Implementing AI in MRI Image Reconstruction: A Clinical QI Project

Joe Martin [1,*], Zohreh Hurcum[1], Susan Cross[1], Francisco Pepito Ablen[1], Sunitha Sivarajah[1], Vasia Papoutsaki[1], David Adams[1], Agnieszka Peplinski[1], Rosy Jalan[1], Krishanantham Ambalawaner[1], Sujit Vaidya[1], Dina Pefanis[1], Sara Moeen[1], Sivadas Ganeshalingham[1], Muaaze Ahmad[1], Hannah Dupreez[1] & Marc Miquel[1,2] [1]Barts Health NHS FT; [2]DERI & WHRI, Queen Mary's University of London; *Corresponding Author: joe.martin@nhs.net

Barts Health NHS Trust

Thoughts on AI in MRI? Scan Here

Introduction

NHS England (NHSE) has repeatedly stated that increasing MRI scanning capacity is essential to reduce backlogs and address the ever-increasing number of referrals.

Therefore, NHSE provided central funding for Artificial Intelligence based Image Reconstruction in MRI (AI-IR in MRI) [1] .

This work demonstrates how a two-phase Quality Improvement (QI) initiative can be followed to increase capacity using AI-IR in a community diagnostic centre (CDC) and an acute Trauma Centre while ensuring stakeholder engagement.

Methods and Material

Our methodology utilised the Model for Improvement framework, which includes Plan-Do-Study-Act (PDSA) cycles [2,3]. To aid engagement, we created a multidisciplinary team of prominent stakeholders, MR Physicists, Radiographers and Radiologists. The whole process can be seen in *figure 1*.

The measurement metrics used are:

- Time saved per protocol - a minimum of 5 minutes will be required to change a booking time.
- Number of scans per day – Baseline measurement: the average for the first three months of opening prior to AI installation.

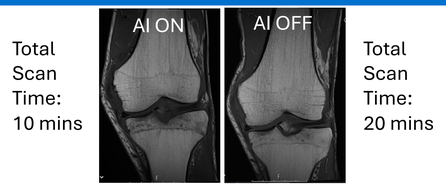


Figure 1: Example T1 Cor Knee images with and without AI active produced at our centre after optimisation. Time savings were achieved on all 4 sequences, leading to an overall reduction of 10 mins.

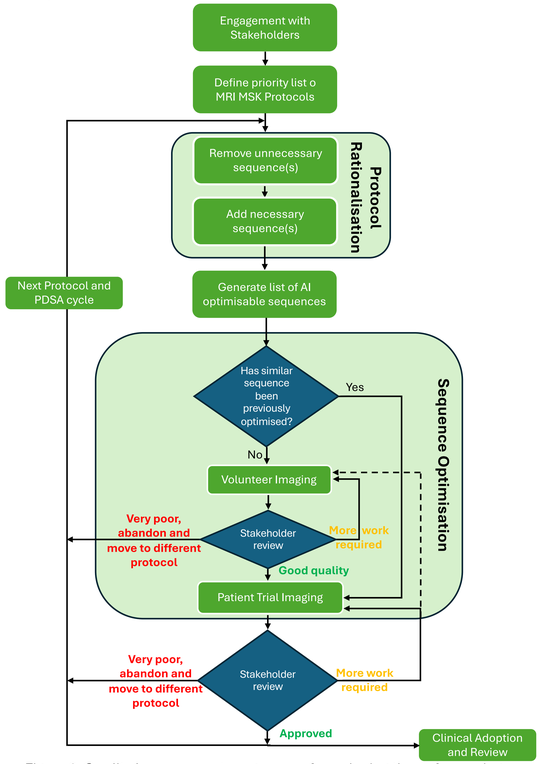


Figure 2 Quality Improvement programme for reducing time of scanning using AI-IR in MRI for multiple MRI protocols/anatomies of interest in MSK at our major trauma centre.

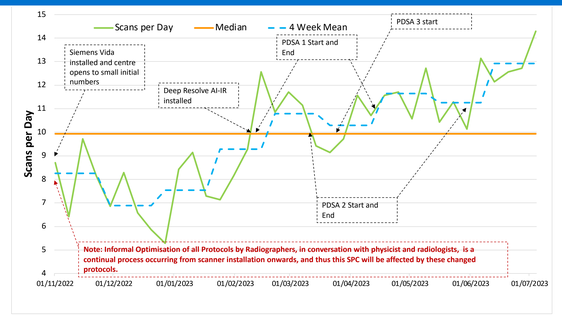


Figure 3 SPC chart for CDC MRI Scanner scans per day before and after the implementation of AI in MR Reconstruction.

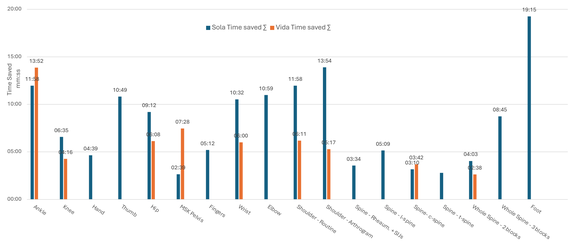


Figure 4 Time Savings for different MSK MRI scanning protocols at a trauma centre in East London following an extensive QI project based on PDSA cycles and the Model for Improvement.

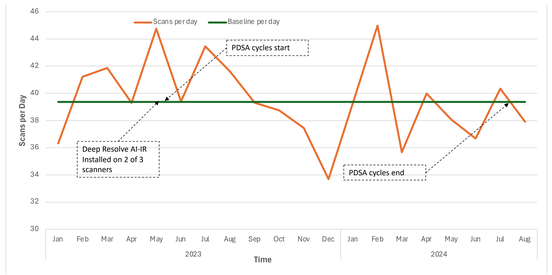


Figure 5 SPC chart for our trauma centre MRI Scanners scans per day before and after the implementation of AI in MR Reconstruction on two of its 3 scanners.

Results

In our CDC pilot study, we were able to reduce booking times by 10 minutes for Knee, Ankle and Spine protocols. This is correlated with the run chart in figure 3.

In our expansive MSK programme at our trauma centre, substantive time savings were made on the majority of protocols (figure 5). Although the number of patients scanned has remained stable, it allowed for an increase in complex cases* by 6% , while inpatients and A+E patients, have risen 12%.

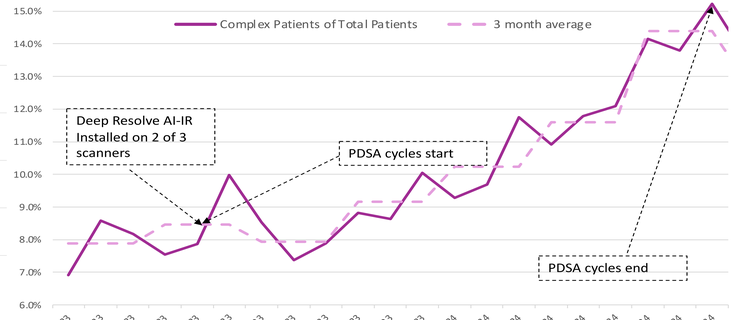


Figure 6: Complex patients scanned as a percentage of total scans at our trauma centre. This includes but not limited to ICU, PICU, NICU, A&E, Psychiatric Ward, Paediatrics, Neonates but not patients with complex medical implants.

Conclusion

Our two-centre study suggest a structured QI programme can significantly reduce scanning times. Whilst increased throughput was not achieved at the trauma centre an increase in complex GA , sedated and paediatric patients occurred.

Additionally, the significant throughput increase at the CDC for low-risk ambulatory patients suggests efforts to increase capacity using this technology should be focused at such centres.

References

1. NHS Digital (2021). Diagnostic digital capability programme. Available at: https://webarchive.nationalarchives.gov.uk/ukgwa/20230113001250/https://digital.nhs.uk/news/events/2021-events/diagnostics-digital-capability-programme-supplier-webinar
2. Courtlandt, C. D., Noonan, L. & Feld, L. G. (2009). 'Model for improvement-part 1: A framework for health care quality' Pediatric Clinics of North America, 56 (4), pp. 757-778.
3. Taylor, Michael J., et al. "Systematic review of the application of the plan–do–study–act method to improve quality in healthcare." *BMJ quality & safety* 23.4 (2014): 290-298.

Queen Mary University of London