduction barriers, while strategic HRM practices (encompassing teamwork, extensive training, information sharing, rewards, recognition, and promotion opportunities) were a more effective way of achieving a sustainable competitive advantage. These findings were corroborated by a second study among a sample of 372 hospital managers in the USA[94] showing that employee commitment initiatives (information sharing, quality programme meetings, employee recognition, results sharing) and employee control initiatives (training, financial rewards, promotion opportunity) were more strongly associated with two dimensions of perceived quantitative (quality improvement, customer satisfaction increase, net cost savings, reduced error frequency, reduced error severity) and qualitative performance (increased understanding of error, heightened awareness of errors, reduction in impact of errors) than the implementation of a range of healthcare quality practices such as customer satisfaction, employee quality teams, statistical process control, benchmarking, and supply chain management.

More recently, a number of studies have reported the transplant of the TPS to hospital management [100]. Most of

these contributions consist of exploratory attempts to “determine whether and how the principles of TPS might apply to health care” [101]. In general, these studies describe single site interventions aiming to reduce medical and medication distribution errors [102,103], improving operating room turnover times[104], reducing waiting lists[105] and patient waiting times[106], and streamlining clinical trial protocols [107] and patient flows[111].

It was not until 2005 that the first attempts to implement lean management across hospital units have been reported in the literature. There are, however, no reported cases of lean implementations across an entire hospital[13]. The cases of the Virginia Mason Medical Center in the USA, Flinders Hospital in Australia and the Royal Bolton NHS Foundation Trust in the UK are among the best known. These hospitals have retained the notions of value, patient focus and continuous improvement from the TPS and implemented practices of value stream mapping and rapid process improvement teams/workshops which are considered to have had a positive impact on operational and financial performance. Bohmer and Ferlins[108] report how Virginia Mason Medical Center embraced managerial principles from the TPS to address financial losses and competition from other hospitals. As a result of waste reduction and streamlined processes, staff walking distance was reduced by 38%, the travel distance of parts declined 77% and lead time was cut by 53%. In addition, there was a 44% gain in productivity and savings between 12 and 15 million dollars between 2000 and 2002.

Ben-Tovim *et al*[109] reported how lean principles were applied at the Flinders Medical Centre in Australia to redesign the triage system in the emergency department. The new system was inspired by Toyota’s manufacturing cells and divided patients in two groups: those likely to go home and those likely to be admitted to hospital. The steps needed to complete the journey of these two patient-care groups through the hospital were mapped and streamlined in order to identify waste and simplify the process. The Emergency Department was redesigned and two production cells were created to focus on each patient-care group. During the first year of implementation the number of patients leaving without treatment was reduced from 7% to 3%, and the time patients spent in the department was cut by 48 minutes. Casey *et al*[110] noted that within the US ambulatory care setting lean management facilitated the identification and elimination of waste. The key concepts of flow time, inventory and throughput were utilized to improve the flow of patients through the clinic, and to identify points that slow this process. Nonessential activities were shifted away from bottlenecks (identified in this case as the physician), and extra work capacity was generated from existing resources. They argued that additional work capacity facilitated a more efficient response to variability, which in turn results in cost savings, more time for the physician to interact with patients, and faster completion of patient visits. However, application of ‘lean’ via ‘just-in-time’ did eliminate excess clinic inventory and synchronized with patient demand reduced costs, but the effect on quality of care was not quantified. This captures the trade-off between cost and quality – the former is clearly identified while the latter is extremely difficult to quantify.

In the UK, Bolton Hospitals NHS Trust is considered to be at the forefront of lean implementation. In order to address a spiraling financial deficit and problems with long waits for diagnostics and treatments, Bolton Hospitals adopted a lean philosophy, implementing a series of rapid improvement events throughout its departments[112]. Multidisciplinary teams of doctors, nurses, therapists, managers and patients focused on patient’s flow from arrival to discharge to identify waste, sources of error and duplication. Their efforts resulted in significant operational and financial improvements. For instance, in the trauma services there was a 42% reduction in paperwork, a 38% reduction in the time taken to get patients into theatre with a fractured hip, a 33% reduction in the length of stay, and a 36% reduction in mortality. In pathology there was a 10%

increase in income with 2% fewer staff, a 50% reduction in floor space, and a reduction in the average time to process blood from 5 hours to 1 hour.

Overall the research evaluating the impact of lean practices on healthcare performance, particularly the contributions which focus on the implementation of strategic HRM and TPS practices, offer encouraging support for the transplant of lean practices from manufacturing. However, the evidence is limited and needs to be interpreted with caution. There are three reasons for this:

I) While the impact of lean management in industry is evaluated against mass production, there is not a universally accepted organizational paradigm in healthcare against which any changes in performance can be benchmarked. Given that better performing organisations are also likely to be at the forefront of innovation, it is unclear whether any improvements in performance result from the added value of lean practices or from pre-existing differences in performance between organisations.

II) The majority of studies focusing on the implementation of TPS principles in hospitals, report successful interventions aiming to reduce waste and increase performance within specific types of units, which limits the possibility of generalising findings to the healthcare sector[88]. So the ability to generalise results across healthcare is limited.

III) These interventions seem, in general, to be promoted by champions of change[113]. This raises doubts about their sustainability or ability to scale up to other areas of healthcare. Hence, with the exception of progressive HRM practices, which the industry literature has also positively associated with performance, there is limited evidence that lean management is a panacea against the rising costs in public healthcare and patient safety issues. These are summarised (Table 1).

## Discussion

Proponents of ‘lean’ argue that health care can benefit from its application: from waste and cost reduction, to increasing the quality of care for patients, to the application of techniques to reduce turnaround time in critical services. However, applying lean management principles in health care also has its limitations.

The primary difficulty with its introduction is that large healthcare providers are diverse organisations with complex demand and resource issues, exacerbated by technological developments and human perceptions. These complexities manifest themselves across a range of issues as diverse as the timeliness of provision to levels of patient satisfaction. While the timeliness of service delivery is relatively easily defined and accepted in a manufacturing setting, delivery in the health sector is not always a linear process, but is dependent on complex supply factors. Timeliness of service delivery is diffuse and influenced by culture, expectations and perceptions which differ regionally and internationally. Cost factors, both financial and economic, create unique demands for the health sector which are entirely disparate to those in the manufacturing sector[114]. Equally, in terms of quality there are contested viewpoints as to the efficiency of lean management, particularly over short term versus long term costs, e.g. the accuracy and cost benefit of prostate specific antigen testing being a case in point (*ibid*). Lean management processes may not be able to be applied universally to a system in which human perceptions mix with easily measureable input/output processes, and where the cost and quality outcomes may not be directly connected or even understood. Quality is a perceived experience based principally on expectations rather than predictable outcomes: overall patient satisfaction is dependent on factors which negate many aspects of lean principles, and are entirely different from manufacturing. Thus the dilemma faced by lean management is the trade-off between cost and quality – the former is clearly identified while the latter is extremely difficult to quantify cogently[115]. Healthcare is different from manufacturing; lean techniques cannot be easily replicated or transplanted.

**Table 1.** Summary results of main studies on Lean management in health sector

Authors & reference number	Date	Summary of study/Conclusion
13. Bigelow & Arndt	1995	Continuous quality improvement (CQM) in healthcare, USA
78. Øvretveit	2000	Continuous quality improvement (CQM) in healthcare, Europe
79. James <i>et al</i>	1993	Proposed guidelines for the implementation of quality practices
80. Milakovich	1991	
81. Counte <i>et al</i>	1992	Case studies of successful implementation of quality improvement (TQM) measures in healthcare
82. Duncan <i>et al</i>	1991	
83. Rowen	1992	
84. Douglas and Judge	2001	The impact of TQM practices on hospital performance, USA: implementation of seven TQM practices) in a sample of 229 hospitals had a significant positive impact on financial performance.
85. Shortell <i>et al</i>	2005	Implementation of TQM philosophies and practices <i>not</i> significantly linked to improved financial performance.
86. Weiner <i>et al</i>	2008	The impact of TQM programmes on performance using data from a sample of 1784 community hospitals
87. Alexander <i>et al</i>	2006	A positive link exists between the intensity of implementation of quality improvement practices and lower costs per case.
88. Weiner <i>et al</i>	2006a	Contrary to expectations, the extent of implementation of quality improvement practices was found to be negatively associated with patient safety indicators, such as post-operative complications and failure to rescue
89. Weiner <i>et al</i>	2006b	The involvement of hospital staff and managers' in quality improvement efforts had a positive impact on clinical performance, although this is not always replicated throughout medical and nursing care
90. Kunst and Lemmink	2005	A positive link between progress in TQM and perceived service quality by patients. However, the perceptions of patients' quality of experience and TQM implementations are only modestly associated with performance, as measured by occupation rate and financial results. (Spain, Netherlands, UK)
91. Gowen III <i>et al</i>	2006a	The link between participatory HRM practices and performance in healthcare, USA: emphasized the importance of leadership, empowerment and teamwork in enhancing operational and financial performance in hospitals
92. McFadden <i>et al</i>	2009	Data from a survey of over 200 hospitals shows that a transformational leadership style is an effective catalyst of a patient safety chain. Suggests leadership based on charisma and inspiration at the highest levels of the organization is associated with the creation of a culture of safety and the adoption of patient safety measures that are positively reflected in patient safety outcomes: e.g. reductions in the frequency, severity, and impact of errors, as well as increased understanding and awareness of errors
93. Gowen III <i>et al</i>	2006b	The impact of strategic HRM on performance above and beyond the adoption of continuous quality improvement practices. A sample of 587 hospital quality and risk directors found the implementation of both HRM and quality practices linked with improved organizational performance. However, the findings found that quality management processes were more strongly associated with fewer healthcare errors and error reduction barriers, while strategic HRM practices (encompassing teamwork, extensive training, information sharing, rewards, recognition, and promotion opportunities) were a more effective way of achieving a sustainable competitive advantage
94. Gowen III <i>et al</i>	2006c	A sample of 372 hospital managers (USA) showed employee commitment initiatives (information sharing, quality programme meetings, employee recognition, results sharing) and employee control initiatives (training, financial rewards, promotion opportunity) were more strongly associated with two dimensions of perceived quantitative (quality improvement, customer satisfaction increase, net cost savings, reduced error frequency, reduced error severity) and qualitative performance (increased understanding of error, heightened awareness of errors, reduction in impact of errors) than the implementation of a range of healthcare quality practices such as customer satisfaction, employee quality teams, statistical process control, benchmarking, and supply chain management.
95. Kollberg and Dahlgard	2001	A sample of over 500 nurses from a large academic health centre (Canada) found that empowerment was positively associated with perceived productivity and self-rated effectiveness.
36. Koberg <i>et al</i>	1999	Explored the correlation and consequences of perceived psychological empowerment among a group of 612 healthcare professionals and managers in an American hospital. Empowerment perceptions were associated with job satisfaction and work productivity/effectiveness, as well as a lower propensity to leave the organization
96. Harmon <i>et al</i>	2003	Data from 146 Veterans Health Administration centers (USA) show that high involvement work systems (HIWS: encompassing practices including performance-based rewards, empowerment and teamwork) were strongly associated with higher employee satisfaction and financial performance. Despite the costs associated with HIWS, Health Administration centers implementing these sets of practices benefited from average annual savings of \$1.2 million
97. Wysocki	2004	Emphasised that hospitals are not factories: doctors, nurses and other hospital staff <i>do not</i> think of themselves as assembly-line workers, nor their patients as a product 'under construction'. There is a clash between the culture of efficiency and the culture of caring,



99. West <i>et al</i>	2002, 2006	with doctors sceptical of the former; nor do they want to be told how to do things Samples of acute Hospital Trusts (UK) show positive links between progressive HRM practices (e.g. performance appraisal, training, teamwork and employee participation) and lower mortality rates.
100. Jimmerson <i>et al</i>	2008	"whether and how the principles of TPS might apply to health care"
101. Ballé & Régnier	2007	Describe single site interventions aiming to reduce medical and medication distribution errors
102. Raab <i>et al</i>	2006	improving operating room turnover times
103. Leslie <i>et al</i>	2006	improving operating room turnover times
104. Hobson	2007	Reducing waiting lists
105. Lodge and Bamford	2008	Reduced patient waiting times
106. McJoynt <i>et al</i>	2009	Streamlining clinical trial protocols
108. King <i>et al</i>	2006	Streamlining patient flows
12. Burgess <i>et al</i>	2009	No reported cases of lean implementations across an entire hospital
108. Bohmer and Ferlins	2005	How Virginia Mason Medical Center embraced managerial principles from the TPS to address financial losses and competition from other hospitals. As a result of waste reduction and streamlined processes, staff walking distance was reduced by 38%, the travel distance of parts declined 77% and lead time was cut by 53%. In addition, there was a 44% gain in productivity and savings between 12 and 15 million dollars between 2000 and 2002.
109. Ben-Tovim <i>et al</i>	2007	Lean principles were applied at the Flinders Medical Centre in Australia to redesign the triage system in the emergency department. Inspired by Toyota's manufacturing cells, patients were divided into two groups: those likely to go home and those likely to be admitted to hospital. The steps needed to complete the journey of these two patient-care groups through the hospital were mapped and streamlined in order to identify waste and simplify the process. The Emergency Department was redesigned and two production cells were created to focus on each patient-care group. During the first year of implementation the number of patients leaving without treatment was reduced from 7% to 3%, and the time patients spent in the department was cut by 48 minutes
110. Casey <i>et al</i>	2009	noted that within the US ambulatory care setting lean management facilitated the identification and elimination of waste
111. Fillingham	2007	Bolton Hospitals NHS Trust (UK) considered to be at the forefront of lean implementation, implementing a series of rapid improvement events throughout its departments. Multidisciplinary teams of doctors, nurses, therapists, managers and patients focused on patient's flow from arrival to discharge to identify waste, sources of error and duplication. Their efforts resulted in significant operational and financial improvements. For instance, in the trauma services there was a 42% reduction in paperwork, a 38% reduction in the time taken to get patients into theatre with a fractured hip, a 33% reduction in the length of stay, and a 36% reduction in mortality. In pathology there was a 10% increase in income with 2% fewer staff, a 50% reduction in floor space, and a reduction in the average time to process blood from 5 hours to 1 hour.

Nonetheless, were 'lean' to be grafted onto a health care provider, business process improvement methodologies (BPIMs) would need to be introduced. This would require a cultural change unheralded in the history of the NHS. BPIMs are built upon staff and management autonomy unrestricted by political interference. Because the NHS is a highly politicized organization, a decentralized autonomous management structure would be problematic and politically sensitive. At this juncture it must be noted that the introduction of BPIMs in manufacturing was an evolutionary process, and this must be the same for lean in health care. Lean structure needs an overall strategy built on capable leadership, monitoring of behaviour and engagement with all stakeholders. Without such underlying enablers effective lean management becomes an illusion and its implementation a delusion. Ultimately it may not be possible to directly apply lean management to health care delivery; lean is not a single point invention, but the outcome of a dynamic value creating learning process. Lean management in manufacturing was a learning process; with the NHS the same would be true. The challenges lie not in theory but as always, in application.

Value is sometimes difficult to specify in services because they deliver important intangible benefits (e.g. trust) alongside the tangible benefits (improved health). The danger, in these circumstances, is that improvement efforts focus on the short-term, easily measured aspects of the service and neglect the

intangible outcomes. It is necessary to balance short-term, proxy-markers of value with some estimation of the true value of the service, even if wholly qualitative, in order that the whole system (i.e. the value stream) can be identified and improved[116].

A defining characteristic of services is that the tasks that deliver them can vary in time and standards. In manufacturing, standardisation of tasks is used to overcome this, but much of the variability of services comes from the variability of input from customers (customers buying cars specify their demands within a limited set of alternatives; customers needing the help of health services tend to make complex and variable demands on providers. In lean services this variability is reduced by reducing the variability in performance between individual health professionals while relying on their flexibility, intelligence and judgment to work effectively[75,116].

A common feature of health services is a relatively high variation in patient demand by volume and type of services. A significant proportion of this demand is likely to be generated by an earlier unsatisfactory experience (i.e. an earlier failure to deliver the service effectively). There is also likely to be a degree of missed demand where people give up trying to get through on busy telephones or lengthy service waiting times or modify their demands because of low expectations of a capability to help them. When the demand is really understood, patterns can be identified that help the organisation respond

and improve[75,116].

Another source of variability and errors in services derives from the many units or compartments, inside and outside a health care organisation, that are involved in service provision. This leads to many hand-overs of work and therefore chances of error, delay, misunderstanding or variation. Because of the variety of organisations and people that are involved, and because these risks are well known, there are often many reviews and checks built into delivery systems. All these reviews and check are, in lean terms; represent unnecessary work caused by the poor design of the system[116].

It is clear that healthcare is not directly or easily comparable to manufacturing. Healthcare systems are driven by healthcare expenditure, with resources dictating volume of provision. While 'lean' may be applied in some instances it is important to recognize fundamental differences. Despite the importance of lean management, it cannot be viewed as a panacea for all operational issues that plague healthcare, particularly in light of implementation issues in large organizations.

## Conclusion

This review of the literature on the application of lean management in the health sector reveals mixed results. Whether this is due to the relatively small sample of studies, or because of the differing ways in which lean has been implemented cannot be determined here. The evidence in the current literature shows neither overwhelming support towards the acceptance of 'lean' as a concept that can be applied to the health sector, nor of its outright rejection. However, evidence revealed within the literature suggests that related lean concepts, tools and techniques could only ever be 'piecemeal' due to the need for service processes to be able to cope with a wider variety of outputs and accompanying uncertainty rather than to be more standardised and inflexible, as is often the case in manufacturing. This may be due to the greater capital intensity required in manufacturing compared to the heavier labour intensity in healthcare.

Research evaluating the impact of lean practices on healthcare performance, particularly those contributions focusing on the implementation of strategic HRM and TPS practices, offers some encouraging support for the application of lean practices imported from manufacturing. But, the evidence remains limited and needs to be interpreted with caution. There are two primary reasons for this. First, while the impact of lean management in industry is evaluated against mass production, there is no universally accepted organisational paradigm in healthcare against which any changes in performance can be benchmarked. Given that better performing organisations are also likely to be at the forefront of innovation, it is not clear whether any improvements in performance result from the added value of lean practices or from pre-existing differences in performance between organisations. Second, the majority of contributions, particularly those studies focusing on the implementation of TPS principles in hospitals, report successful interventions aiming to reduce waste and increase performance within specific units, which limits the possibility of generalising findings to the healthcare sector[89]. These interventions seem to be in general promoted by champions of change[113] which raises some doubts about their sustainability. Hence, with the exception of progressive HRM practices, which the industry literature has also positively associated with performance, there is limited evidence that lean management is a panacea against the rising costs in public healthcare and patient safety issues.

The literature does not support the position that 'lean' can be successfully adapted for use extensively in the health sector to achieve a wide variety of strategic objectives. Some of the literature cautions against simple replication of existing manufacturing-based approaches in the health sector, suggesting that service organisations need to move away from the restrictive rationale of the manufacturing version of 'lean'. This position contrasts with the generalised enthusiasm with

which some managers, consultants and academics welcome lean management. It may well be pertinent and relevant to complete a form of reverse engineering research looking at its application in the health sector and comparing it against a truly comparable manufacturing equivalent, if one exists.

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