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## **A Design Science Research Approach to Reduce Multiple Sclerosis (MS) Misdiagnosis**

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## A Design Science Research Approach to Reduce Multiple Sclerosis (MS) Misdiagnosis

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The objective of design science research is to develop novel technology-based solutions to important and relevant problems [1]. One such problem is the extended length of time it sometimes takes multiple sclerosis (MS) patients to be formally diagnosed, as well as the misdiagnoses that they experience along their journey to MS diagnosis. The National Institute for Health and Care Excellence (NICE) recommends a timeline of 12 weeks or less between onset of symptoms and the diagnosis of MS [2]. A multicenter study conducted in Portugal found that the average time to diagnosis for MS patients was nine months [3]. This delay in diagnosis was associated with first presenting to another specialist other than a neurologist, as well as misdiagnosis in up to 50% of cases. A study in Israel found that on average MS patients had seen three separate specialists before seeing a neurologist. Among 29 patients, they received a total of 41 misdiagnoses, and it took them a mean duration of three and a half years after the onset of symptoms before receiving a formal diagnosis, causing severe anxiety for these patients [4].

Delayed or incorrect diagnoses are classified as diagnostic errors. These diagnostic errors fall into three categories: no fault errors, system-based errors, and cognitive errors [5]. No fault errors are caused by atypical disease presentation or the patient providing misleading information. System-based errors include communication problems, care coordination problems, equipment errors, and technical failures. Cognitive errors are caused by the physician failing to recognize the symptoms either from inadequate knowledge, poor critical thinking, lack of data gathering, or failure to synthesize information. System errors can often lead to cognitive errors. Diagnostic errors can be detrimental to patient health outcomes and reduce quality of life and may have negative effects on perceived quality, safety, cost, efficiency, morale, and public confidence in the health care system. Focusing on a combined system-based and cognitive-based view of information gathering, information integration and interpretation phases of the diagnostic process, there are two main problems that surface. One is that busy treating providers may not have time to read the complete patient history and so they may not connect all the symptoms and therefore can miss diagnostic patterns. Another problem is that the patient electronic health record (EHR) provides an incomplete view of the patient's health journey to the diagnostician even if read in full. This is because the patient often visits different clinics and specialists, with a lack of interoperability between facilities often creating information silos across EHRs [6].

The goal of this design science research is therefore to alleviate the information silos present in EHRs and deliver more rapidly digestible information to the physician to decrease MS misdiagnosis and delayed diagnosis. We propose to integrate healthcare information from all-

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payer claims, a rich source of complete longitudinal patient history, into a visually appealing timeline design artefact and clinical decision support tool to be used alongside the current EHR system. The timeline will allow the treating diagnostician a bird's eye view of every diagnosis and procedure a patient has ever had, irrespective of the treating organization. A planned pilot study will be used to evaluate the artefact based on real claims from the state of New Hampshire. According to the knowledge paths and gaps in design science research described by Drechsler and Hevner, this research seeks to close a performance gap in diagnosis time and accuracy using  $\lambda$ -knowledge [7]. If implemented at scale, the proposed artefact has the potential to dramatically decrease healthcare cost inefficiencies, improve the standard of care for MS patients as well as other patients with chronic conditions and improve overall patient health outcomes.

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