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Using Process Mining to Assess the Fidelity of a Home Visiting Program

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Using Process Mining to Assess the Fidelity of a Home Visiting Program

Abstract

Background: The Maternal, Infant, and Early Childhood Home Visiting (MIECHV) program is a federal public health initiative which supports at-risk families through evidence-based programs and promising approaches for pregnant women, and childhood development for children aged 0 to 5. These public health program funding mechanisms commonly include process evaluation mandates.

Purpose: The use of process mining was explored as a methodology to assess the fidelity of the MIECHV programs' actual workflow to that of their intended models.

Methods: Research Electronic Data Capture (REDCap) data files that were populated with program process data elements from the local implementing agencies were mined. The focus was on three main variables: participant identification, activity labels, and timestamps. These variables were imported into the Disco process-mining software. Disco was used to develop process maps to track process pathways and compare the actual workflow against the intended model.

Results: Using process mining as a diagnostic tool, fidelity to the MIECHV process model was assessed, identifying a total of 262 different process variations. The 15 most frequent variations represent 60.7% of the total pool of process variations, 13 of which were deemed to have fidelity to the intended model. Analysis of the variations indicated that many activities in the intended process were skipped or implemented out of sequence.

Implications: Process mining is a useful tool for organizations to visually display, track, understand, compare, and improve their workflow processes. This method should be considered by programs as complex as MIECHV to improve the data reporting and the identification of opportunities to strengthen programs.

Keywords

program evaluation, fidelity, process

Cover Page Footnote

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INTRODUCTION

The Patient Protection and Affordable Care Act (ACA) fostered several public health initiatives, including the funding of the Maternal, Infant, and Early Childhood Home Visiting Program (MIECHV). MIECHV supports early childhood development for at-risk families through evidence-based and promising-approach home visiting programs, and has provided more than 1.4 million home visits since 2012 nationally. This public health initiative focuses on preventing child injuries, abuse, neglect, and emergency department visits; improving school readiness; reducing crime, including domestic violence; and improving family economic self-sufficiency. A final objective is that the program improve the coordination and referrals for other community resources and supports, essentially creating a complex public health systems infrastructure. An evaluation of the program implementation is included in the federal requirement.

The Missouri implementation of MIECHV is a complex public health systems structure that requires multiple local implementing agencies (LIAs) to follow a specified workflow when reporting the activities of their programs. Program activities by the LIAs are tracked using Research Electronic Data Capture (REDCap). This process has a defined pathway of activities (Figure 1) necessary for operational efficiency and for appropriately monitoring progress on benchmarked outcomes associated with the MIECHV program. Assessing fidelity to the intended systems-process model is crucial to understanding the LIAs' reporting activities.

Process mining is a diagnostic method that tracks processes through the use of event logs and provides insight about the reality of the workflow.[1] This method has demonstrated promise in various industries, especially with data-heavy processes, large degrees of heterogeneity, uncertainty, or if fast changing, such as health care.[2] Process mining was previously used to track differences in stroke procedures at comparative hospitals, check adherence to physician hand-off protocols, and assess nursing care procedures through extracting and mining event logs from transactional information systems.[3,4] This method can be applied to: (1) discover the current process; (2) assess the conformity of the actual implementation of a process to a theoretical model; or (3) enhance and enrich the current model using the process mined data by locating areas for quality improvement, such as identifying bottlenecks or redundancies.[5]

Essentially, process mining is performed using automatically generated event logs from transactional information systems that contain case identifications, activity labels, and time-stamp elements; these comprise the minimum attributes needed for process-mining algorithms. Given the importance of public health systems improvements, the use of process-mining methodology was explored to assess the fidelity of MIECHV LIAs' processes to their intended workflow models. We asked: *How does the actual process sequence align with the intended process sequence for the intake and referral process?*

METHODS

Research Electronic Data Capture (REDCap) is a web-based application for building and managing online surveys and research databases. Missouri's MIECHV program designed a REDCap data-collection system based on their forms and processes. Missouri's Department of

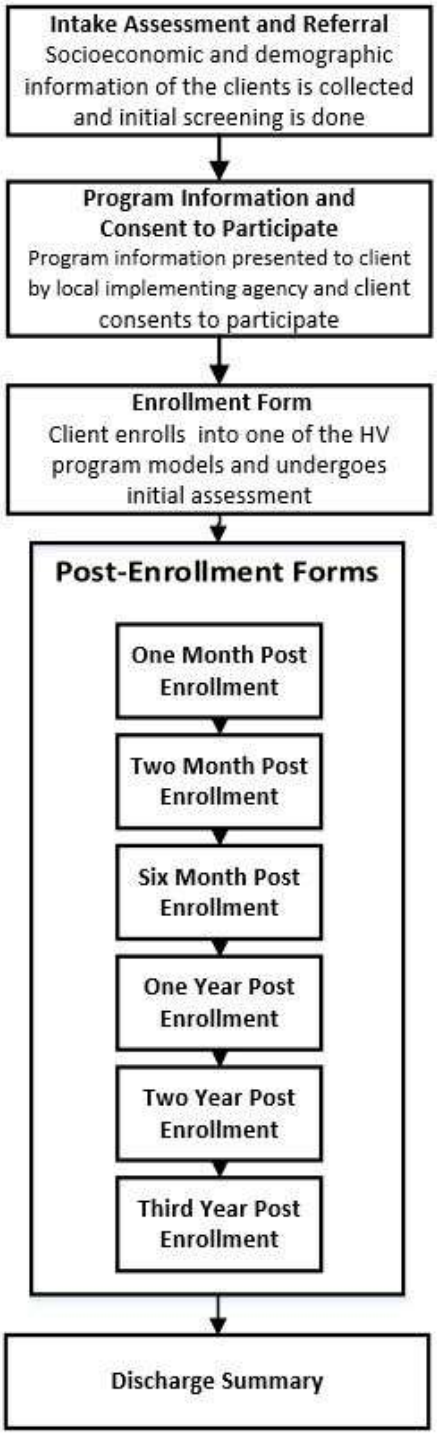

Figure 1. Missouri Maternal, Infant, Early Childhood Home Visiting Program Process: Intended Workflow (Components Related to Post-Enrollment Only)

Health and Senior Services (DHSS) uses this data-collection system to implement, manage, and track MIECHV program performance. De-identified MIECHV REDCap data collected for participants enrolled in the home visiting programs between May 29, 2011 and July 30, 2015 were examined. REDCap data were output into Microsoft Excel. For process-mining purposes, data-reporting activities that were required, discrete, and linear were considered, excluding ancillary or repeated activities. These activities comprised the following forms: (1) initial forms (intake assessment, referral, and enrollment); (2) participation forms (1 month to 3 years post enrollment, and discharge); and (3) home visit forms.

Initial data management focused on the identification of duplicates and the application of filtering criteria to subset the data as follows: only visits marked complete by the home visitor; records marked no, attempted, or cancelled were excluded; records marked incomplete or unverified were excluded; records with indecipherable or missing date entries were excluded; re-enrollment entries were excluded; initial enrollment entries were retained; considered only the first child enrolled; and considered whole family discharges.

The final sample size was 1042 participants. Event logs included the participant ID and date of survey. Data were imported into Disco, a process-mining software that uses algorithms, log management, and filtering frameworks to analyze processes against an intended path, and to generate maps for visualization. Conformance to the intended model with a manual review was then validated.

RESULTS

Figure 2 displays a Disco-generated process map, characterizing the program model activities within the Missouri MIECHV home visiting process. Each box includes the frequency of that activity.

The arrows between activities represent the chronology of the activity based on its time-stamp; the arrow thickness indicates its frequency (thicker arrow indicates a higher frequency). The green arrows lead to the initiating activity while the red arrows lead to the termination activity.

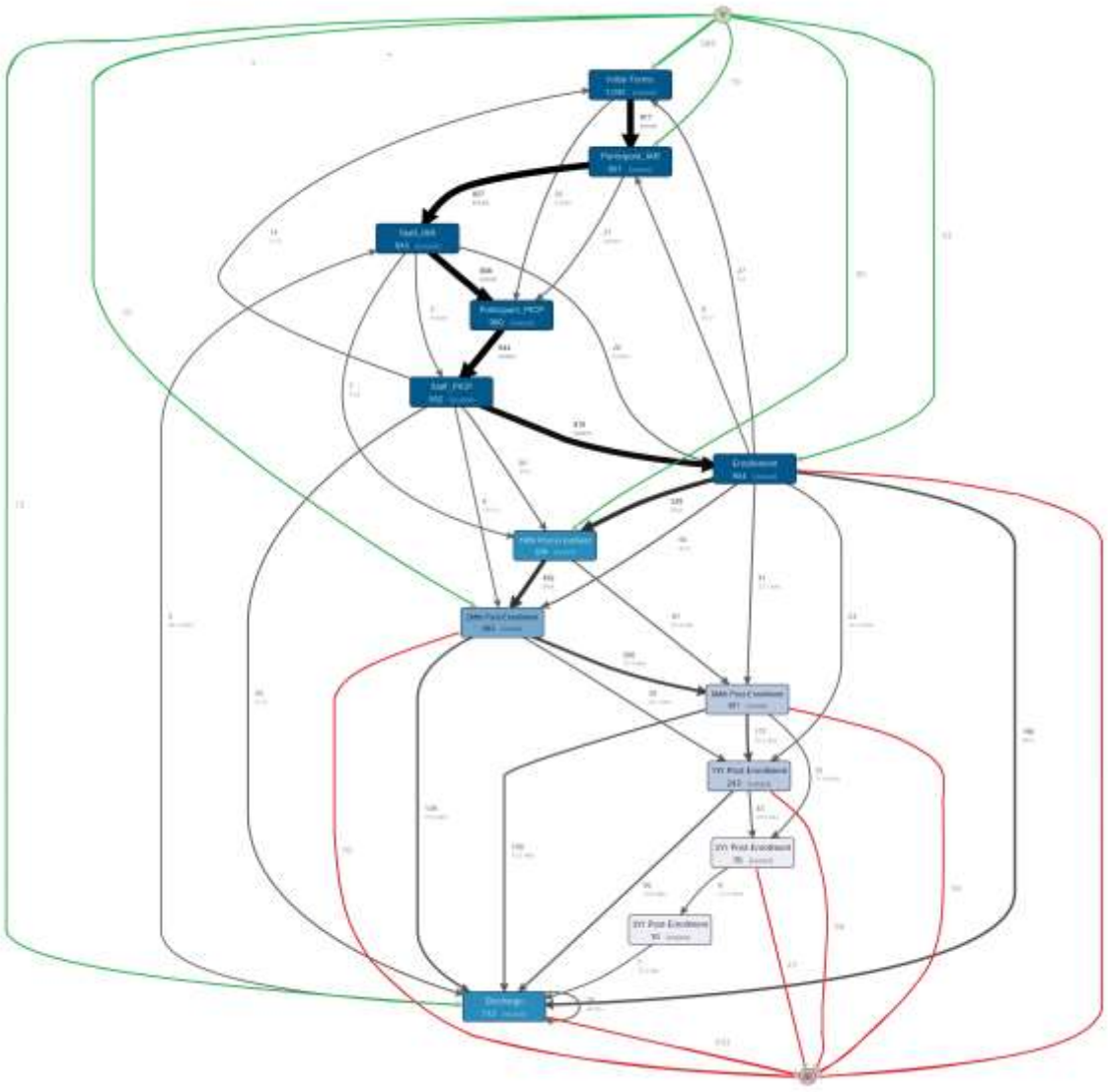

Figure 2. Missouri Maternal, Infant, Early Childhood Home Visiting Program Disco Process Map*:* Actual Workflow*

*For the sake of readability and illustration, only the top 50% of the most frequent pathways are shown.
IAR, Intake Assessment and Referral; PICP, Program Information and Consent to Participate

Figure 2 demonstrates that the most frequent pathway used, highlighted by the thickest arrows, is aligned with the intended workflow. A total of 262 pathways were identified. A pathway (e.g., ABCD) has fidelity if it occurs or progresses in accordance with the intended model (e.g.,

ABCD; ABC; or AB). The map demonstrates a high degree of variation from the intended process, i.e., activities reported out of order or skipped (e.g., BC, ACB, BD). When reviewing the 15 most frequent process variations (60.7% of the total of variations), 13 (57.3% of the total of variations) demonstrated complete fidelity to the intended model, either completed or progressing in sequence.

IMPLICATIONS

The use of process mining in public health, and to specifically track activities and process variations within home visiting programs, has yet to be broadly implemented. Process mining has enormous programmatic implications, as maps generated by the process-mining methodology provide a visual and viewer-friendly way to assess the fidelity of large-scale, complex programs, such as Missouri MIECHV, to their intended processes. These data reflect seven agencies implementing four program models under the MIECHV umbrella. Process mining allows for identifying improvement opportunities, alignment with several levels of stakeholders, and collaborating on key issues for next steps. This methodology can also be easily replicated within-agency to provide tailored, agency-specific reports on their fidelity to process.

Missouri MIECHV is a relatively young program. Therefore, while it is a limitation to apply process mining at the same time data collection practices are being developed, it serves the added purpose of formative feedback to the programs. The use of process-mining methodology and related software is an important diagnostic tool that can be used by any public health program in evaluations and decision making to identify fidelity issues and to target quality improvement initiatives.

SUMMARY BOX

What is already known on this topic? Process mining is used in many industries to understand workflow processes by analyzing data logs from transactional information systems, but its application is uncommon in public health and program evaluation settings, especially from non-transactional information systems (e.g., survey and data-collection software).

What is added by this report? By utilizing case ID, activity label, and timestamp variables, process maps were generated for the Missouri MIECHV program, allowing a deeper understanding of workflow for the purpose of evaluating the program fidelity to the intended model.

What are the implications for public health practice/policy/research? Process mining is a practical methodology that can be easily incorporated into the public health setting to conduct quality improvement, evaluation, and fidelity assessment of processes and workflows, provided the minimum data elements are present.

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