

Systematic Review of the Application of Lean and Six Sigma Quality Improvement Methodologies in Radiology

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Abstract

Purpose: Preventable yet clinically significant rates of medical error remain systemic, while health care spending is at a historic high. Industry-based quality improvement (QI) methodologies show potential for utility in health care and radiology because they use an empirical approach to reduce variability and improve workflow. The aim of this review was to systematically assess the literature with regard to the use and efficacy of Lean and Six Sigma (the most popular of the industrial QI methodologies) within radiology.

Methods: MEDLINE, the Allied & Complementary Medicine Database, Embase Classic + Embase, Health and Psychosocial Instruments, and the Ovid HealthStar database, alongside the Cochrane Library databases, were searched on June 2015. Empirical studies in peer-reviewed journals were included if they assessed the use of Lean, Six Sigma, or Lean Six Sigma with regard to their ability to improve a variety of quality metrics in a radiology-centered clinical setting.

Results: Of the 278 articles returned, 23 studies were suitable for inclusion. Of these, 10 assessed Six Sigma, 7 assessed Lean, and 6 assessed Lean Six Sigma. The diverse range of measured outcomes can be organized into 7 common aims: cost savings, reducing appointment wait time, reducing in-department wait time, increasing patient volume, reducing cycle time, reducing defects, and increasing staff and patient safety and satisfaction. All of the included studies demonstrated improvements across a variety of outcomes. However, there were high rates of systematic bias and imprecision as per the Grading of Recommendations Assessment, Development and Evaluation guidelines.

Conclusions: Lean and Six Sigma QI methodologies have the potential to reduce error and costs and improve quality within radiology. However, there is a pressing need to conduct high-quality studies in order to realize the true potential of these QI methodologies in health care and radiology. Recommendations on how to improve the quality of the literature are proposed.

Key Words: Quality improvement, Lean, Six Sigma, radiology, diagnostic imaging

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INTRODUCTION

In its 2000 report *To Err Is Human: Building a Safer Health System*, the Institute of Medicine noted that 98,000 patients die in the hospital each year from preventable medical error, spawning a renewed focus on health care quality. More than a decade later, follow-up studies

indicate that the goals set by the Institute of Medicine to reduce medical error have not been met despite continued spending [1]. Indeed, US health care spending is projected to grow 1.1% faster than the gross domestic product, rising from 17.4% of the gross domestic product in 2013 to 19.6% by 2024 [2]. Moreover, by 2015, health care spending was anticipated to reach \$10,000 per person for the first time in US history [3], an arguably unsustainable figure. As a consequence, the public and government are all demanding improvements in health care quality, while insisting on reducing health care costs, a seemingly paradoxical request.

The field of radiology has not escaped attention, as error rates approach 10% [4,5], while being a large consumer of health care dollars. Hence, many regulatory organizations are now mandating that radiology

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departments undertake quality improvement (QI) and cost-savings initiatives [6], and as a result, a variety of methodologies to improve quality have been proposed. Of these, industrial QI methodologies, such as Lean and Six Sigma, show a great deal of potential and relevance to the field of radiology because they focus on empirical changes to the system, not just the individual, with the goal of improving workflow and reducing variability.

The Lean methodology dictates that the utilization of resources for any goal other than the creation of value is wasteful and should be eliminated. In radiology, this translates into strategies to reduce quality metrics such as wait times and increase patient satisfaction. Tools supporting Lean (eg, value stream mapping) have been used successfully in imaging departments to improve the efficiency and quality of care. Six Sigma uses a structured cycle (define, measure, analyze, improve, and control) by

which to identify and solve quality issues. Sometimes both methodologies are combined in what is termed Lean Six Sigma.

Systematic reviews have been conducted to investigate the effectiveness of these methodologies in various health care settings [7-11], but the benefits within the field of radiology remain unknown. Hence, the aim of this study was to conduct a systematic review to investigate the effectiveness of applying Lean, Six Sigma, or Lean Six Sigma within the field of radiology.

METHODS

A systematic review was performed in accordance with current best practices through close adherence to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses [12] statement (Fig. 1) and the *Cochrane*

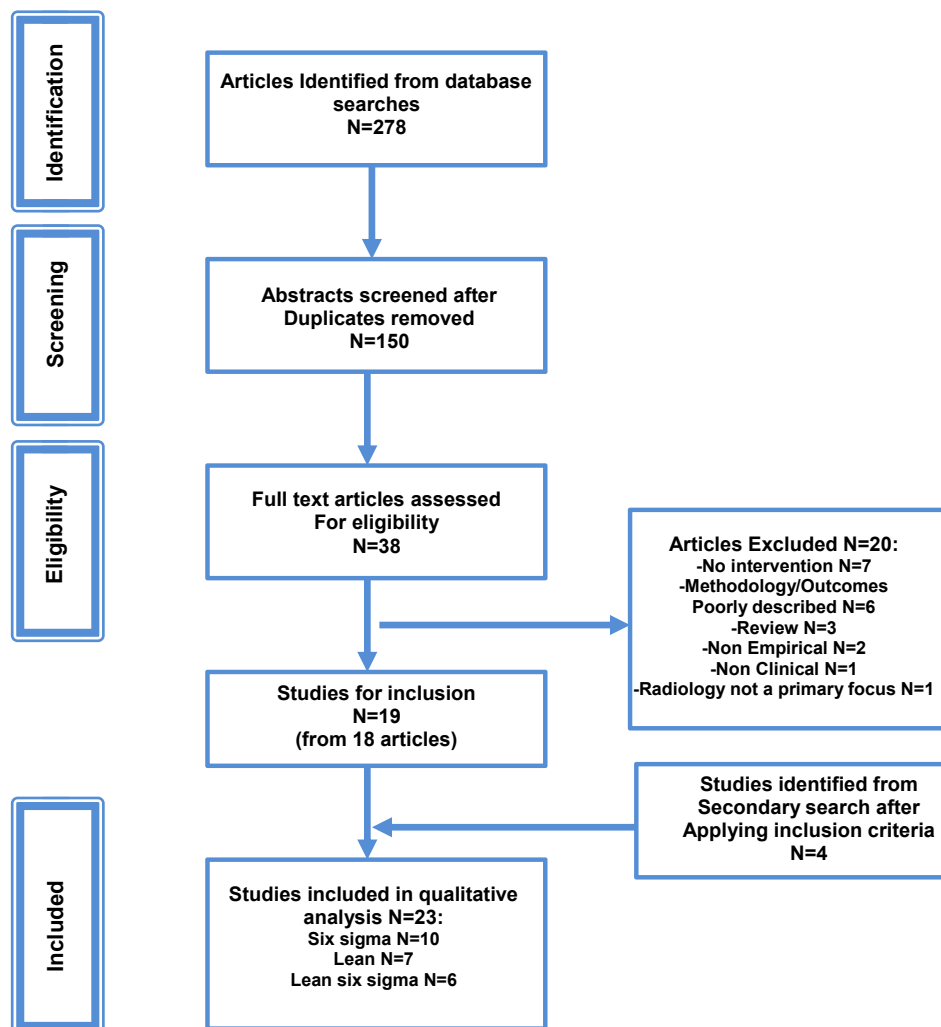


Fig 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow diagram of included studies.

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