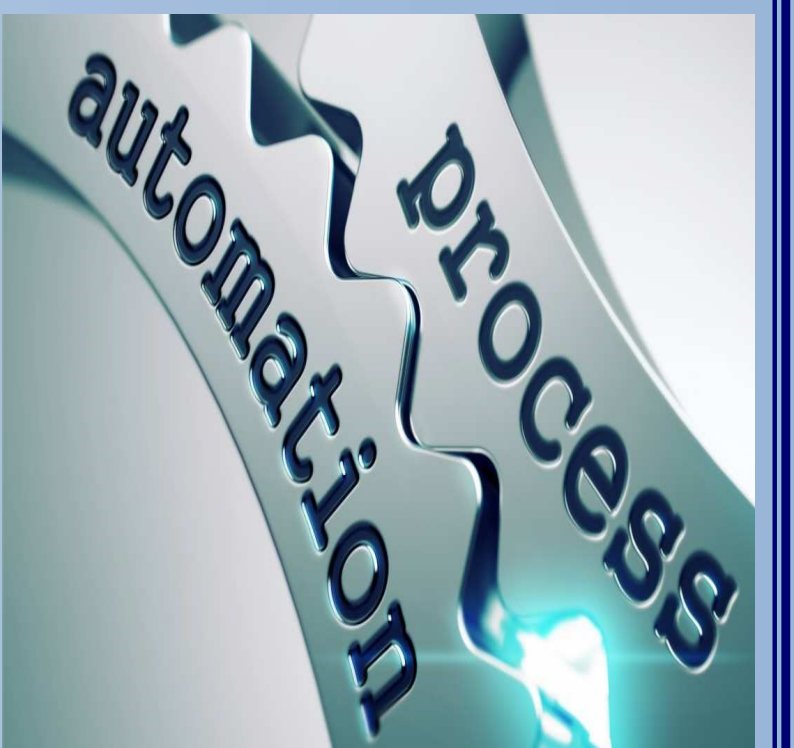# Automated Linkage: Creating a New Tumor for an Existing Patient

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Background

In order to improve data quality and shorten the cycle between file receipt and completion, the California Cancer Registry's (CCR) Production Automation and Quality Control (PAQC) unit of the California Cancer Reporting and Epidemiologic Surveillance Program (CalCARES) has focused on implementing automation solutions into the CCR's customized application.

Our goal is to move towards system-wide continuous quality control and to automate processes that are currently completed manually. Prior to the implementation of our tumor auto-linkage rules, automation occurred only when a new admission did not find a patient match in the database. The patient and tumor would then be automatically created. This is demonstrated by the blue shaded area in Graph 2. Our preliminary focus was to create Exact Match linkage automation where the incoming admission found a single positive patient match and matched at the tumor level. Subsequently site specific tumor linkage automation rules were written based on the Surveillance, Epidemiology, and End Results Program (SEER) Multiple Primary and Histology (MPH) Coding Rules Manual. Rules were written to fire after the single positive patient match was identified resulting in one of three outcomes: link as the same tumor, link as a new tumor or send to manual review if necessary. After the implementation of multiple rules specific to the MPH rules, efforts transformed to resolve the question of how to create a new tumor automatically when it is obvious that it is not the tumor in the database. As a result, the "Negative Linkage Rule" was created.

Objective

The overall objective of the negative linkage rule logic is to automatically create new tumors for incoming cases that are a patient match, but the site specific tumor linkage rules do not apply to the tumor already collected in the database; thereby sending cases to manual review only when the sites are likely to be related.
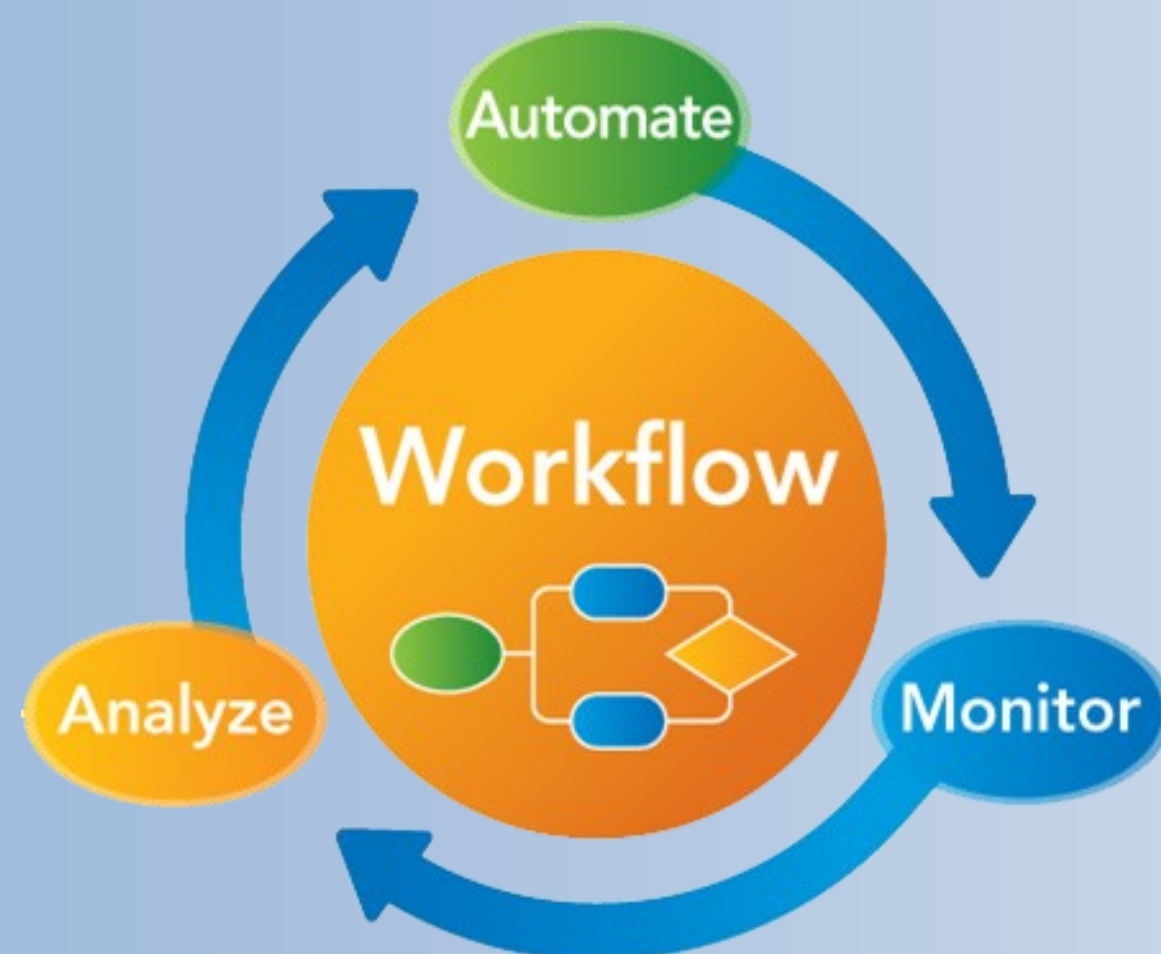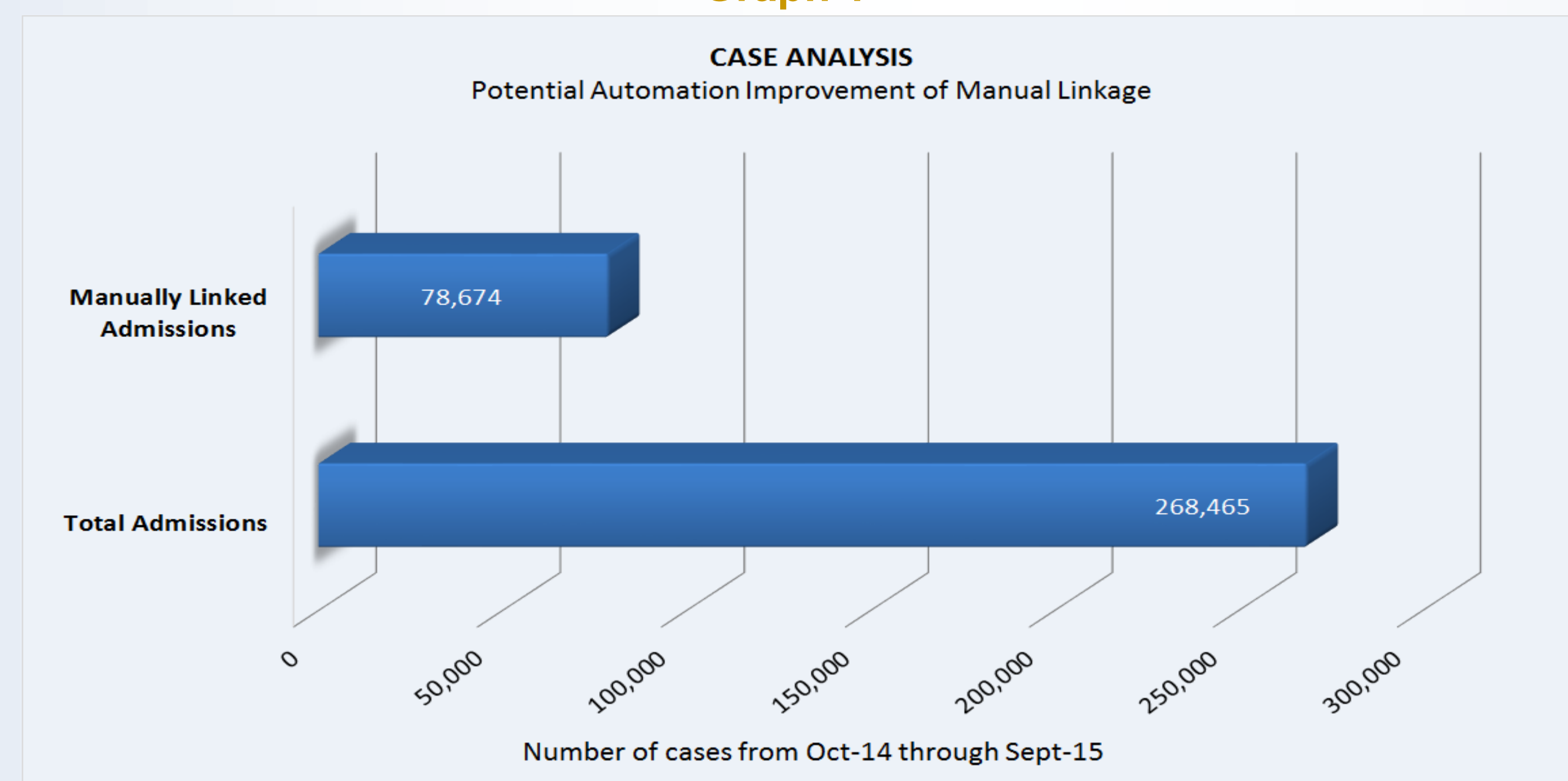
Methodology

The Production Automation and Quality Control (PAQC) unit, consisting of multiple Business Analysts (CTRs), programmer, and a System Architect used a project management style approach. A combined energy was exercised to determine an approach for creating a rule that would identify a new tumor. The decision was made to further analyze manual linkage to determine complex cases that could possibly match a tumor however did not fire on the site specific rules implemented (Graph 1).

SQL queries were run to identify tumors in the database that fit the MPH site groupings used in the site specific rules as well as the associated site codes of the admissions linked to them. The query results were placed into spreadsheets and a detailed analysis was performed by a central registry CTR.

Early analysis determined that there are primary sites where manual review is necessary because the sites are known as being locations for metastatic disease to spread to. These cases were excluded from the negative linkage automation rule. Analysis was then done on each site grouping used in the site specific rules to review the admissions where sites were commonly found to be the same tumor at consolidation. These sites were determined to be potential tumor matches therefore, we could not make a clear choice that they would be a new tumor. Tables were created for each site grouping of (existing tumors) where a corresponding code (incoming admissions) would be considered a potential match.

Graph 1

CASE ANALYSIS
Potential Automation Improvement of Manual Linkage

- Manually Linked Admissions: 78,674
- Total Admissions: 268,465

Number of cases from Oct-14 through Sept-15

The possible scenarios are:

- An admission is uploaded into the application that has an existing tumor in the database. The existing tumor in the database is coded to a site in our site grouping and the incoming admission's tumor is coded to a tumor listed in the potential match table. The admission would be excluded from automation at this point and it would be sent to be manually processed.
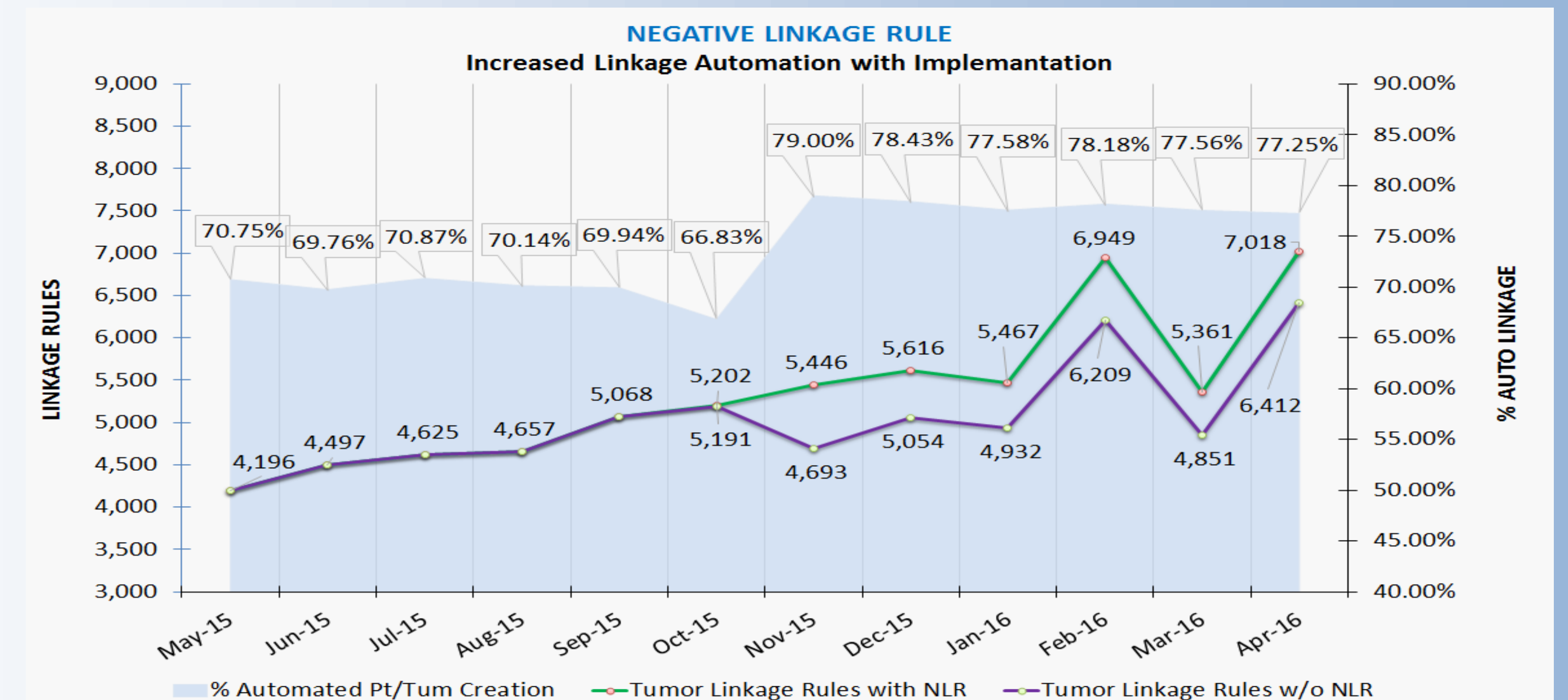
- An admission is uploaded into the application that has an existing tumor in the database. The existing tumor in the database is coded to a site in our site grouping and incoming admission was coded to a site not listed in the potential match table, it would automatically create a new tumor.

Extensive testing was performed prior to implementation to ensure that the negative linkage rule automation would not erroneously create new tumors. Modifications to the tables occurred early to capture findings during testing. The negative linkage automation was successfully implemented into production October 31, 2015.

Overall Results

Reports were run from May 2015 through April 2016 to capture the impact of tumor linkage automation rules including Exact Match, Site Specific, and Negative Match as well as the auto creation of a new patient and tumor. We were able to indicate how much of the overall automation was based on tumor linkage automation, as well as the improvement based on the execution of the negative tumor linkage rule.

Graph 2

NEGATIVE LINKAGE RULE
Increased Linkage Automation with Implementation

LINKAGE RULES values: 4,196 (May-15); 4,497 (Jun-15); 4,625 (Jul-15); 4,657 (Aug-15); 5,068 (Sep-15); 5,191 (Oct-15); 5,202, 5,446 (Nov-15); 4,693; 5,616, 5,054 (Dec-15); 5,467, 4,932 (Jan-16); 6,949, 6,209 (Feb-16); 5,361, 4,851 (Mar-16); 7,018, 6,412 (Apr-16)

% AUTO LINKAGE: 70.75%, 69.76%, 70.87%, 70.14%, 69.94%, 66.83%, 79.00%, 78.43%, 77.58%, 78.18%, 77.56%, 77.25%

Legend: % Automated Pt/Tum Creation — Tumor Linkage Rules with NLR — Tumor Linkage Rules w/o NLR
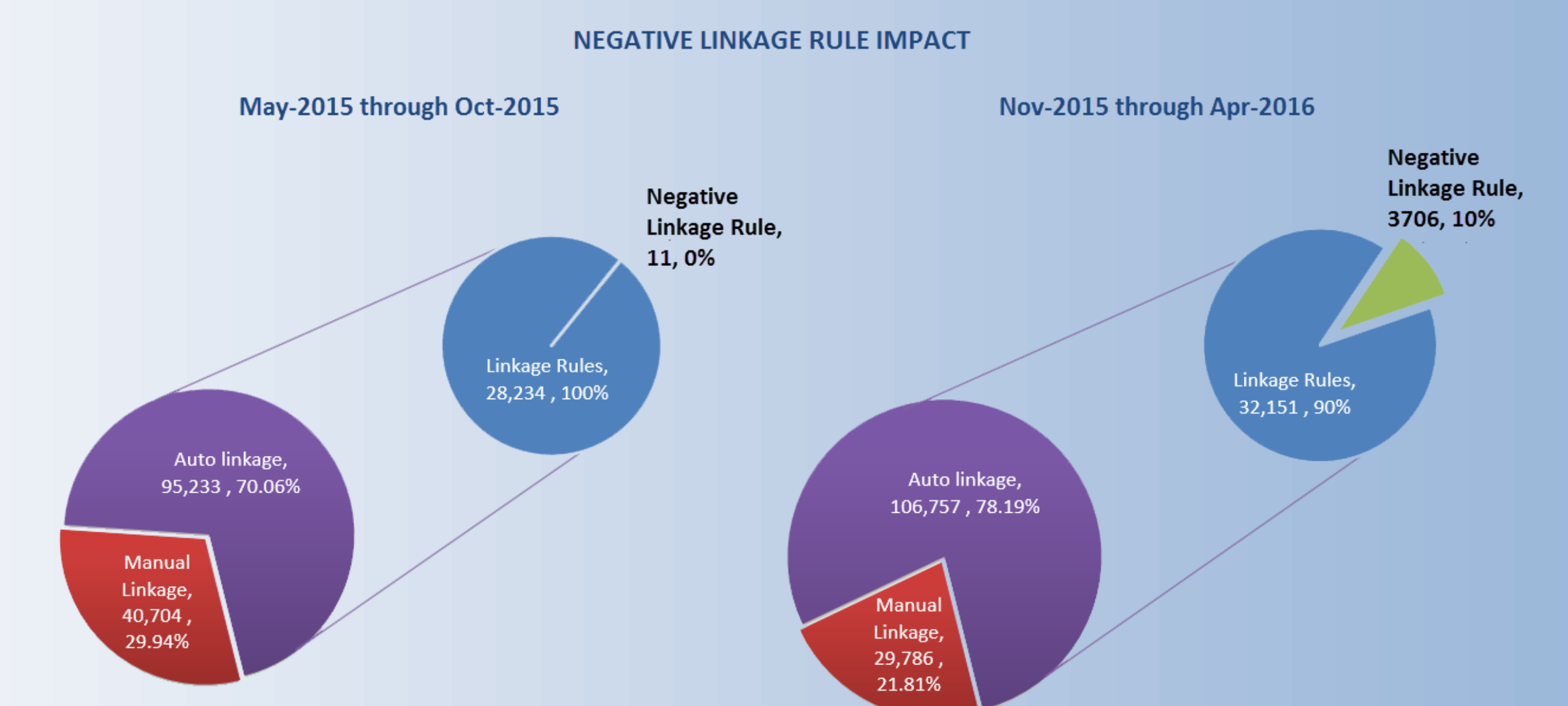
Major Take-a-Ways:

The "Negative Linkage Rule" has improved automation in the following ways:

1. Overall automation has increased by approximately 3 percent (Graph 2).
2. Improvement of the overall tumor linkage rule automation by approximately 10 percent (Graph 3).
3. The overall manual linkage work effort has been reduced by approximately 8 percent (Graph 3).

Graph 3

NEGATIVE LINKAGE RULE IMPACT

May-2015 through Oct-2015
- Negative Linkage Rule, 11, 0%
- Linkage Rules, 28,234, 100%
- Auto linkage, 95,233, 70.06%
- Manual Linkage, 40,704, 29.94%

Nov-2015 through Apr-2016
- Negative Linkage Rule, 3706, 10%
- Linkage Rules, 32,151, 90%
- Auto linkage, 106,757, 78.19%
- Manual Linkage, 29,786, 21.81%

Conclusion

Analysis and implementation of additional automation logic such as the "Negative Linkage Rule" has had significant impact on automation overall. Executing additional automated tumor linkage will ensure reduction of linkage processes that are completed manually. An improvement to data quality will transpire by confirming that tumor linkage is consistent, occurs in a timely manner, and shortens the cycle between file receipt and completion. Moving forward, we will be adding additional metrics to help analyze the most common reasons that admissions go to manual linkage. Our new goal will then be to focus on enhancements such as adding additional rules and/or provide analysis as to why the data submitted does not allow for automation.

Workflow — Automate, Monitor, Analyze

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*The CalCARES Program partners with the California Department of Public Health (CDPH) to manage the operations of the state mandated California Cancer Registry program