

# Does your EHR support a Learning Healthcare System?

## An exploration of possible indicators

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### Abstract

**Background:** The Learning Health System is a concept born from the Institute of Medicine roundtable in 2006 which aims for overcoming the limitations of evidence-based medicine. Since its conception several nations and organizations have actively proposed health policies, research plans, and innovation strategies for its implementation. The effective realization of practices enabling a Learning health system hinge on the availability of Information system functionality and tools.

**Objective:** To describe the EHR functionality that is needed and corresponding indicators for use in evaluation.

**Methods:** Analysis of the content of influential scientific publications on the topic.

**Results and discussion:** The key enabling practices are linked to the life-cycle of biomedical knowledge as well as to knowledge on how to implement evidence-based care.

### Keywords

Learning health system; Learning healthcare system; Learning health care system; Electronic health record; Evaluation of EHR;

## 1 INTRODUCTION

### 1.1 Learning health system

Learning Healthcare System (LHS) is a US health policy initiative and research agenda that was conceptualized by the Institute of medicine (now the National Academy of medicine) in 2006 to identify and address the need for ‘reengineering clinical research and healthcare delivery’ to advance the systematic development and implementation of evidence-based medicine [25]. The initiative has developed into a broad research agenda that is supported by a worldwide community of researchers.

According to Friedman [13], learning refers to having access to, and analyzing data to continuously seek to improve care by developing and implementing new knowledge. Health is both a valuable objective and an imperative for high quality care. System relates to the components that must act in unison to “achieve goals not attainable by any subset of the components”.

The Learning health system (LHS) initiative has been developed against the backdrop of accelerating healthcare costs, unequal access to care, and a plethora of quality and safety issues in the US and elsewhere. Although the possible benefits of LHS have been ascertained, for instance, in PEDSnet, and TRANSFoRm project, there has been little adoption in practice [9], [11], [26], [10]. A wide range of barriers can be identified when implementing LHS, such as: ethical issues, the complexity of clinical decision-making, missing data (patients data are dispersed across multiple organizations), and the ability of clinicians to routinely used, maintain, and monitor routinely produced data extracted from EHR [11],[5]. In line with the discussion aforementioned,

Nordic healthcare has established initiatives to promote and accelerate high-quality care by promoting a transparent and knowledge-based healthcare system, capable of sharing data across sectors and secondary use of data gathered in everyday practice [8]. Furthermore, since 2012 the Nordic council of ministers has supported a Nordic network cooperation on indicator development [17].

Most of the literature on LHSs is mainly theoretical [27]. Several models and frameworks have been developed in the last decade [2]. A framework for value-creating learning health systems [22] seems to fit with the Nordic healthcare system. Their framework has four elements that characterize an LHS: core values, pillars and accelerators, processes, and outcomes. Their core values are also valued in Nordic healthcare: participatory leadership, inclusiveness, scientific rigor, person-centeredness, equity, and solidarity.

### 1.2 Electronic health records

Electronic health records (EHR) are health information systems that manage and integrate: a) clinical notes; b) medical tests such as laboratory, pathology etc.; c) PACS of medical image systems; and other ancillary systems such as Clinical Decision Support modules [16]. An EHR can be considered an information system for the programming, delivery, documentation and assessment of knowledge-, competence- and skills- based care in a safe and effective manner. The scientific literature describes a Learning health system as a socio-technical system [14], and the performance of the system hinges on the comprehensive and effective interaction between the human worker and the system. Etheredge [9] defines a LHS as a system that generates and applies data from EHR to increase the value of healthcare.

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### 1.3 Evaluation science

LHSs architectural framework comprises of five dimensions: scientific, technical, ethical, social, and goals. Lessard's framework suggested six decision layers that adjust these dimensions: The performance layer models goals, the scientific layer, the organizational layer, the data, and information technology layer, and the ethics and security layer [18]. Our focus in the present paper is on the data and information technology layer, more specifically on LHS which generates and applies data derived from EHR.

Like any other healthcare technology, an EHR is a product of design and engineering. Just like biomedical knowledge, health information technologies are conceptualized, designed, developed, taken into use, assessed, evaluated, phased out and, in the end, replaced by something newer and hopefully better.

The evaluation and assessment of EHRs and other health information system tools both serve to validate the chosen designs and to assess the true outcomes of using the technology. The science of evaluation of health information systems is the key to accelerate learning, both in the organizations that design, engineer and sell such systems as well as among their customers.

An LHS, with its socio-technical nature, makes them difficult to evaluate [14]. In addition, the very nature of an LHS is a system that is constantly evolving. The outcome measures and available data may also evolve.

One of the biggest challenges in evaluating research on LHS is defining relevant indicators, outcomes, and levels of measurement [4]. LHS and EHR share similar barriers and facilitators [20], [21].

As a means to assess and foster good designs as well as killing bad designs, evaluation science is the key to quick but lifelong learning in the health informatics community. Considering that EHR is an essential prerequisite for implementation and expansion of LHS, it is imperative to identify indicators for evaluating the contribution of EHR to a learning healthcare system.

### 1.4 Objective

To describe the EHR functionality that is needed to support a Learning healthcare system and to develop candidate indicators that can be used as a starting point in the evaluation of EHRs with respect to the ability to support Learning health systems.

### 1.5 Research question:

What are the potential indicators and which data can say something about their value?

## 2 METHODS

Focussed review on the literature on learning healthcare systems. Sampling strategy: A comprehensive search was conducted in June 2022, using the PubMed (MEDLINE) and Scopus databases. The search was limited to articles published between 2007 and 2022. The keywords used were: "learning health systems" OR "learning healthcare system" OR "learning health care system" AND "electronic health record".

Inclusion criteria: We included papers that complied with any of the following criteria: (a) explained the concept of the Learning Healthcare System; (b) covered the implementation of an LHS; (c) described the evaluation of a LHS reporting on key features to evaluate it. Articles that fulfilled inclusion criteria, and that present a significant theoretical cornerstone of key features of the LHS system and articles that describe the implication of EHR to accelerate the development of an LHS were revised and included in the paper..

Exclusion criteria: papers covering specific implementations such as AI projects reusing data from EHR but not clearly framed within a LHS were excluded.

Database search resulted in 2859 articles.

Firstly, papers were checked on title only, by reviewer (OG), excluding 2734 studies. Secondly, title and abstract were checked excluding 12 studies. Thirdly, full text review was performed by reviewers (AF and OG) excluding 71 studies. Articles meeting inclusion criteria but containing information that is covered in the already cited sources were excluded due to the page number limitation, which was set by the conference committee. The full flowchart for the screening of articles is depicted in Figure 1

We did not use any specific extraction form. For each publication we identified all the aspects that were likely to contribute to the implementation of LHS. Whenever possible we mapped LHS implementation contributors to potential indicators of success in the LHS adoption.

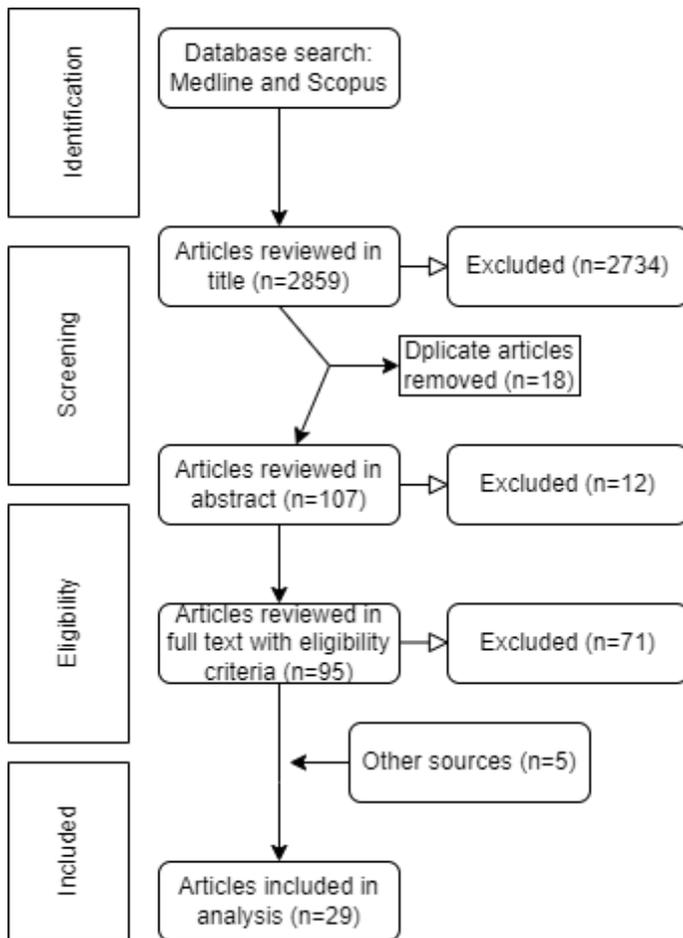


Figure 1. Flowchart followed in the review.

## 2.0 Results

### 2.1 Features of a learning health system

Since a health system is a socio-technical system, this means that the technology alone does not suffice to provide services that are of value to the patient. In such a socio-technical system, people that are engaged in the key enabling practices are supported by data and effective tools [13]. Greene [15] describes an evolving learning health system and a model for implementing learning health system practices in a healthcare organization. In the UK, McLachlan and co-workers have developed a conceptual framework to characterize learning health systems [19].

Taken together, the key enabling practices are related to insight- and knowledge-building as well as implementation and dissemination of care delivery practices that are data-driven and based upon the developed insights and knowledge.

### 2.2 Health information system functionality to support a learning health system

A list of EHR / Health information system back-end functionalities and human-facing front-end tools are presented in table 1. The functionality encompasses the automatic sampling of patient-controlled data, analysis of data for knowledge development, risk modeling, programming, delivery, documentation, and assessment of care.

### 2.3 Possible indicators

[A list of possible indicators is also presented in table 1.](#)

Learning health system feature or functionality	Possible Indicator
Functionality for automatic sampling and storage of data about the health problem, the care that is provided and the care outcomes [3], [20], [21].	Data that are sampled by the patient are made accessible for the decision-maker via the EHR Outcome data that are recorded by the patient are available and can be integrated and analyzed together with data about the processes that contributed to the outcome.
Access to a shared health data infrastructure [11], [1], [7].	The EHR can be used to share and aggregate data about patients with rare diseases.
Access to a shared knowledge development infrastructure [7], [24].	The EHR can be used to enact the participation in multicenter clinical trials
Functionality to define and characterize patient cohorts with use of data from multiple sources [7], [20], [21], [29].	The EHR can be used to define and characterize patient cohorts
Functionality for system-wide surveillance of safety of health operations [15], [20], [21].	The EHR can be used to monitor the safety of health operations across the healthcare system The EHR can be used to describe and assess the quality of the care that has been provided to patients in the cohorts
Functionality to characterize and assess the quality of care that has been provided to the patients that constitute the cohort [15], [23].	Data from the EHR can be used to train a machine with the objective to model and assess risk (Predictive patient risk modeling)
Tools to apply insights and experiences of what works into doable programs of care that are ready to be implemented in clinical workflows across the health system [15], [1].	Data from the EHR can be used to train a machine with the objective to model and assess risk (Predictive patient risk modeling) Availability of EHR functionality that supports the implementation, monitoring and evaluation of care pathways, documentation templates and order sets.

Tools to make clinically relevant knowledge available at point of care across the entire healthcare system [15], [16].

Tools that engage patients in decision-making [28].

Tools to disseminate learning health system practices in wider networks [15], [20], [21].

Availability of EHR functionality that supports the implementation, monitoring and evaluation of Clinical decision-support.

Patients can use a GUI to enact in shared decision-making

Availability of EHR - functionality to share and disseminate knowledge artifacts by using open, standardized formats (e.g Open CDS) and shared knowledge repositories.

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**Table 1** Features of a Learning health system and the corresponding indicators.

## 2.4 Data sets that can inform the value of those indicators

The data should preferably be obtained from the data sets that directly arise from clinicians', application analysts' or business intelligence developers' use of the EHR-system. The use of survey constructs is an alternative when system- or log data cannot be obtained.

## 3 DISCUSSION

According to McLachlan's framework [19], the operability of an LHS relies on the functionality of the EHR. In order to deliver patient-centered/ personalized care, data within EHR should be available, capable of transferring to a different context, and possible to share across multiple organizations. LHS can be seen as an expansion of the existing health care system into a system that is adept at learning from patient data [12]. Furthermore, routinely collected data can give a more accurate and detailed picture of the clinical care, contrary to the data collected specifically for the purpose of research [6].

To our knowledge, there is no data available about candidate indicators that can be used as a starting point in the evaluation of EHRs with respect to the ability to support Learning health systems.

In this report, we have motivated the development of indicators for assessing EHR-system back-end functionality and clinician-facing front-end tools that aid in the realization of Learning health systems. The list of indicators can inform the search for the data points that can be used to populate the indicators.

## 4 CONCLUSION

The scientific literature describes a Learning health system as a socio-technical system. In such a system, people that are engaged in the key enabling practices are supported by data and effective tools. In a Learning health system, key enabling practices are related to insight- and knowledge-building as well as implementation and dissemination of care delivery practices that are data-driven and based upon the developed insights and knowledges. We have drafted and presented a list of possible indicators for assessing HER functionality that are to support the key enabling practices.

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