APPLYING HUMAN FACTORS ANALYTICAL TECHNIQUES TO ASSESS PATIENT SAFETY AT HOME

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INTRODUCTION

Although home care is becoming more commonplace in Canada with an estimated 900,000 Canadians receiving care at home in 2007,[1] relatively little is known about patient safety in the home care environment.[2] These environments pose unique challenges for the provision of care that are not present in institutional settings. For example, families and unpaid caregivers play a leading role in care delivery, medical equipment and technology are often operated by non-professional users, and each home poses unique physical constraints.[3] A need for research to identify patient, provider and system level variables that contribute to adverse events (AEs) in the home care environment has been identified.[4] Human factors (HF), a discipline dedicated to uncovering and addressing elements of mismatch between people, tools and environments, can help in calling attention to factors with the potential to lead to AEs. HF is increasingly being applied to healthcare systems both retrospectively to examine AEs and prospectively, to expose potential opportunities for error that may compromise patient safety.

The objectives of this study were to explore the applicability of HF analytical techniques in the home care environment and to generate a hypothesis regarding the applicability of these tools for use in the home care environment.

METHODS

This study consisted of a retrospective analysis of qualitative data acquired from a pilot study of two home care environments in Hamilton, Ontario.[5] The pilot study provided one client, one caregiver and one client/ caregiver transcript from three semi-structured interviews focusing on the experiences of stakeholders in the home care environment. Transcripts were broken down into elements, identified as the smallest grouping of words that retained the essence of a given passage.[6] Transcript elements were iteratively sorted and grouped and each group was assigned a descriptive name to describe its content. Element groupings that described processes carried out in the home care environment were retained for further analysis. Process-related element groupings were preferred for the HF analysis because generally, HF considers how people interact with their surroundings to complete a task or achieve a goal.[6]

To examine potential opportunities for error within the home care environment, several analytical techniques and structured data sources including use case diagrams, process flow diagrams (PFDs), hierarchical task analysis (HTA), failure mode and effects analysis (FMEA), systematic human error reduction and prediction approach (SHERPA), hazard analysis and critical control point (HACCP), heuristics, the Safe Living Guide[7] and the Resident Assessment Instrument – Home Care (RAI-HC)[8] were applied to the process-related element groupings that had been identified.

This paper focuses only on the diagramming techniques (specifically PFDs and HTA) and human error identification (HEI) techniques (FMEA, SHERPA and HACCP). The average time to apply each analytical technique and the number of outputs (sub-tasks for the diagramming techniques and failure modes, causes, effects, recommendations and hazard score for the HEI techniques) were considered. The content of the outputs for the HEI techniques was also analyzed to determine the extent to which different analytical techniques identified common failure modes, causes, effects and recommendations.

Sub-tasks were considered the steps required to carry out a goal. Failure modes were considered the ways in which a process could deviate from an anticipated flow of events. Causes were considered the reasons why a process could deviate, while effects were considered the anticipated outcomes resulting from a deviation. Recommendations were considered suggestions intended to mitigate failure modes from occurring in the first place. Although most of the HEI techniques yielded the aforementioned types of outputs, it should be noted that this was not the case for every HEI technique considered.

RESULTS

A total of 135 element groupings were identified from the pilot data, 60 of which were process-related and thus retained for further analysis.

Time to Complete

The mean time to apply each technique across all 60 processes is reported in Table 1,

Table 1. Mean time (min) to apply each analytical technique to a process

Technique	Time Mean (SD)
PFD	9.4 (7.7)
HTA	3.7 (1.7)
FMEA	17.5 (10.3)
SHERPA	30.7 (13.4)
HACCP	10.4 (9.1)

Outputs

The mean number of sub-tasks each process was broken down into across all 60 processes was 29 (27) for PFD and 7 (3) for HTA.

FMEA and SHERPA each yielded failure modes, with SHERPA uncovering 4.5 times more failure modes than FMEA (1913 vs. 428). Because the HACCP analysis required failure modes from the FMEA as an input, it did not identify any new failure modes. Out of the 2341 total failure modes identified, 218 (9%) were found to have common content.

FMEA and SHERPA each allowed failure modes to be ranked according to severity and likelihood of occurrence. Failure modes with a hazard score above a threshold value[6] were considered higher risk.[9,10] A total of 39% and 56% of all the failure modes uncovered for the 60 processes were found to be higher risk, for FMEA and SHERPA, respectively.

The FMEA analysis was the only HEI technique to yield causes and so no comparison was conducted. An average of 20 (10.7) causes were found per process.

Only the FMEA and SHERPA analyses yielded effects with SHERPA yielding 2.1 times more effects than FMEA (1385 vs. 658). A total of 247 effects out of 2043 (12 %) were found to have common content.

SHERPA uncovered 2.0 more recommendations than FMEA (1720 vs. 845) and 3.6 times more recommendations than HACCP (1720 vs. 477). FMEA uncovered 1.8 times more recommendations than HACCP (845 vs. 477). A total of 285 recommendations out of 2565 (11%) were found to have common content between FMEA and SHERPA. A total of 231 recommendations out of 1322 (17%) were found to have common content between FMEA and HACCP and a total of 137 recommendations out of 2197 (6%) were found to have common content between SHERPA and HACCP.

DISCUSSION

PFD, HTA and FMEA could all be applied to the dataset without having to complete any prerequisite analysis, while SHERPA and HACCP each required prior analysis as an input to the tool.

PFDs enabled tasks occurring in parallel as well as decision points to be diagrammed, whereas HTA did not allow concurrent tasks to be represented nor decision points to be diagrammed explicitly. FMEA, SHERPA and HACCP were used to take processes that had been broken down into sub-tasks and to identify ways in which those sub-tasks could be problematic. In order to identify failure modes using FMEA, an "if anything can go wrong it will" approach was used, while for SHERPA the approach was more systematic because the technique used an error taxonomy based on human behaviour to consider the possible errors at each task step.[6] The comparatively high number of failure modes identified through the SHERPA analysis is likely due in part to the systematic manner in which errors could be identified. Although the error taxonomy assisted in considering the many ways in which a task step could go wrong, it also resulted in the identification of improbable errors, which may never occur in reality.[6]

Application of FMEA and SHERPA permitted the identification of potential effects of each failure mode, while only FMEA yielded potential causes of each failure mode. HACCP was the only technique yielding information about critical limits, critical control points, monitoring procedures, plans of action and the person responsible for ensuring a process operated within control.[10] Although these unique classes of information were yielded, it was challenging to apply this tool to the home care-related processes being analyzed. HACCP is generally applied to manufacturing processes operating within measureable limits, and consequently, when trying to apply this technique to more qualitative processes, it was often challenging to define critical limits, decide how best to implement those limits and determine how monitoring should be conducted.[6]

For others contemplating how best to apply HF analytical techniques to qualitative process-related data, it is suggested that both a diagramming technique and an HEI technique be applied. In this way, not only can processes be visualized, but potential failure modes, effects of those failure modes, criticality and likelihood of those failure modes and recommendations to mitigate those failure modes, can be identified. Also, the entire analysis strategy should be considered before completing the diagramming technique because different HEI techniques require different process diagram inputs. If SHERPA is the desired HEI technique, an HTA is required, whereas if an FMEA is to be conducted, either a PFD or an HTA could be used. If a HACCP analysis is to be conducted, a PFD is suggested, along with an FMEA, because although technically either a PFD or HTA could be created, visually, it may be easier to locate and indicate critical control points on a PFD as opposed to an HTA diagram.

Applying HF analytical techniques to qualitative data was found to be time consuming, as processes had to be identified and diagrammed, and finally, HEI techniques had to be applied. Additionally, those unfamiliar with the diagramming and HEI techniques may find it challenging to visualize processes or to consider how a process could potentially go wrong. Consequently, instead of having providers conduct this type of analysis on a per household basis, it is recommended an analyst or group of analysts apply these techniques to a general grouping of home care-related processes. Based on an analysis of this kind, mitigating strategies and quality improvement tools could be developed and then implemented, tested and monitored in select home care environments, to assess efficacy. To ensure that an exercise of this nature is an efficient and effective use of resources, the most prevalent processes undertaken by clients, caregivers, family members and paid providers should be identified. Additionally, having an understanding of the severity and likelihood of various failure modes occurring, as predicted by the FMEA and SHERPA analyses, can help in targeting mitigating strategies and quality improvement tools to higher risk processes and sub-tasks within processes.

In this study of 60 home care processes many potential failure modes were uncovered by applying FMEA and SHERPA, with an average of 7.1 (4.4) and 31.9 (17.6) failure modes predicted, respectively. It is clear that many of the home care-related processes stakeholders carry out in the home environment have the potential to result in error. Colleagues familiar with the complexity and variability of providing and receiving care at home have indicated the unique perspective enabled by applying these techniques offers a new understanding of some of the barriers that exist in home care.[11]

The meaningfulness of the outputs yielded by each technique is also important to consider. Although one might assume that the more failure modes identified, the more rigorous the analytical tool, it is important to note that those outputs must also reflect what is likely to happen in reality. Applying an analytical tool that identifies false positives is not an effective use of resources. An ideal prospective analytical technique would uncover as many potential failure modes as possible and enable prioritization of those items such that a match between what was uncovered using the technique and what occurred in reality was achieved.

LIMITATIONS

Due to the small sample size of just one visit to two home care environments, study findings cannot be generalized to other home care cases or populations. Additionally, a single analyst applied all analytical techniques to the 60 processes. As a result, inter-rater reliability as well as the robustness of the analysis is unknown. Generally when conducting an FMEA, a group of people is involved to ensure a broad range of perspectives are represented when trying to identify potential failure modes. Additionally, although measures were taken to minimize this effect,[6] it is likely the analyst inadvertently carried outputs forward to subsequent HEI analyses once they had been identified. Finally, it is unknown whether these predictive tools were able to identify potential errors that could truly happen in reality.

CONCLUSION

To date, little is known about patient safety issues in the home care environment. HF analytical techniques can be used to prospectively consider potential opportunities for error, which can compromise patient safety. Applying diagramming and HEI techniques to understand these potential opportunities for error could be useful in developing mitigating strategies and quality improvement tools to enhance the safety of those stakeholders involved in home care.

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