EVALUATION OF A RULE-BASED HAEMATOLOGY AUTOVERIFICATION PERFORMANCE USING MIDDLEWARE: A QUALITY IMPROVEMENT INITIATIVE IN MALAYSIA'S LARGEST PRIVATE QUATERNARY HOSPITAL

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Background and Objectives

The complete blood count (CBC) is one of the highest-volume laboratory tests in hospital practice, accounting for more than half of the total haematology workload. Ensuring consistently accurate, reliable, and timely result reporting requires substantial workflow control and professional oversight. This initiative aimed at identifying workflow factors contributing to delayed haematology result reporting and evaluating the performance of haematology auto-verification implementation.

Methods

A retrospective review of data from the middleware of our haematology system was conducted from November 2024 to March 2025 for CBC, Peripheral Blood Film (PBF), and Platelet-F (PLT-F). Root cause analysis was used to identify causes of delayed haematology result reporting. In response, a rule-based auto-verification system was implemented in middleware using in-house rules incorporating delta checks, analytical measurement and linearity limits, critical value alerts with mandatory clinician notification, slide review triggers, reflex-rerun testing, sample integrity and interference checks, and block validation logic. Rules were applied at the specimen and analyte levels to prevent automatic release of clinically unsafe or technically unacceptable results. Post-intervention analyses were performed from November 2025 to March 2026.

Results

Figure 1 shows a root-cause analysis using Fishbone diagrams that identified manual verification as a key contributor to delayed reporting, inconsistent decision-making, and increased staff dependency. Post-intervention, a total of 78,031 CBC samples were analysed. Rule-based auto-verification markedly reduced the need for manual review of results, as shown in Figure 2. There was an overall 80% reduction in manual verification. Apart from that, lab turnaround-time (LTAT) performance after implementation of auto-verification rules was improved to 98-99% from the previous 95-97% prior to its implementation, as shown in Figure 3. Selected parameters appropriately requiring manual verification, were appropriately prevented from auto-release as shown in Figure 4.

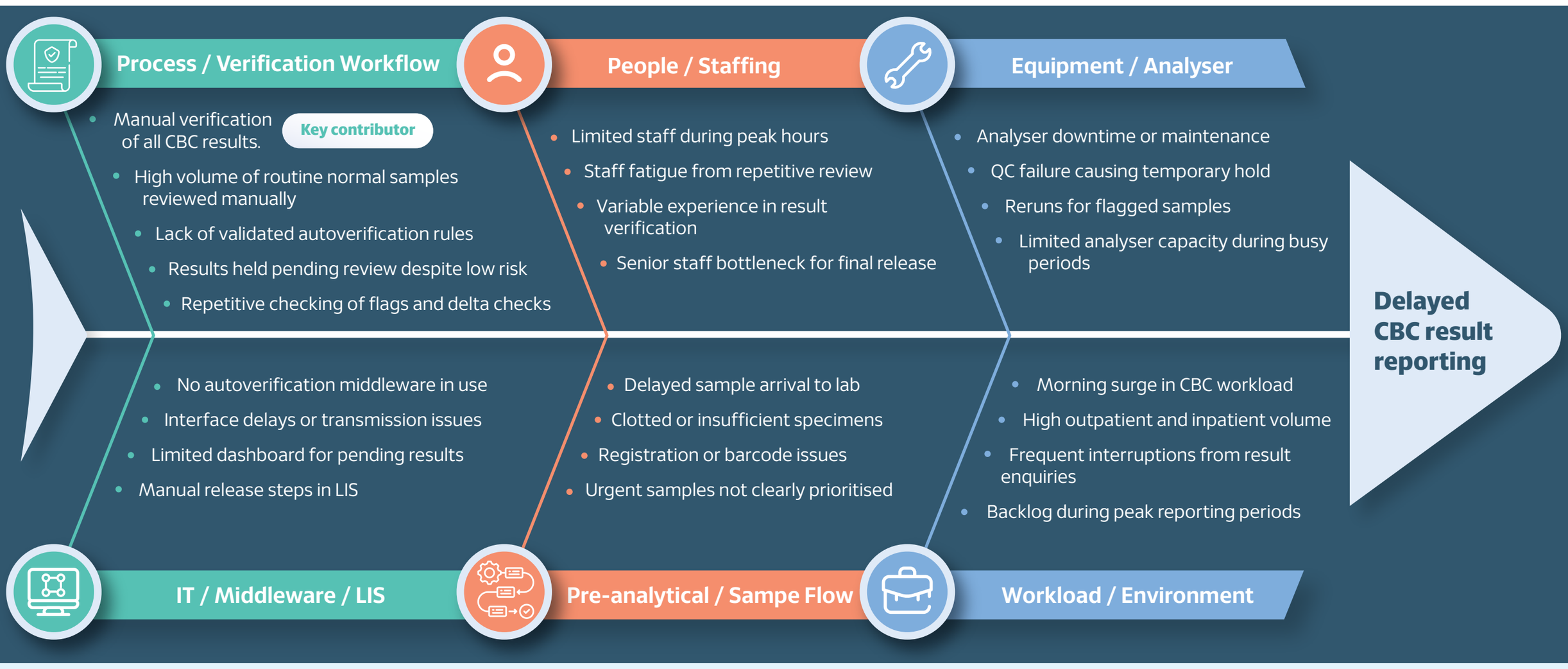

Figure 1: Root-cause analysis using Fishbone diagrams for delayed CBC reporting

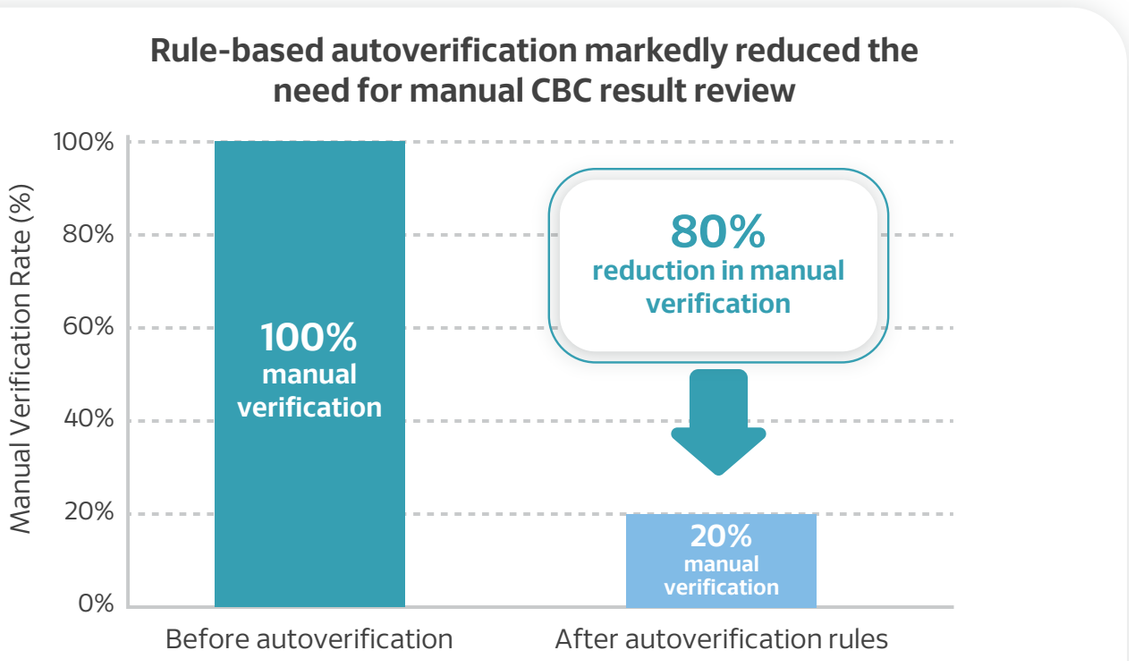

Figure 2: Impact of CBC auto-verification on CBC reporting

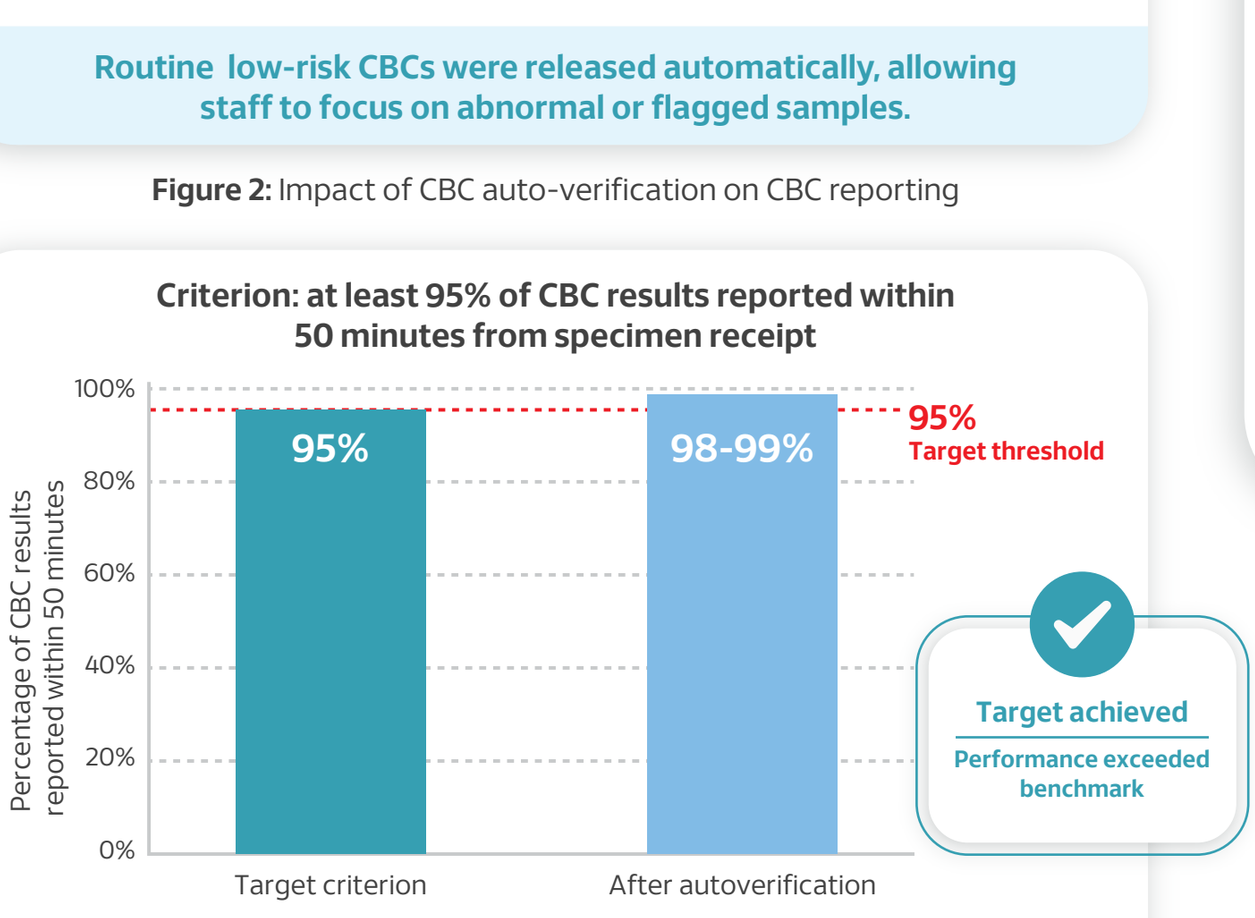

Figure 3: Lab turnaround-time (LTAT) performance after implementation of auto-verification rules.

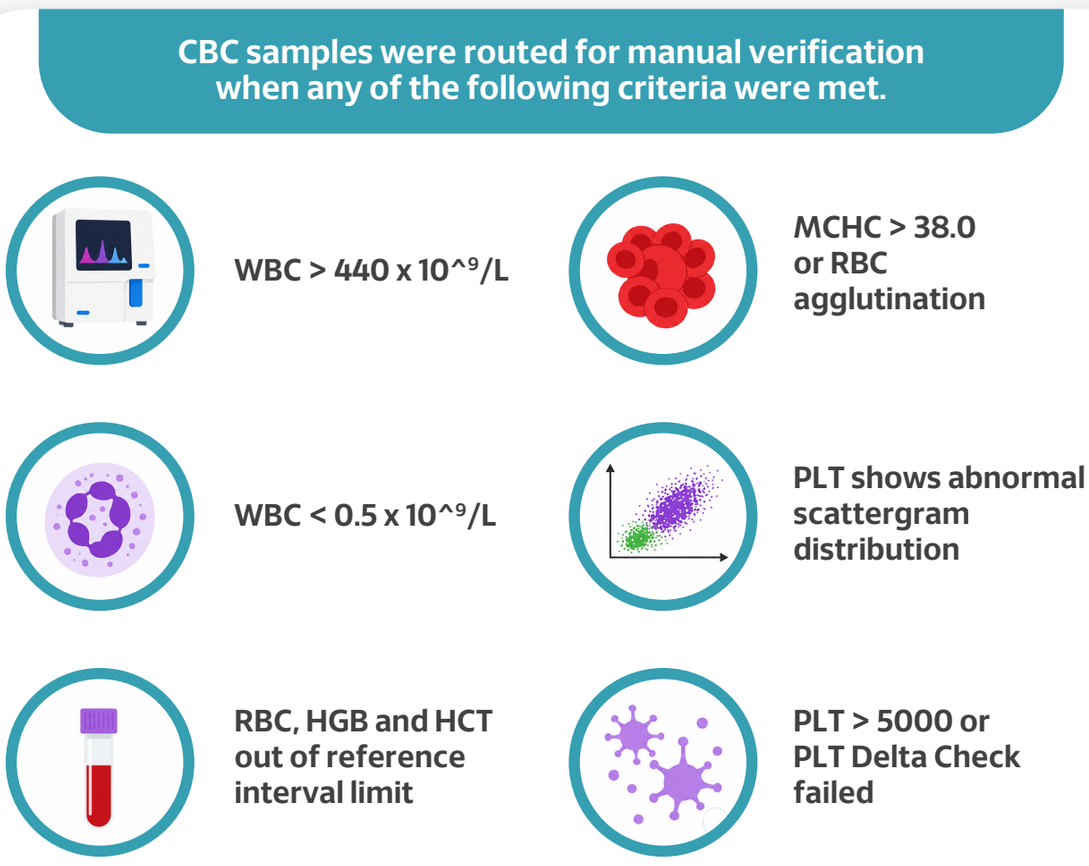

Figure 4: Scenarios requiring manual verification

Conclusion

Manual verification contributed to delays and variability. Implementation of auto-verification improved workflow efficiency while maintaining result safety, with consistent performance across varying workloads and appropriate control of parameters requiring manual review. The auto-verification system demonstrated reliable performance in a busy quaternary hospital, reflecting a strategic shift toward scalable, standardised, and safety-focused laboratory operations, enabling efficient management of high-test volumes while preserving expert review for clinically complex cases.