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Title	A Lean Six Sigma Approach to Improvement of Paediatric Iron Deficiency Care
Authors	Lam Wing Kit[1], Wong Tsz Fung Winson[1], Lee Yuen Han Tracy[2], Li Chak Ho[2], Yip Sze Fai[1]
Institutions	[1]Department of Clinical Pathology, Tuen Mun Hospital [2]Department of Paediatrics and Adolescent Medicine, Tuen Mun Hospital

Abstract

Introduction:

Iron deficiency is common in children and adolescents with significant implications for their growth and development in addition to iron deficiency anaemia. The Royal College of Pathologists Australasia recommends a cut-off of <20 ng/ml (<45 pmol/L) for diagnosing paediatric iron deficiency. We aimed to evaluate the impact of a Lean Six Sigma intervention on the diagnosis and treatment of paediatric iron deficiency.

Methods:

A retrospective review was conducted on children and adolescents below 18 years who were tested to have a ferritin level <45 pmol/L in the New Territories West Cluster between July 2022 and December 2023. Patients with known iron deficiency, on iron replacement or recent transfusion within 1 year were excluded. A Lean Six Sigma approach was used to identify and address key factors contributing to the under-diagnosis and under-treatment of paediatric iron deficiency. A pre-intervention survey was performed to review the diagnosis and treatment of paediatric iron deficiency in the period July to December 2022. Root causes and potential interventions were identified. Multidisciplinary meeting involving haematopathology, biochemistry and the paediatric haematology and oncology teams was arranged to engage the stakeholders for interventions. After intervention, a repeat survey was performed to review the diagnosis and treatment of paediatric iron deficiency in the period November to December 2023.

Results:

Of 164 pre-intervention and 61 post-intervention ferritin results below 45 pmol/L in patients under 18 years old, 64 and 20 new cases were identified, respectively. Pre-intervention, 54.7% (35/64; 1.6σ) were diagnosed with iron deficiency and 50% (32/64) were given iron replacement. The rate of WHO-defined anaemia was 71.9% (46/64). In a follow-up period of 180 days, patients receiving iron replacement had a median best haemoglobin improvement of 2.3 g/dL compared with 0.1 g/dL in patients without ($p<0.00001$).

The major problems identified in the process included: 1) only reference interval was available in the ferritin laboratory report but not the decision cut-off for diagnosing paediatric iron deficiency (lower limit of reference interval ranges from 12 (1-4 years) to 31 (5-13 years) pmol/L in the paediatric and adolescent groups); and 2) lack of clear guidance for diagnosis and management of iron deficiency.

Specific interventions included an addition of the decision cut-off of <45 pmol/L for diagnosis of paediatric iron deficiency in the ferritin laboratory reports and a teaching session organized by the paediatric haematology and oncology team on the diagnosis and management of iron deficiency.

Post-intervention, the diagnosis rate improved significantly from 54.7% (35/64; 1.6σ) to 90.0% (18/20; 2.8σ) ($p=0.0032$). Of note, the paediatric team has identified 100% (12/12) of cases post-intervention compared with 59.6% (31/52) pre-intervention ($p=0.0047$). The iron replacement prescription rate improved from 50% (32/64) to 75.0% (15/20) ($p=0.0421$).

Conclusion:

The Lean Six Sigma intervention was successful in identifying the problems in the process of diagnosis and treatment of paediatric iron deficiency, and offers insights to the potential solutions. This study highlights the potential of Lean Six Sigma as a tool for improving the quality of paediatric iron deficiency management.