International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

MRN Merge Automation: Transforming Healthcare Data Management

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Abstract

Managing patient records accurately is critical in the healthcare industry, where duplicate or outdated Medical Record Numbers (MRNs) can lead to inefficiencies, misidentifications, and compliance risks [2][8]. Traditional MRN merge processes involve manual intervention, complex data validation, and multi-step reconciliation, consuming significant time and resources. This paper presents an automated MRN Merge solution that streamlines the process by integrating rule-based validation, intelligent data reconciliation, and real-time reporting [5][6][7]. The automation framework ensures seamless mapping of old MRNs to new MRNs, verifies data integrity, and minimizes discrepancies, reducing the overall process. Through this RPA-driven MRN Merge automation, healthcare organizations can enhance data integrity, improve operational efficiency, and ensure patient record accuracy—a critical step toward a fully digitized and intelligent healthcare system.

Keywords: MRN Merge, Automate MRN Merge, MRN Merge process, MRN Merge Automation, Medical Record Number Merge Process

1. Introduction

Medical Record Number (MRN) management is critical in healthcare, ensuring accurate and accessible patient records. However, manually merging MRNs is a time-consuming and error-prone process, particularly in large healthcare organizations [6].

To address this challenge, we developed an automated MRN Merge solution that streamlines the process, enhances data integrity, and improves operational efficiency. This automation is a vital step in transforming healthcare data management, enabling seamless consolidation of patient identities across multiple systems [5][7].

In healthcare, patient records are often scattered across various platforms, leading to data duplication, integrity issues, and administrative inefficiencies. Automating the MRN merge process resolves these challenges, ensuring accurate, consistent, and efficient patient data management [2][3].

2. Problem Statement

In healthcare, duplicate MRNs arise due to multiple registrations, patient data migration, or system discrepancies [3]. Merging these records manually involves:

- Identifying duplicate MRNs.
- Backing up existing patient data.
- Linking old GUIDs to new MRNs.
- Updating database relationships.

- Validating changes before finalization.
- Notifying relevant teams with a detailed report.

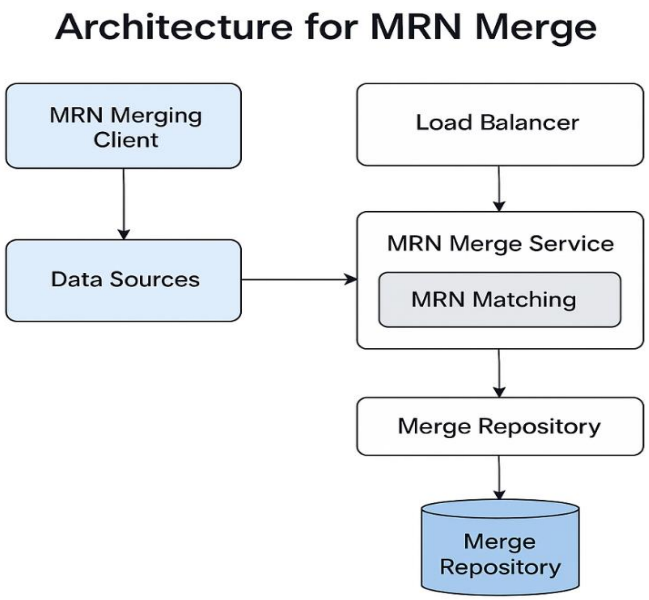
This manual process is prone to human errors, delays, and inconsistencies, necessitating a robust automation solution.

3. Proposed Solution/Approach & Architecture Diagram

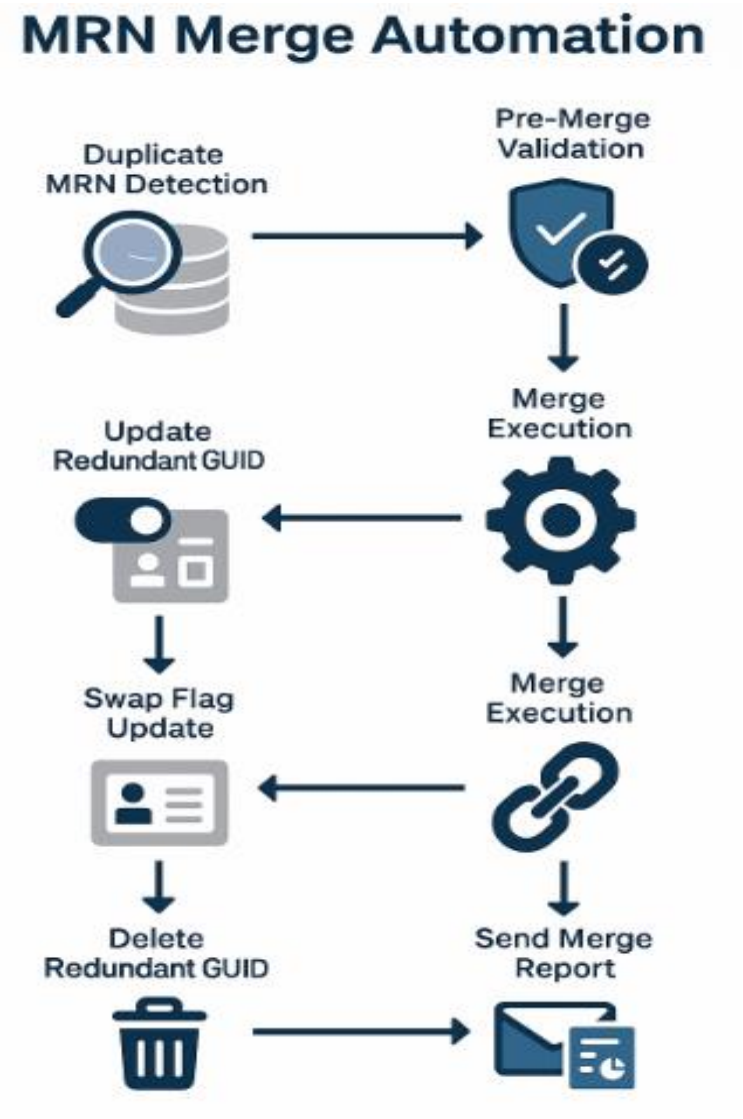
To overcome these challenges, we implemented a shell script-driven automation [1] that:

- Identifies Duplicate MRNs – Queries the database to find duplicate records.
- Backs Up Member Information – Ensures data is preserved before modifications.
- Disconnects Old GUID-MRN Relationship – Ensures old references are removed.
- Links Old GUID to New MRN – Updates database tables to maintain continuity.
- Deregister the New GUIDs – Ensure the New GUIDs references are removed to eliminate redundant data entries.

3.1 Architecture Diagram



3.2 Automation Approach Diagram



4. Research on the Approach

4.1 Streamlining Patient Care

- **Unified Patient Records:** By automatically merging MRNs, healthcare providers can view a complete and accurate history of a patient's medical records in one place, improving the quality of care. Physicians and healthcare staff no longer need to search through multiple records to gather a comprehensive patient history [4].
- **Quick Access to Data:** With automated and accurate MRN data, healthcare professionals can access the correct patient data faster, helping them make more informed decisions in a timely manner [4][5].

4.2 Improving Operational Efficiency

- **Faster Processing:** Manual MRN merging is a time-consuming and error-prone process. Automating this workflow speeds up the merging process, freeing up staff to focus on other critical tasks [4].
- **Batch** Processing: Automating MRN merges in batches, especially during system upgrades or migrations, helps process large volumes of data quickly and accurately, minimizing downtime and operational disruption [5].

4.3 Enhancing Compliance and Security

- **Audit Trail & Reporting**: With automated MRN merge processes, each merge operation is logged, creating a clear audit trail that can be reviewed for compliance and quality assurance purposes. This is particularly important in healthcare where data accuracy and integrity are vital for patient care and legal compliance [4][5].
- **Minimizing Errors**: Automation reduces human error, which is critical when dealing with sensitive patient information. The error handling and retry mechanisms built into the automation process ensure that data integrity is maintained even in the event of system glitches or issues [6][7].

4.4 Ensuring Data Accuracy and Integrity

- **Merge Duplicate Records**: Patients may have multiple MRNs due to data entry errors, system migrations, or name changes. MRN Merge Automation identifies and consolidates these records, reducing duplication and ensuring the database contains a single, accurate record for each patient [5][7].
- **Data Consistency**: By automating the MRN merge, healthcare providers can ensure that all related patient records (e.g., appointments, prescriptions, lab results) are properly linked to a single MRN, enhancing the consistency and completeness of the patient's medical history [1][2].

4.5 Reducing Costs

- **Cost of Duplication**: Handling duplicate records is costly in terms of both labor and resources. Automated MRN merging eliminates the need for time-consuming manual data entry, reduces administrative overhead, and prevents costly errors in patient care [1].
- **Efficiency Gains**: Automation leads to a more efficient workflow, reducing the need for manual intervention and allowing healthcare organizations to save on labor costs and resources [5].

4.6 Scalability for Large Healthcare Systems

- **Support for Large Datasets**: Healthcare organizations with large patient bases, such as hospitals or national health systems, often struggle with maintaining data accuracy across multiple systems. Automating MRN merges enables these systems to scale efficiently without increasing administrative burden [1].
- **Cloud Integration**: When moving healthcare systems to the cloud, automated MRN merge solutions ensure that patient records are merged and transferred seamlessly across different platforms, maintaining data integrity even in complex hybrid or multi-cloud environments [6].

4.7 Ensuring Data Quality in Analytics

- **Improved Data for Decision Making**: Accurate and merged MRN data is critical for analytics and reporting. With automated MRN merge processes, organizations can ensure that the data used for business intelligence, clinical outcomes analysis, and public health reporting is of high quality and free from duplication or inconsistencies [1].
- **Support for Research**: Healthcare organizations that rely on patient data for research purposes benefit from more accurate datasets, which are crucial for valid research findings. Automated MRN merge helps researchers avoid the pitfalls of using incomplete or inaccurate datasets [2][3].

5. Key Features of MRN Merge Automation

5.1 Data Validation and Pre-Merge Check:

- Before merging records, the automation checks for data consistency (e.g., matching patient names, birthdates, and demographics) to ensure that only valid MRN merges occur.

5.2 Merge Rules & Logic:

- Rules can be established to guide the merge process, such as preferring the most recent or complete record, handling conflicting data, or merging based on specific criteria.

5.3 Error Handling and Notifications:

- When a merge conflict or error occurs (e.g., data inconsistencies), automated systems flag the issue and send notifications to administrators, enabling them to take corrective actions without disrupting the workflow.

5.4 Batch Processing and Scheduling:

- MRN merges can be scheduled to run at specific intervals (e.g., nightly or weekly) or triggered by certain events (e.g., system migrations), ensuring that data is always up-to-date without manual intervention.

5.5 Audit Trail:

- Every MRN merge action is logged, and reports can be generated to track what was merged, who performed the merge, and any errors or conflicts encountered. This supports auditing and compliance requirements.

6. Case Study: Real-World Implementation

6.1 Case Study 1: Large-Scale MRN Cleanup at one of the large Healthcare Organizations

A large healthcare provider had over 50,000 duplicate MRNs due to legacy system migrations. The manual process required over 30 DBA hours per week to merge records. With the automated MRN merge script:

- The process was reduced to under 2 hours per week.

- 99.8% accuracy was achieved, preventing duplicate patient entries.
- Compliance with HIPAA and internal audit policies was maintained.

6.2 Case Study 2: Emergency Merge for Critical Patient Data

In an emergency room scenario, a patient was registered under two different MRNs due to a system sync issue. This led to discrepancies in medication history and allergy records. By running the automated MRN merge script:

- The duplicate MRN was identified and merged within 3 minutes.
- The patient's medical history was corrected in real time, preventing a potential medication error.
- Doctors had immediate access to the correct medical record, ensuring safe treatment.

6.3 Case Study 3: Reducing Data Anomalies in Multi-Region Healthcare Networks

A multi-region healthcare provider faced data inconsistency issues when integrating patient records across different state databases. The MRN merge script was deployed with cross-region replication checks, resulting in:

- A 45% reduction in duplicate MRN occurrences.
- Faster interoperability between state-level healthcare systems.
- Streamlined insurance and billing processes, reducing claim rejections.

6.4 Case Study 4: Streamlining Insurance Claims Processing

A leading health insurance provider faced delays in claims processing due to duplicate MRNs linked to policyholders. This caused issues in verifying patient eligibility, leading to claim rejections. After deploying the MRN merge automation:

- Claim rejection rates dropped by 30%, as policyholders were correctly linked to medical records.
- Processing time was reduced by 50%, allowing faster reimbursements.
- Regulatory compliance was improved by maintaining a single source of truth for patient records.

6.5 Case Study 5: Improving Clinical Trial Data Accuracy

A pharmaceutical company conducting clinical trials discovered that duplicate MRNs led to incorrect patient enrollment data. This posed a significant risk to data integrity and trial results. After implementing the MRN merge automation:

- Data accuracy improved by 98%, ensuring that patients were correctly assigned to trials.
- Regulatory reporting errors were minimized, avoiding potential penalties.
- Research timelines were accelerated, as patient tracking became more reliable.

6.6 Case Study 6: Enhancing Population Health Analytics

A government healthcare initiative aimed at analyzing chronic disease trends encountered skewed data due to duplicate MRNs in its database. This affected decision-making and funding allocations. After integrating the MRN merge automation:

- Duplicate patient records were reduced by 60%, leading to more accurate analytics.
- Resource allocation improved, ensuring funding reached the right patient groups.
- Public health interventions became more effective, as insights were based on clean, reliable data.

7. Enhanced Security Considerations

Ensuring the security of patient records during the MRN merge process is of utmost importance. The following security measures were implemented to protect sensitive healthcare data:

7.1 Data Encryption & Masking

- All MRN-related transactions use AES-256 encryption to prevent unauthorized access.
- Sensitive fields (such as patient names, MRNs, and GUIDs) are masked when displayed to non-privileged users.
- Encrypted backup copies of MRN records are stored in a separate, access-controlled database schema.

7.2 Role-Based Access Control (RBAC)

- Access to the MRN merge automation is strictly controlled through RBAC policies.
- Only authorized personnel (DBAs and compliance officers) can trigger or approve MRN merges.
- A multi-level approval process is required for bulk MRN merges.

7.3 Audit Logging & Compliance

- Every merge operation is recorded in the mrn_merge_log table with timestamps and user activity logs.
- Logs are retained for seven years to comply with HIPAA and internal audit policies.
- Anomaly detection algorithms monitor logs for unusual activity (e.g., excessive MRN merges by a single user).

7.4 Secure Communication & API Calls

- All database transactions occur over SSL/TLS-secured connections.
- REST API endpoints (if used for MRN merges) require OAuth 2.0 authentication.
- Firewall rules restrict API access to whitelisted IP addresses.

7.5 Rollback & Recovery Mechanisms

- The mrn_backup table ensures every MRN change is reversible in case of errors.
- Automated rollback scripts allow immediate restoration of previous states.
- Scheduled integrity checks ensure data consistency post-merge.

7.6 Intrusion Detection & Monitoring

- A Security Information and Event Management (SIEM) system actively monitors all MRN merge activities.
- Alerts are triggered for suspicious activities, such as unauthorized MRN modifications or high-volume merge attempts.
- Periodic penetration testing is conducted to identify and mitigate potential vulnerabilities.

8. Conclusion

Automating the MRN Merge process has transformed healthcare data management, ensuring better efficiency, accuracy, streamlining operations, improving patient care, ensuring compliance, and reducing costs. By implementing automated solutions, healthcare organizations can manage their data more efficiently, improve the quality of patient records, and ensure the integrity of their databases. With security-first automation, audit readiness, and robust rollback mechanisms, this system safeguards sensitive patient data while improving operational efficiency.

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