FRED: Fall Risk Evaluation Database Based on Electronic Health Record Data

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***Abstract*—This paper presents a four-part database, FRED, for fall risk evaluation based on electronic health record data from MIMIC-III. Part 1 compromises demographic data and admission IDs. Part 2 presents information on Morse Fall Scale intervals and fall risk labels (high, low, increasing or decreasing fall risk). Part 3 shows corresponding physician notes. Part 4 contains administered medication. The database is open-source and available on PhysioNet.**

***Index Terms*—fall risk assessment, electronic health record, Morse Fall Scale, MIMIC-III**

I. Introduction

Unintended falls are a significant source of morbidity and mortality within the hospital. In response, hospitals now highly prioritize fall prevention programs that use comprehensive methods, including fall risk assessments. Among the common assessment tools in fall-related clinical trials, the Morse Fall Scale (MFS) reportedly has the highest sensitivity and specificity [1]. Textual notes in a patient's medical record can reflect changes in the mental status which are the main predictor of increased fall risk in Intensive Care Units (ICUs). Many medications administered in the hospital are known risk factors for falls [2]. So, Electronic Health Record (EHR) data, which records patients' MFS records, medical notes, and medication use, can be applied in fall risk assessment. However, there is no database that organizes fall-related EHR data and is available for researchers to study fall risks and develop evaluation methods.

In this study, we propose a Fall Risk Evaluation Database (FRED) based on the EHR data in the MIMIC-III database. MIMIC-III is a large, single-center database comprising information relating to patients admitted to critical care units at a large tertiary care hospital [3]. The proposed FRED database comprises MFS records for each adult patient taken at different points in time, medical notes from physicians and nurses, and medication information. In our research, this database has been applied to develop data-driven methods to predict changes in fall risk for patients in ICUs.

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II. Materials and Methods

We derive this database from the MIMIC-III database, which contains anonymized electronic health records of 49,785 distinct hospital admissions over 38,597 adult patients between 2001 and 2008 in intensive care units of Beth Israel Deaconess Medical Center. Among these admissions, 21,668 (43.5%) include more than one Morse Fall Scale assessment result. All data in MIMIC-III are timestamped.

We begin with separating the 21,668 admissions and their data into time intervals, with each interval starting and ending with an MFS assessment. The data before the first or after the last assessment are discarded. We can interpret each assessment result as either "high fall risk" or "low fall risk" with one of the three methods:

1) Total MFS score ≥ 55 as high, < 55 as low
2) Ambulatory aid = "crutches" or "furniture" as high, = "none" as low
3) Mental status = "forgets limitations" as high, = "oriented to own ability" as low

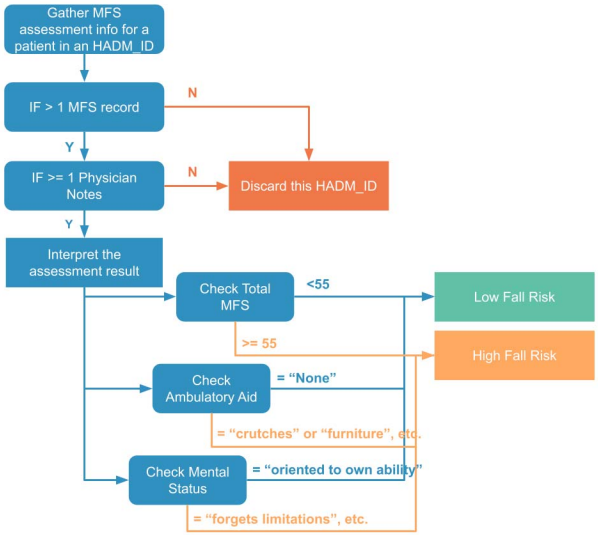

Fig. 1: Logic behind labeling MFS assessments

In our study, we chose method 3 since most MFS queries do not change much throughout time and do not reflect the patient's current fall risk, such as the history of falling. Only

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ambulatory aid and mental status have relatively rapid changes. Moreover, the value "crutches" in ambulatory aid is ambiguous to determine one's fall risk. Figure 1 shows the logic behind labeling an MFS assessment.

TABLE I: Number and percentage of each type of interval

Interval Type	Number	Percentage
Increasing Fall Risk	3,389	6.3%
Decreasing Fall Risk	3,928	7.4%
Remaining Low Fall Risk	17,426	32.5%
Remaining High Fall Risk	28,813	53.8%
Total	53,556	100.0%

III. Results

After we decide the risk level reflected by each MFS record, the time intervals separated by these assessments can be labeled as "increasing risk" if it starts from low risk and ends up with high, and symmetrically, "decreasing risk", "remaining low" and "remaining high". The statistics of the intervals are shown in Table I.

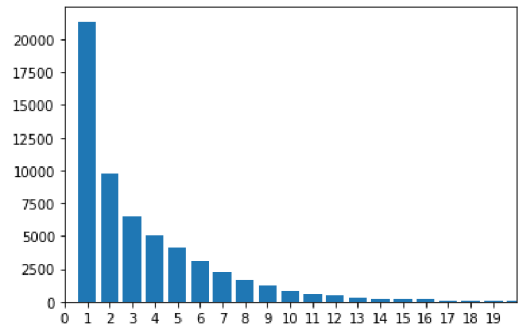

Fig. 2: Distribution of the number of physician notes in one interval. The average number of notes per interval is 3.46.

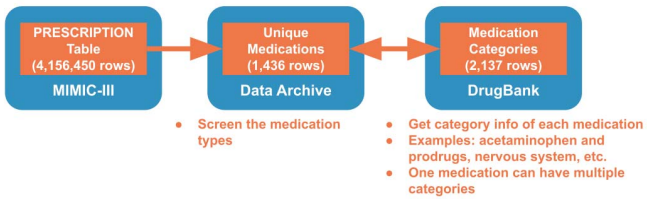

Fig. 3: Process of collecting medication information

Then, other data can be matched to these intervals based on the timestamps at data collection. So far, we have organized two types of data: **physician notes** and **administered medication**. More data from the MIMIC-III database can be matched to these intervals, given timestamps are provided. Figure 2 represents the distribution of the number of physician notes in one interval. Figure 3 shows the process of collecting unique medication types from MIMIC-III and generating medication categories from DrugBank [4].

IV. Data Structure

The data are organized into entity-relationship tables, consisting of:

1) A table with static information of each hospital admission that does not vary or vary little throughout time, including patient age, sex, weight, and height. Each row corresponds to one admission and is associated with an admission ID (HADM_ID).
2) A table with the information of all MFS intervals. That is, the beginning and ending timestamps, label (high, low, increasing or decreasing fall risk), corresponding HADM_ID, and an assigned interval ID (MFS_INT_ID).
3) A table with physician notes, with corresponding timestamps, HADM_ID and MFS_INT_ID.
4) A table with administered medication, with corresponding timestamps, HADM_ID and MFS_INT_ID.

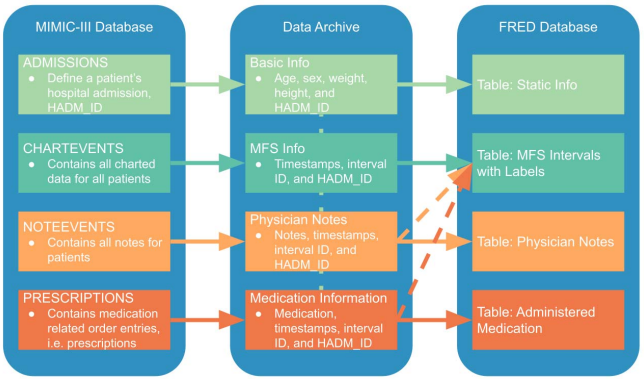

Fig. 4: Overview of the FRED database

If more time-stamped data are organized in the future, they will be in the same structure as physician notes and medication. Figure 4 shows the overview of the structure of the proposed FRED database.

V. Conclusion

In this study, we propose a Fall Risk Evaluation Database, FRED, based on the EHR data, which contains MFS records, medical notes, and medication information, in the MIMIC-III database. The FRED database has been applied to develop data-driven methods to predict changes in fall risk for patients in ICUs. Moreover, it can be used by researchers to develop comprehensive fall prediction and fall prevention methods.

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