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Aditya Jhaveri April 16, 2021

Morse Fall Scale Score Impact on Administration of Benzodiazepines and Opioids

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Abstract

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Falls for geriatric populations are a leading cause of death, injury, and have a high economic burden. The toll of falls on patients and hospitals is high, which has led to a significant effort to reduce the rising rate and impact of falls. Prevention of falls starts with using fall assessment measures and incorporating nursing to de-silo data in order to build treatment plans, allocate resources, and target patients at the highest risk. The Morse Fall Scale (MFS) is commonly utilized in clinical care as an assessment tool for fall risk. Data collected from the MFS can then be used in making healthcare decisions and exists for the purpose of informing care providers of fall risk levels for patients. A key area of use for the Morse Fall Scale is potentially in determining how much and which medications to prescribe patients in the context of fall risk. Several pharmacotherapeutic agents have been identified as modifiable risk factors for falls. Benzodiazepines and opioids are two classes of drugs linked to increasing the likelihood for a patient to fall. Thus, patients that have high MFS scores and are at high risk of falling should not be prescribed benzodiazepines or opioids as frequently. In this paper, the likelihood of prescribing benzodiazepines and opioids is evaluated based on the Morse Fall Scale. The Logit model is used to determine average partial effects of the Morse Fall Scale on prescription. Preliminary findings from the data suggest that the opposite of what medical guidance would expect occurs, with patients that have higher MFS scores being more likely to be administered both benzodiazepines and opioids. Initial results highlight that the Morse Fall Scale and fall risk assessment measures may be underutilizing in altering modifiable risk factors for falls.

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Table of Contents

Background Information

1.1 The Impact of Falls

Falls for geriatric populations is a leading cause of death and injury and are associated with loss in quality of life. The age-adjusted mortality rate from falls has increased in adults, aged 75 years or older, from 60.7 per 100,000 men in 2000 to 116.4 per 100,000 men in 2016 and from 46.3 per 100,000 women in 2000 to 105.9 per 100,000 women in 2016 (Hartholt et al., 2019). The leading cause of injury-related death among adults over 65 stems from falls and has increased about 30% from 2009 to 2018 (Centers for Disease Control and Prevention, 2021). Moreover, the impact of falls is economic with an estimated $49.5 billion dollars attributed to healthcare expenditures from falls (Haddad, Bergen, and Florence, 2019). Worldwide, falls are the second leading cause of unintentional death after road-traffic accidents (Alshammari et al., 2018).

1.2 Morse Fall Scale

Screening patients is needed for effective care regarding fall prevention. The Morse Fall Scale (MFS) is a tool that has been one of the most tested, recommended, and implemented tools for fall risk assessment in clinical practice. The predictive value of the Morse Fall Scare varies depending on setting but has been recommended in identifying high-risk patients based on several validation studies (Bóriková et al., 2016). Nurses and care practitioners often use the Morse Fall Scale as a quick and simple assessment of risk level for patients.

Item	*Scale*	*Scoring*
1. History of falling; immediate or within 3 months	No 0 Yes 25	_____
2. Secondary Diagnosis	No 0 Yes 25	_____
3. Ambulatory Aid Bed Rest/nurse assist Crutches/cane/walker Furniture	 0 15 30	_____
4. IV/Heparin Lock	No 0 Yes 20	_____
5. Gait/Transferring Normal/bedrest/immobile Weak Impaired	 0 10 20	_____
6. Mental status Oriented to own ability Forgets limitations	 0 15	_____

Table 1.2.1 Morse Fall Scale Form Example

The Morse Fall Scale is recorded through forms such as in Table 1.2 (SAGE Publications, 2016).

"History of falling: This is scored as 25 if the patient has fallen during the present hospital admission or if there was an immediate history of physiological falls, such as from seizures or an impaired gait prior to admission. If the patient has not fallen, this is scored 0. Note: If a patient falls for the first time, then his or her score immediately increases by 25.

Secondary diagnosis: This is scored as 15 if more than one medical diagnosis is listed on the patient's chart; if not, score 0.

Ambulatory aids: This is scored as 0 if the patient walks without a walking aid (even if assisted by a nurse), uses a wheelchair, or is on a bed rest and does not get out of bed at all. If the patient uses crutches, a cane, or a walker, this item scores 15; if the patient ambulates clutching onto the furniture for support, score this item 30.

Intravenous therapy: This is scored as 20 if the patient has an intravenous apparatus or a heparin lock inserted; if not, score 0.

Gait: A normal gait is characterized by the patient walking with head erect, arms swinging freely at the side, and striding without hesitant. This gait scores 0. With a weak gait (score as 10), the patient is stooped but is able to lift the head while walking without losing balance. Steps are short and the patient may shuffle. With an impaired gait (score 20), the patient may have difficulty rising from the chair, attempting to get up by pushing on the arms of the chair/or by bouncing (i.e., by using several attempts to rise). The patient's head is down, and he or she watches the ground. Because the patient's balance is poor, the patient grasps onto the furniture, a support person, or a walking aid for support and cannot walk without this assistance.

Mental status: When using this Scale, mental status is measured by checking the patient's own self-assessment of his or her own ability to ambulate. Ask the patient, "Are you able to go the bathroom alone or do you need assistance?" If the patient's reply judging his or her own ability is consistent with the ambulatory order on the [chart], the patient is rated as "normal" and scored 0. If the patient's response is not consistent with the nursing orders or if the patient's response is unrealistic, then the patient is considered to overestimate his or her own abilities and to be forgetful of limitations and scored as 15.

Scoring and Risk Level: The score is then tallied and recorded on the patient's chart. Risk level and recommended actions (e.g., no interventions needed, standard fall prevention interventions, high risk prevention interventions) are then identified. Important Note: The Morse Fall Scale should be calibrated for each particular healthcare setting or unit so that fall prevention strategies are targeted to those most at risk. In other words, risk cut off scores may be different depending on if you are using it in an acute care hospital, nursing home or rehabilitation facility. In addition, scales may be set differently between particular units within a given facility." (SAGE Publications, 2016).

1.3 Benzodiazepines Linked to Falls

Exposure to Benzodiazepines (BZD) is associated with a higher risk of falling in older adults when administered as monotherapy or in combination therapy (Gutiérrez et al., 2017). There is established evidence of an upward trend in fall incidents when BZD use starts and that the risk of fall remains elevated throughout treatment (McDonald and Caslangen, 2019).

1.4 Opioids Linked to Falls

Opioids have also been linked to falls and a meta-analysis of thirty studies found that opioid use was significantly associated with falls, fall injuries, and fractures in adults (Yoshikawa et al., 2020).

1.5 Assessment and Prevention

Fall prevention requires a plan to reduce patient risk. The overall fall risk assessment and prevention process includes assessment of fall risk, documentation and communication, creation of a safe environment, and promoting both balance and strength (Phelan et al., 2015). The

Centers for Disease Control and Prevention has created a Stopping Elderly Accidents, Deaths, and Injuries (STEADI) Initiative that includes: (1) identifying patients at risk of fall (2) identifying modifiable risk factors (3) using effective clinical and community strategies (Haddad, Bergen, and Luo, 2018).

1.6 Research Questions

(1) Is the Morse Fall Scale Score used in administering benzodiazepines and opioids to patients?

(2) Does a difference in medication prescription exist between patients that have fallen and patients that have not fallen?

(3) Are there any other factors that impact the dispensation of benzodiazepines and opioids?

Project Data Overview

Data for the present study was obtained from the Project NeLL Database of the Nell Hodgson Woodruff School of Nursing of Emory University

2.1 Project NeLL Overview: About the Project

> Project NeLL (**N**urses' **e**HR **L**earning **L**ab) was conceptualized by faculty and staff at the Emory School of Nursing's Center for Data Science (CDS). Project NeLL serves the students of the NeLL Woodruff Hodgson School of Nursing. It provides students the opportunity to experience “big data” use of a real Electronic Health Record for the purpose of deriving hypotheses for further study and assessing Quality in the healthcare system. This experience opens the door for understanding big data, demonstrating

innovation in workflow, creating opportunities for exploration of data analytics and determining value-based nursing care analogies by exploration of data.

2.2 Project NeLL Overview: About the Data

The Project NeLL database ((**N**urses' **e**HR **L**earning **L**ab) contains de-identified patient data extracted by Emory University's Data Solutions Group. The database currently includes patients from January 2013 through August 2019, and plans are to expand the database annually. The data represent all hospital and clinical interactions across the continuum of care for 1,000,000 patients, randomly selected from the Emory University Clinical Data Warehouse. Data are de-identified according to HIPAA regulations. This includes anonymity of patients' ID numbers, removal of patient names, birthdates, addresses and phone numbers, shifted visit dates, and zip codes at the 3-digit level are all part of anonymizing this data.

2.3 Classification

Patients with hypertension were classified as those that did not fall and used as controls. Patients with ICD-9 scores indicating they had fallen were classified as patients that had fallen. Those who had fallen did not necessarily have a diagnosis of hypertension, but it was largely present as a comorbidity in those patients.

Methodology

3.1 Query Method for Patients That Fell

1. Found all patients with a fall diagnosis defined between ICD9 E880 and ICD9 E889. Additionally, patients were limited to age being greater than or equal to 50 years at the time of their encounter.
    a. After removing duplicates, there were 50,678 patients with a Fall diagnosis.
        i. These were patients for all years and it was later selected to be only for the years between 2013 to 2014.
    b. Due to HIPAA restrictions, ages over 89 are shown as age 89.
2. Determined Morse Scale Scores for each Encounter by matching each patient in a table with all Morse Scale Scores.
    a. For a given encounter, there may be more than one Morse Score when the patient has been evaluated over multiple timepoints (n=210,014). Thus, for data analysis purposes the most recent Morse Fall Scale score was used.
3. Determined Medications for each patient by matching the patient in a table with all medications reported by the patient at the time of the encounter, as well as newly prescribed medications.
    a. The therapeutic class of each medication is based upon the Anatomical Therapeutic Chemical Classification System.

4. Determined patient demographics by matching the record in a table with the demographics

5. After merging all data to patients there were 1619 patients with demographic data, Morse Fall Scale scores, and medication information.

3.2 Query Method for Hypertension (Did Not Fall) Patients

1. Pulled a random sample of 13,000 patients with a diagnosis defined by the ICD-9 401.9 code for hypertension. Additionally, patients were limited to age being greater than or equal to 50 years at the time of their encounter.

    a. Due to HIPAA restrictions, ages over 89 are shown as age 89.

2. Received Morse Scale Scores for 760,000 patients with hypertension.

    a. For a given encounter, there may be more than one Morse Score when the patient has been evaluated over multiple timepoints (n=760,000). Thus, for data analysis purposes the most recent Morse Fall Scale score was used.

    b. The scores received were all of the Morse Fall Scale Scores available at the time for hypertension patients and not necessarily for every patient in the random sample.

3. Determined Medications for each patient by matching the patient in a table with all medications reported by the patient at the time of the encounter, as well as newly prescribed medications.

   a. The therapeutic class of each medication is based upon the Anatomical Therapeutic Chemical Classification System.

   b. All data was not cleaned and some of the medication files were unable to be matched to patients and patients without records were removed from the dataset.

4. Determined patient demographics by matching the record in a table with the demographics

5. After merging all data to patients there were 237 patients with demographic data, Morse Fall Scale scores, and medication information.

3.3 Selection of Years

Selecting the years 2013 and 2014 for analysis was mainly based on data availability from Project NeLL. Data on the Morse Fall Scale was not currently available for patients prior to 2013. Additionally, for the years following 2014 the patients were recorded with varying International Classification of Diseases Clinical Modification (ICD-CM) codes between the 9th and 10th revisions. The reason for this was because of the policy change on October 1, 2015 that implemented ICD-CM-10 codes and transitioned away from ICD-CM-9 codes (Slavova et al., 2018).

3.4 Selection of Age Group

The age group that was selected for the study was those 50 and over to center on geriatric populations. Performance in mobility measures such as the 4-m fast speed task have been shown to decline only after the age of 40-50 years (Ferrucci et al., 2016). Additionally, the cutoff was

utilized in order to have more data be available and for convenience in pulling data due to several data processing issues.

3.5 Logit Model

$$\Pr(y = 1 | Morse\_Fall\_Scale, Age, GenderMale, African\_American\_or\_Black, Other$$
$$= \Lambda(\beta_0 + \beta_1 Morse\_Fall\_Scale + \beta_2 GenderMale$$
$$+ \beta_3 African\_American\_or\_Black + \beta_4 Other$$

In this study, I am interested in whether the Morse Fall Scale score is reflected in the prescription of benzodiazepines and opioids. Specifically, the dependent variable of interest—the medications being analyzed—is denoted as y being a binary variable that indicates whether the patient received a medication or not. When y=1 that refers to the set of medications that have been selected for that model. This is specified for each model and which medications have been chosen. Thus, y=0 entails that no selected medications have been administered to the patient and y=1 refers to when selected medications are present for a patient. The Morse Fall Scale, which is the main independent variable of interest, score ranges from 0 to 125. To prevent possible confounding effects, the model controls for age, race, and gender. The Gender parameter was set to be a factor with the levels of 0 being Female and 1 being Male. Race is divided into three groups: African American or Black, Caucasian or White, and Others. Caucasian or White race was used as the base when creating the dummy variables for race in which African American or Black and Other was compared to. Other is the group of people that identified as Asian, Multiple, or Unknown, Unavailable, or Unreported.

Patient Demographics

4.1 All Patients Age, Gender, and Race

Baseline Characteristics of Combined Dataset		
	Combined (n=1856)	
	Number	**Percent**
Age		
50-60	394	21.23%
60-70	531	28.61%
70-80	457	24.62%
80+	474	25.54%
Gender		
Male	1039	55.98%
Female	817	44.02%
Race		
Caucasian or White	1294	69.72%
African American or Black	486	26.19%
Other	76	4.09%

Table 4.1.1 Demographics (Age, Gender, Race) for All Patients

The set of data combined the patients that fell with the patients with a primary diagnosis of hypertension (marked as patients that did not fall).

4.2 Patients That Fell Age, Gender, and Race

Baseline Characteristics of Individual Dataset		
	Fallers (n=1619)	
	Number	**Percent**
Age		
50-60	341	21.06%
60-70	451	27.86%
70-80	394	24.34%
80+	433	26.74%
Gender		
Male	907	56.02%
Female	712	43.98%
Race		
Caucasian or White	1174	72.51%
African American or Black	378	23.35%
Other	67	4.14%

Table 4.2.1 Demographics (Age, Gender, Race) for Patients That Fell

4.3 Patients with Hypertension (Did Not Fall) Age, Gender, and Race

Baseline Characteristics of Individual Dataset		
	Hypertension (n=237)	
	Number	**Percent**
Age		
50-60	53	22.36%
60-70	80	33.76%
70-80	63	26.58%
80+	41	17.30%
Gender		
Male	132	55.70%
Female	105	44.30%
Race		
Caucasian or White	120	50.63%
African American or Black	108	45.57%
Other	9	3.80%

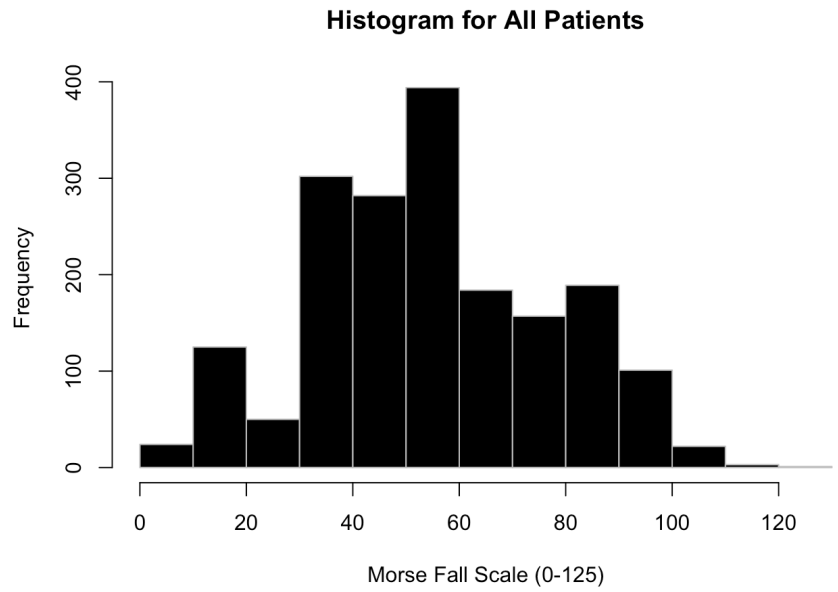
Table 4.3.1 Demographics (Age, Gender, Race) for Hypertension Patients

Morse Fall Scale Distributions

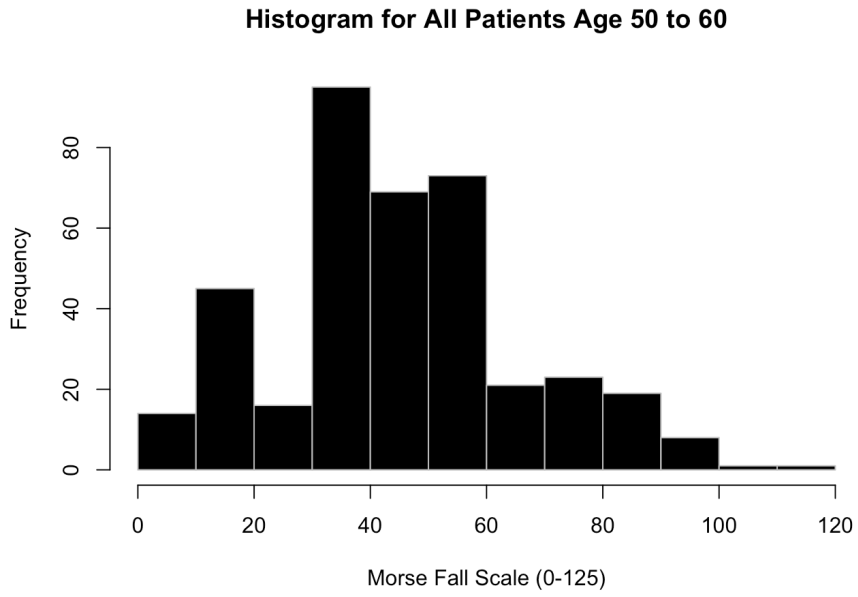
5.1 All Patients Morse Fall Scale Information

Morse Fall Scale Score (Records 2013-2014)		
Low(0-24)	149	8.12%
Medium (25-44)	352	19.19%
High (45+)	1333	72.68%
NA	22	

Table 5.1.1 Morse Fall Scale Score Distribution for All Patients

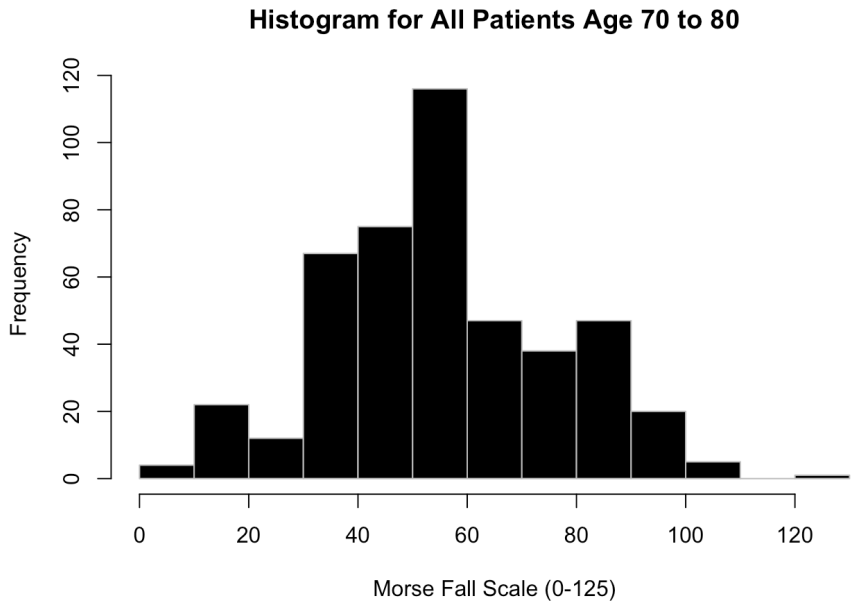


Histogram 5.1.2 MFS for All Patients

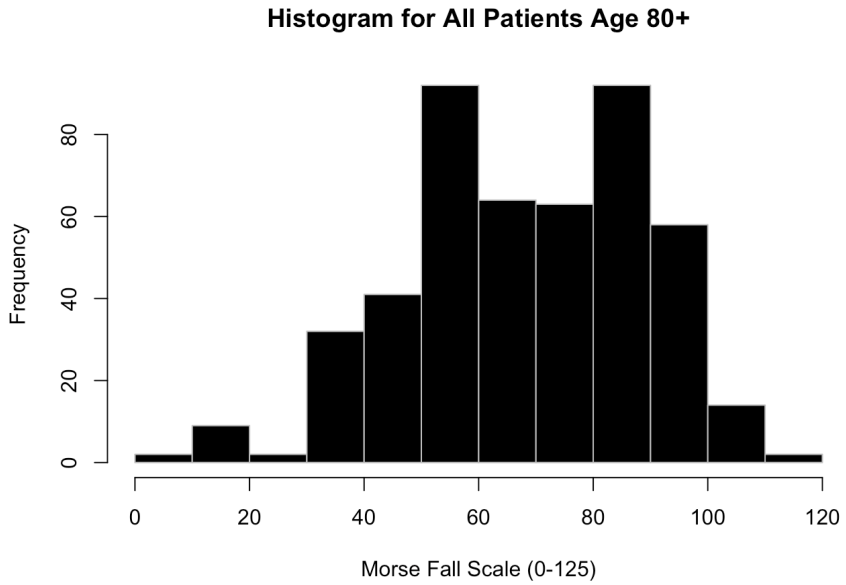


Histogram 5.1.3 MFS for All Patients from Age 50 to 60

Histogram 5.1.4 MFS for All Patients from Age 60 to 70



Histogram 5.1.5 MFS for All Patients from Age 70 to 80

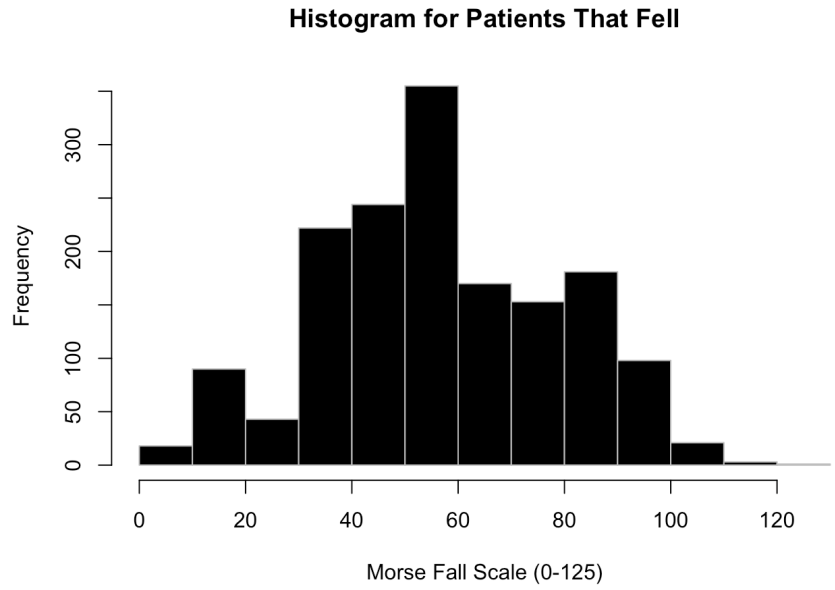


Histogram 5.1.6 MFS for All Patients from Age 80+

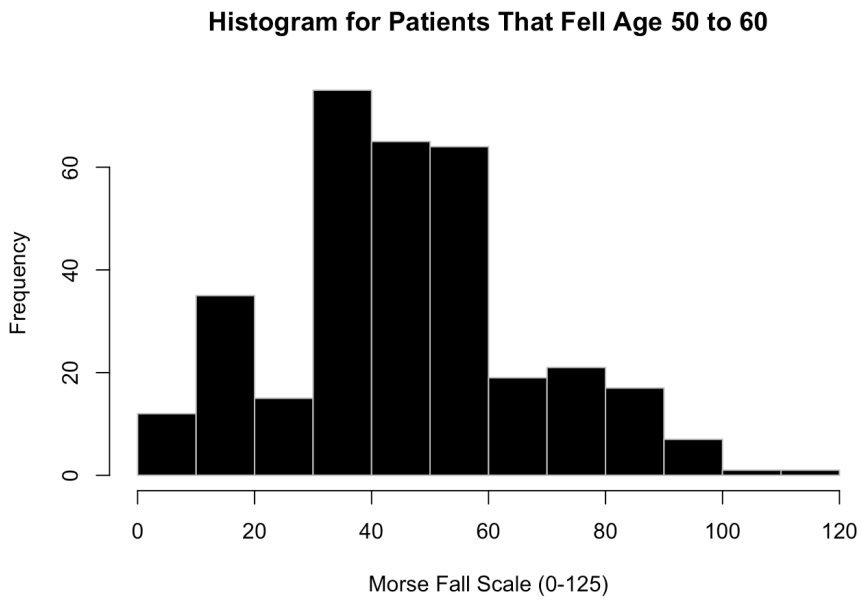
5.2 Patients That Fell Morse Fall Scale Information

Morse Fall Scale Score (Records 2013-2014)		
Low(0-24)	108	6.75%
Medium (25-44)	265	16.57%
High (45+)	1226	76.67%
NA	20	

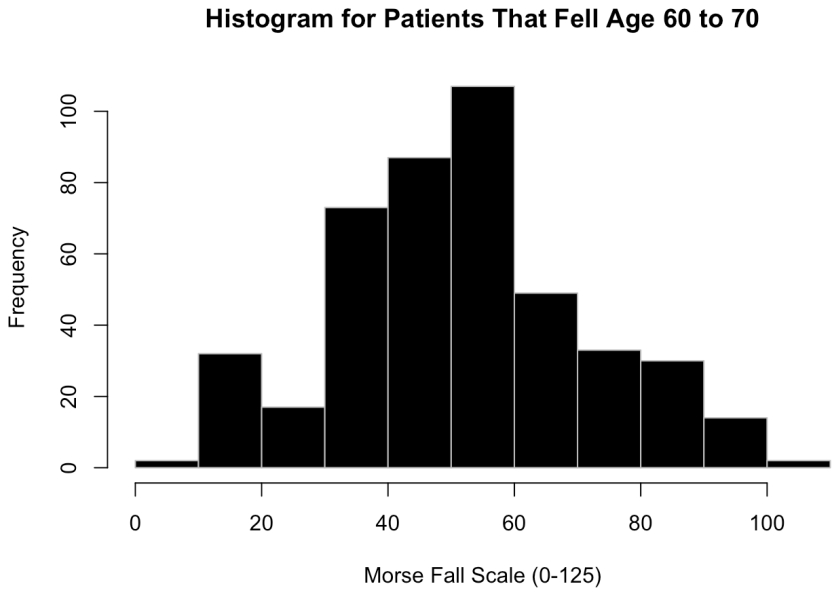
Table 5.2.1 Morse Fall Scale Score Distribution for Patients That Fell



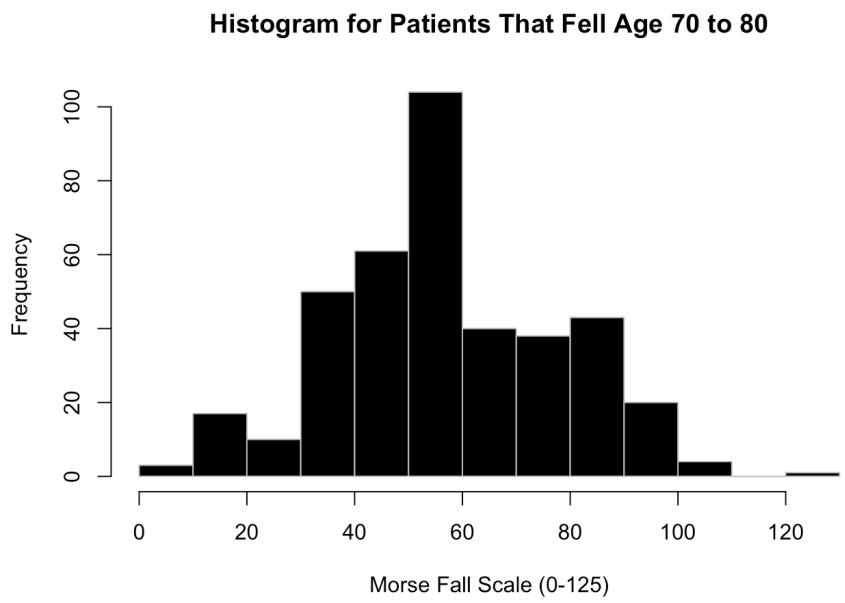
Histogram 5.2.2 MFS for Patients That Fell



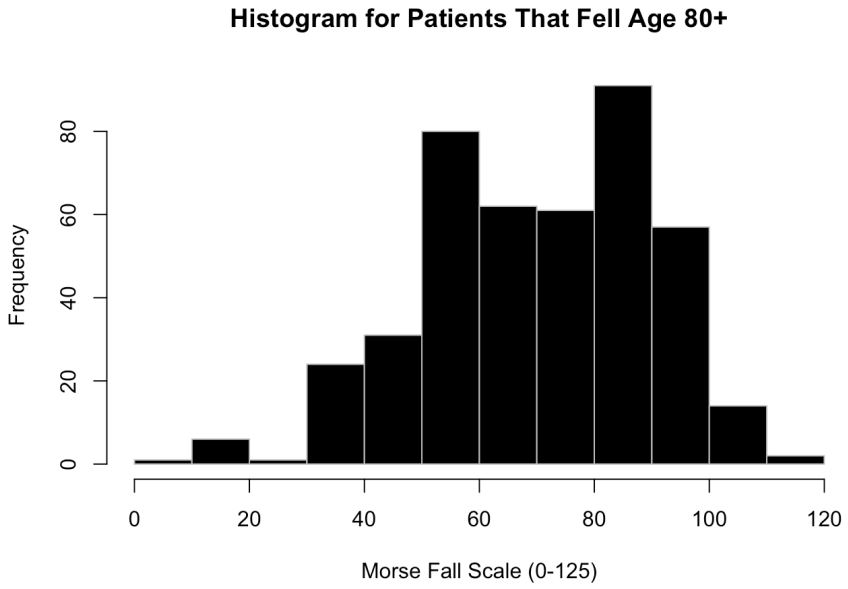
Histogram 5.2.3 MFS for Patients That Fell from Age 50 to 60



Histogram 5.2.4 MFS for Patients That Fell from Age 60 to 70



Histogram 5.2.5 MFS for Patients That Fell from Age 70 to 80

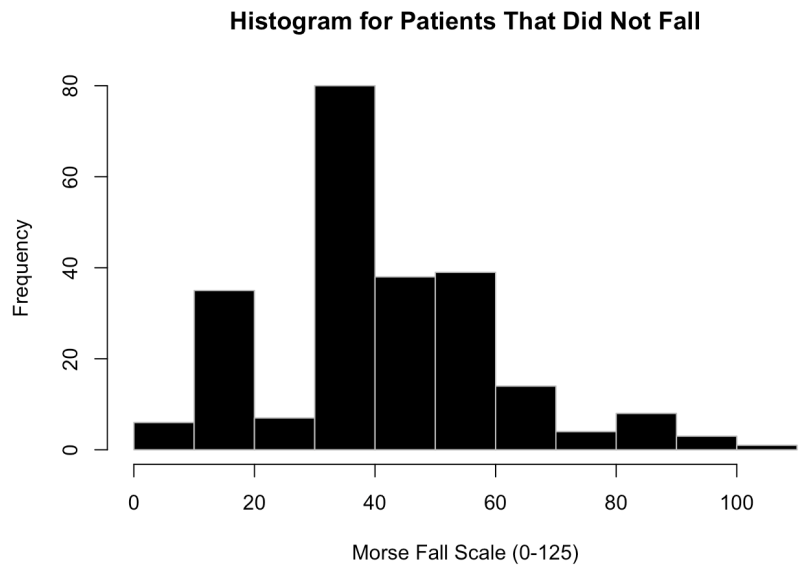


Histogram 5.2.6 MFS for Patients That Fell from Age 80+

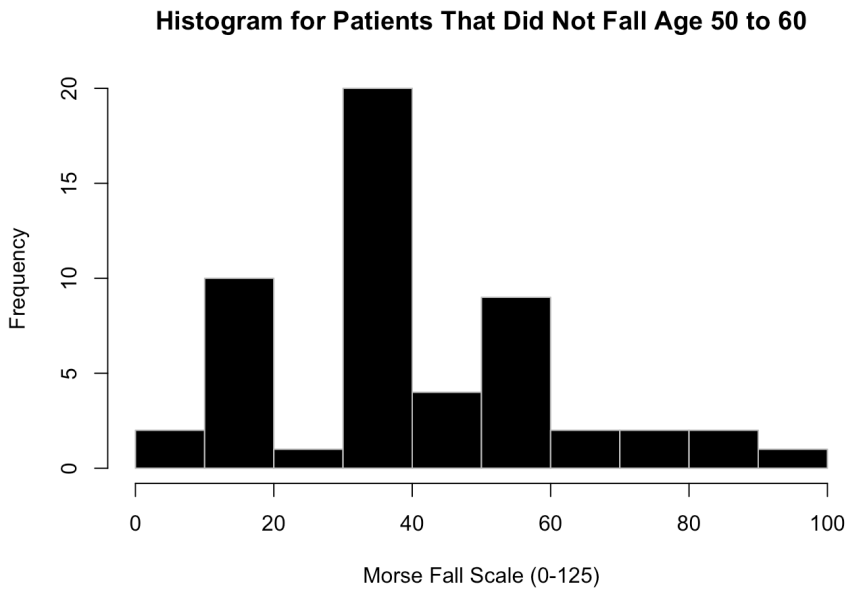
5.3 Patients with Hypertension (Did Not Fall) Morse Fall Scale Information

Morse Fall Scale Score (Records 2013-2014)		
Low(0-24)	41	19.07%
Medium (25-44)	67	31.16%
High (45+)	107	49.77%
NA	2	

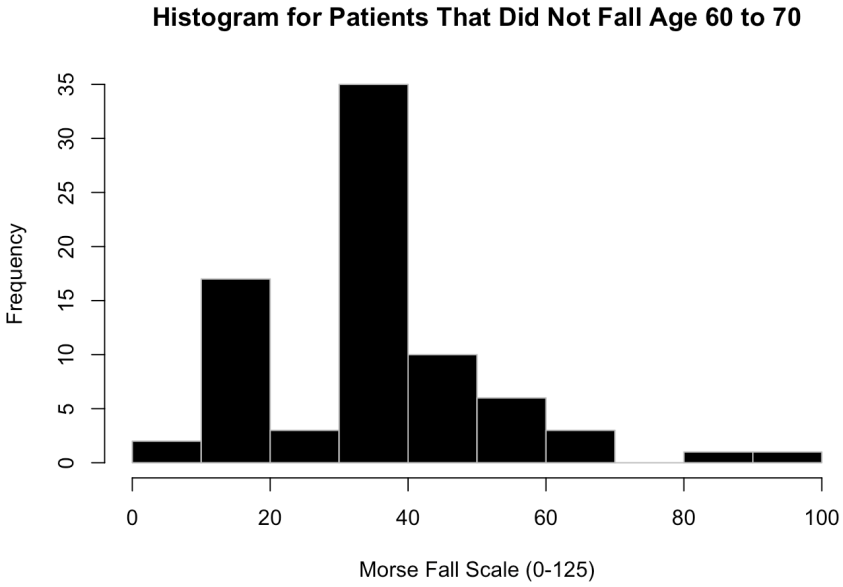
Table 5.3 Morse Fall Scale Score Distribution for Hypertension Patients



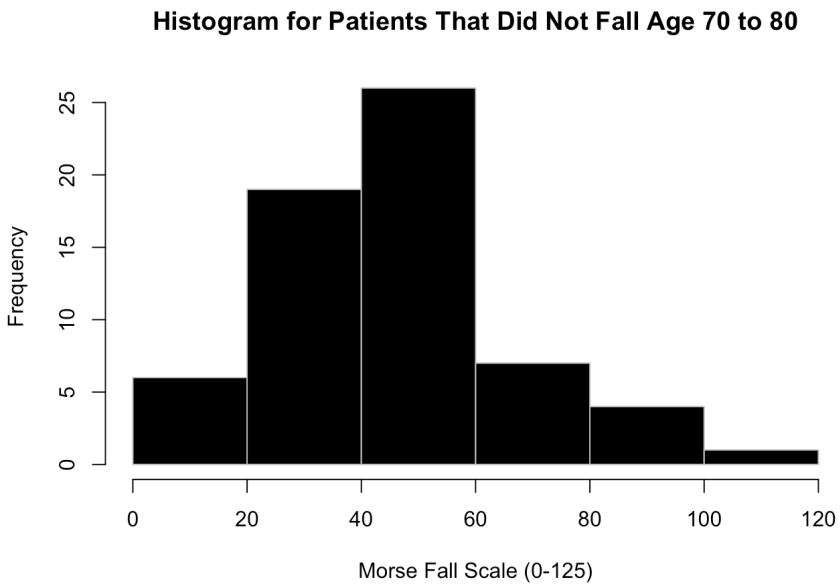
Histogram 5.3.2 MFS for Patients with Hypertension



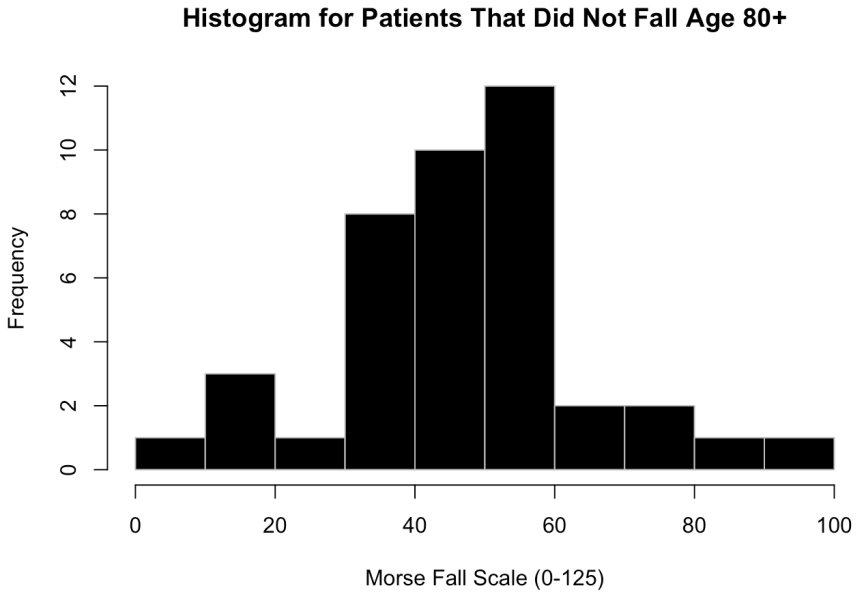
Histogram 5.3.3 MFS for Patients with Hypertension from Age 50 to 60



Histogram 5.3.4 MFS for Patients with Hypertension from Age 60 to 70



Histogram 5.3.5 MFS for Patients with Hypertension from Age 70 to 80



Histogram 5.3.6 MFS for Patients with Hypertension from Age 80+

Benzodiazepines and Opioids

6.1 Overview Logit Model

$$\Pr(y = 1 | Morse\_Fall\_Scale, Age, GenderMale, African\_American\_or\_Black, Other$$
$$= \Lambda(\beta_0 + \beta_1 Morse\_Fall\_Scale + \beta_2 GenderMale$$
$$+ \beta_3 African\_American\_or\_Black + \beta_4 Other$$

6.2 Medications

- Benzodiazepines
    - The benzodiazepines selected were: Midazolam, Lorazepam, Diazepam, Alprazolam, Clonazepam, Temazepam, Chlordiazepoxide.
- Opioids
    - The opioids selected were: Fentanyl, Hydromorphone, Acetaminophen, Morphine, Acetaminophen-oxycodone Acetaminophen-hydrocodone, Oxycodone, Tramadol, Methadone, Meperidine, Hydrocodone, Remifentanil.

6.3 Logit Model for All Patients

```
logit_fit_combined_narc_benz_with_fentanyl_mida_1 <- glm(Medications ~ Morse_Fall_Scale + Age + factor(Gender) +
African_American_or_Black+Other, family = binomial, data= logit_combined_data_narc_benz_fentmira_1)

summary(margins(logit_fit_combined_narc_benz_with_fentanyl_mida_1))
```

```
##                    factor     AME     SE       z      p   lower   upper
##  African_American_or_Black -0.0469 0.0118 -3.9599 0.0001 -0.0700 -0.0237
##                        Age -0.0022 0.0006 -3.8818 0.0001 -0.0033 -0.0011
##                 GenderMale -0.0172 0.0113 -1.5255 0.1271 -0.0393  0.0049
##           Morse_Fall_Scale  0.0023 0.0003  7.3698 0.0000  0.0017  0.0029
##                      Other -0.0195 0.0272 -0.7149 0.4746 -0.0729  0.0339
```

Logit Model Information 6.3.1 for All Patients

The average partial effect indicates that for every increase in 1 for the Morse Fall Scale the probability of prescribing Opioids or Benzodiazepines increases by 0.0023 on average and this is significant as $p < .05$.

6.4 Logit Model for Patients That Fell

```
logit_fit_fall_narc_and_benzos_1 <- glm(Medications ~ Morse_Fall_Scale + Age + factor(Gender) + African_American_
or_Black+Other, family = binomial, data= logit_model_morse_fall_fin_narc_and_benzos_yes_fall_1)

summary(margins(logit_fit_fall_narc_and_benzos_1))
```

```
##                     factor     AME     SE       z      p   lower   upper
##  African_American_or_Black  0.0001 0.0063  0.0104 0.9917 -0.0122  0.0124
##                        Age -0.0009 0.0004 -2.5227 0.0116 -0.0016 -0.0002
##                 GenderMale -0.0022 0.0047 -0.4624 0.6438 -0.0114  0.0071
##           Morse_Fall_Scale  0.0002 0.0001  1.9791 0.0478  0.0000  0.0005
##                      Other -0.0115 0.0070 -1.6414 0.1007 -0.0252  0.0022
```

Logit Model Information 6.4.1 for Patients That Fell

The average partial effect indicates that for every increase in 1 for the Morse Fall Scale the probability of prescribing Opioids or Benzodiazepines increases by 0.0002 on average and this is significant as $p < .05$.

6.5 Logit Model for Hypertension (Did Not Fall) Patients

```
logit_fit_narc_and_benzos_nofall_both_1 <- glm(Medications ~ Morse_Fall_Scale + Age + factor(Gender) + African_Am
erican_or_Black+Other, family = binomial, data= logit_model_narc_and_benzos_no_fall_1)

summary(margins(logit_fit_narc_and_benzos_nofall_both_1))
```

```
##                     factor     AME     SE       z      p   lower  upper
##  African_American_or_Black  0.0085 0.0672  0.1259 0.8998 -0.1233 0.1402
##                        Age -0.0032 0.0031 -1.0124 0.3113 -0.0094 0.0030
##                 GenderMale -0.1109 0.0654 -1.6959 0.0899 -0.2391 0.0173
##           Morse_Fall_Scale  0.0038 0.0016  2.3182 0.0204  0.0006 0.0070
##                      Other  0.1448 0.1739  0.8329 0.4049 -0.1960 0.4857
```

Logit Model Information 6.5.1 for Hypertension Patients

The average partial effect indicates that for every increase in 1 for the Morse Fall Scale the probability of prescribing Opioids or Benzodiazepines increases by 0.0038 on average and this is significant as $p < .05$.

Benzodiazepines and Opioids Without Midazolam and Without Fentanyl

7.1 Overview Logit Model

$$\Pr(y = 1 | Morse\_Fall\_Scale, Age, GenderMale, African\_American\_or\_Black, Other$$
$$= \Lambda(\beta_0 + \beta_1 Morse\_Fall\_Scale + \beta_2 GenderMale$$
$$+ \beta_3 African\_American\_or\_Black + \beta_4 Other$$

7.2 Medications

- Benzodiazepines
    - The benzodiazepines selected were: Lorazepam, Diazepam, Alprazolam, Clonazepam, Temazepam, Chlordiazepoxide.
- Opioids
    - The opioids selected were: Hydromorphone, Acetaminophen, Morphine, Acetaminophen-oxycodone Acetaminophen-hydrocodone, Oxycodone, Tramadol, Methadone, Meperidine, Hydrocodone, Remifentanil.

7.3 Logit Model for All Patients

```
logit_fit_combined_narc_benz_without_fentanyl_mida_1 <- glm(Medications ~ Morse_Fall_Scale + Age + factor(Gender)
+ African_American_or_Black+Other, family = binomial, data= logit_combined_data_narc_benz_nofentanyl_nomira_1)

summary(margins(logit_fit_combined_narc_benz_without_fentanyl_mida_1))
```

```
##                    factor     AME     SE       z      p   lower   upper
##  African_American_or_Black -0.0526 0.0124 -4.2527 0.0000 -0.0768 -0.0284
##                        Age -0.0023 0.0006 -4.0081 0.0001 -0.0035 -0.0012
##                 GenderMale -0.0214 0.0118 -1.8091 0.0704 -0.0446  0.0018
##           Morse_Fall_Scale  0.0026 0.0003  8.0196 0.0000  0.0020  0.0032
##                      Other -0.0132 0.0300 -0.4391 0.6606 -0.0720  0.0457
```

Logit Model Information 7.3.1 for All Patients

The average partial effect indicates that for every increase in 1 for the Morse Fall Scale the probability of prescribing Opioids or Benzodiazepines (not including midazolam and not including fentanyl) increases by 0.0026 on average and this is significant as $p < .05$

7.4 Logit Model for Patients That Fell

```
logit_fit_fall_narc_nofen_benz_nomid_1 <- glm(Medications ~ Morse_Fall_Scale + Age + factor(Gender) + African_Ame
rican_or_Black+Other, family = binomial, data= logit_model_morse_fall_fin_narc_nofen_benznarc_1)

summary(margins(logit_fit_fall_narc_nofen_benz_nomid_1))
```

```
##                    factor     AME     SE       z      p   lower   upper
##  African_American_or_Black -0.0057 0.0066 -0.8629 0.3882 -0.0187  0.0073
##                        Age -0.0010 0.0004 -2.7866 0.0053 -0.0017 -0.0003
##                 GenderMale -0.0018 0.0057 -0.3158 0.7521 -0.0130  0.0094
##           Morse_Fall_Scale  0.0005 0.0002  2.9350 0.0033  0.0002  0.0008
##                      Other -0.0128 0.0099 -1.2829 0.1995 -0.0323  0.0067
```

Logit Model Information 7.4.1 for Patients That Fell

The average partial effect indicates that for every increase in 1 for the Morse Fall Scale the probability of prescribing Opioids or Benzodiazepines (not including midazolam and not including fentanyl) increases by 0.0005 on average and this is significant as $p < .05$.

7.5 Logit Model for Hypertension (Did Not Fall) Patients

```
logit_fit_narc_nofen_benz_no_fall_1 <- glm(Medications ~ Morse_Fall_Scale + Age + factor(Gender) + African_Americ
an_or_Black+Other, family = binomial, data= logit_model_columns_fin_narc_nofen_narc_benz_nofall_1)

summary(margins(logit_fit_narc_nofen_benz_no_fall_1))
```

```
##                     factor     AME     SE       z      p   lower   upper
##  African_American_or_Black  0.0094 0.0673  0.1397 0.8889 -0.1226  0.1414
##                        Age -0.0032 0.0032 -1.0302 0.3029 -0.0094  0.0029
##                 GenderMale -0.1456 0.0654 -2.2256 0.0260 -0.2739 -0.0174
##           Morse_Fall_Scale  0.0037 0.0016  2.2647 0.0235  0.0005  0.0069
##                      Other  0.1851 0.1748  1.0590 0.2896 -0.1575  0.5276
```

Logit Model Information 7.5.1 for Hypertension Patients

The average partial effect indicates that for every increase in 1 for the Morse Fall Scale the probability of prescribing Opioids or Benzodiazepines (not including midazolam and not including fentanyl) increases by 0.0037 on average and this is significant as $p < .05$.

Benzodiazepines

8.1 Overview Logit Model

$$\Pr(y = 1 | Morse\_Fall\_Scale, Age, GenderMale, African\_American\_or\_Black, Other$$
$$= \Lambda(\beta_0 + \beta_1 Morse\_Fall\_Scale + \beta_2 GenderMale$$
$$+ \beta_3 African\_American\_or\_Black + \beta_4 Other$$

8.2 Medications

- Benzodiazepines
    - The benzodiazepines selected were: Midazolam, Lorazepam, Diazepam, Alprazolam, Clonazepam, Temazepam, Chlordiazepoxide.

8.3 Logit Model for All Patients

```
logit_fit_combined_wmida_1 <- glm(Medications ~ Morse_Fall_Scale + Age + factor(Gender) + African_American_or_Bla
ck+Other, family = binomial, data= logit_combined_data_wmida_1)

summary(margins(logit_fit_combined_wmida_1))
```

```
##                     factor     AME     SE       z      p   lower   upper
##  African_American_or_Black -0.2031 0.0219 -9.2539 0.0000 -0.2461 -0.1601
##                        Age -0.0094 0.0010 -9.7294 0.0000 -0.0113 -0.0075
##                 GenderMale  0.0046 0.0212  0.2159 0.8291 -0.0370  0.0461
##           Morse_Fall_Scale -0.0000 0.0005 -0.0362 0.9711 -0.0010  0.0010
##                      Other -0.0974 0.0537 -1.8140 0.0697 -0.2027  0.0078
```

Logit Model Information 8.3.1 for All Patients

The average partial effect indicates that for every increase in 1 for the Morse Fall Scale the probability of prescribing Benzodiazepines decreases on average, but this is not significant as p > .05.

8.4 Logit Model for Patients That Fell

```
logit_fit_fall_wmida_1 <- glm(Medications ~ Morse_Fall_Scale + Age + factor(Gender) + African_American_or_Black+O
ther, family = binomial, data= logit_model_morse_fall_fin_wmida_1)

summary(margins(logit_fit_fall_wmida_1))
```

```
##                     factor     AME     SE       z      p   lower   upper
##  African_American_or_Black -0.1462 0.0228 -6.4147 0.0000 -0.1908 -0.1015
##                        Age -0.0085 0.0010 -8.7876 0.0000 -0.0103 -0.0066
##                 GenderMale  0.0098 0.0209  0.4687 0.6393 -0.0312  0.0508
##           Morse_Fall_Scale -0.0022 0.0005 -4.3462 0.0000 -0.0032 -0.0012
##                      Other -0.0793 0.0523 -1.5164 0.1294 -0.1818  0.0232
```

Logit Model Information 8.4.1 for Patients That Fell

The average partial effect indicates that for every increase in 1 for the Morse Fall Scale the probability of prescribing Benzodiazepines decreases by 0.0022 on average and this is significant as p < .05.

8.5 Logit Model for Hypertension(Did Not Fall) Patients

```
logit_fit_wmida_1 <- glm(Medications ~ Morse_Fall_Scale + Age + factor(Gender) + African_American_or_Black+Other,
family = binomial, data= logit_model_columns_fin_wmida_1)

summary(margins(logit_fit_wmida_1))
```

```
##                    factor     AME     SE       z      p   lower  upper
##  African_American_or_Black -0.0930 0.0576 -1.6163 0.1060 -0.2058 0.0198
##                        Age -0.0047 0.0028 -1.7154 0.0863 -0.0102 0.0007
##                 GenderMale -0.0310 0.0548 -0.5653 0.5719 -0.1385 0.0765
##           Morse_Fall_Scale -0.0009 0.0014 -0.6583 0.5104 -0.0036 0.0018
##                      Other -0.0546 0.1459 -0.3743 0.7082 -0.3407 0.2314
```

Logit Model Information 8.5.1 for All Patients

The average partial effect indicates that for every increase in 1 for the Morse Fall Scale the probability of prescribing Benzodiazepines decreases by 0.0009 on average but this is not significant as p > .05.

Benzodiazepines Without Midazolam

9.1 Overview Logit Model

$$\Pr(y = 1 | Morse\_Fall\_Scale, Age, GenderMale, African\_American\_or\_Black, Other$$
$$= \Lambda(\beta_0 + \beta_1 Morse\_Fall\_Scale + \beta_2 GenderMale$$
$$+ \beta_3 African\_American\_or\_Black + \beta_4 Other$$

9.2 Medications

- Benzodiazepines
    - The benzodiazepines selected were: Lorazepam, Diazepam, Alprazolam, Clonazepam, Temazepam, Chlordiazepoxide.

9.3 Logit Model for All Patients

```
logit_fit_combined_1 <- glm(Medications ~ Morse_Fall_Scale + Age + factor(Gender) + African_American_or_Black+Oth
er, family = binomial, data= logit_combined_data_1)

summary(margins(logit_fit_combined_1))
```

```
##                     factor     AME     SE       z      p   lower   upper
##  African_American_or_Black -0.1844 0.0259 -7.1308 0.0000 -0.2350 -0.1337
##                        Age -0.0089 0.0011 -8.4503 0.0000 -0.0110 -0.0068
##                 GenderMale -0.0391 0.0228 -1.7133 0.0867 -0.0839  0.0056
##           Morse_Fall_Scale  0.0013 0.0005  2.3877 0.0170  0.0002  0.0023
##                      Other -0.0213 0.0602 -0.3542 0.7232 -0.1393  0.0966
```

Logit Model Information 9.3.1 for All Patients

The average partial effect indicates that for every increase in 1 for the Morse Fall Scale the probability of prescribing Benzodiazepines (not including midazolam) increases by 0.0013 on average and this is significant as $p < .05$.

9.4 Logit Model for Patients That Fell

```
logit_fit_fall_1 <- glm(Medications ~ Morse_Fall_Scale + Age + factor(Gender) + African_American_or_Black+Other,
family = binomial, data= logit_model_morse_fall_fin_1)

summary(margins(logit_fit_fall_1))
```

```
##                     factor     AME     SE       z      p   lower   upper
##  African_American_or_Black -0.1425 0.0289 -4.9276 0.0000 -0.1992 -0.0858
##                        Age -0.0086 0.0011 -7.6028 0.0000 -0.0109 -0.0064
##                 GenderMale -0.0370 0.0247 -1.5006 0.1335 -0.0854  0.0113
##           Morse_Fall_Scale -0.0001 0.0006 -0.2098 0.8339 -0.0013  0.0011
##                      Other -0.0034 0.0656 -0.0521 0.9584 -0.1320  0.1251
```

Logit Model Information 9.4.1 for Patients That Fell

The average partial effect indicates that for every increase in 1 for the Morse Fall Scale the probability of prescribing Benzodiazepines (not including midazolam) decreases by 0.0001 on average but this is not significant as $p > .05$.

9.5 Logit Model for Hypertension (Did Not Fall) Patients

```
logit_fit_1 <- glm(Medications ~ Morse_Fall_Scale + Age + factor(Gender) + African_American_or_Black+Other, famil
y = binomial, data= logit_model_columns_fin_1)

summary(margins(logit_fit_1))
```

```
##                     factor     AME     SE       z      p   lower  upper
##  African_American_or_Black -0.0815 0.0447 -1.8235 0.0682 -0.1690 0.0061
##                        Age -0.0031 0.0021 -1.4824 0.1382 -0.0072 0.0010
##                 GenderMale -0.0459 0.0396 -1.1596 0.2462 -0.1235 0.0317
##           Morse_Fall_Scale  0.0002 0.0010  0.2149 0.8299 -0.0017 0.0021
##                      Other -0.0238 0.1036 -0.2298 0.8183 -0.2269 0.1793
```

Logit Model Information 9.5.1 for Hypertension Patients

The average partial effect indicates that for every increase in 1 for the Morse Fall Scale the probability of prescribing Benzodiazepines (not including midazolam) increases by 0.0002 on average but this is not significant as p > .05.

Opioids

10.1 Overview Logit Model

$$\Pr(y = 1 | Morse\_Fall\_Scale, Age, GenderMale, African\_American\_or\_Black, Other$$

$$= \Lambda(\beta_0 + \beta_1 Morse\_Fall\_Scale + \beta_2 GenderMale$$

$$+ \beta_3 African\_American\_or\_Black + \beta_4 Other$$

10.2 Medications

- Opioids
    - The opioids selected were: Fentanyl, Hydromorphone, Acetaminophen, Morphine, Acetaminophen-oxycodone Acetaminophen-hydrocodone, Oxycodone, Tramadol, Methadone, Meperidine, Hydrocodone, Remifentanil.

10.3 Logit Model for All Patients

```
logit_fit_combined_narc_with_fentanyl_1 <- glm(Medications ~ Morse_Fall_Scale + Age + factor(Gender) + African_Am
erican_or_Black+Other, family = binomial, data= logit_combined_data_narc_1)

summary(margins(logit_fit_combined_narc_with_fentanyl_1))
```

```
##                    factor     AME     SE       z      p   lower   upper
##  African_American_or_Black -0.0494 0.0122 -4.0651 0.0000 -0.0733 -0.0256
##                        Age -0.0024 0.0006 -4.1166 0.0000 -0.0035 -0.0012
##                 GenderMale -0.0184 0.0116 -1.5891 0.1120 -0.0410  0.0043
##           Morse_Fall_Scale  0.0023 0.0003  7.3575 0.0000  0.0017  0.0029
##                      Other -0.0300 0.0265 -1.1305 0.2583 -0.0819  0.0220
```

Logit Model Information 10.3.1 for All Patients

The average partial effect indicates that for every increase in 1 for the Morse Fall Scale the probability of prescribing Opioids increases by 0.0023 on average and this is significant as $p < .05$.

10.4 Logit Model for Patients That Fell

```
logit_fit_fall_narc_1 <- glm(Medications ~ Morse_Fall_Scale + Age + factor(Gender) + African_American_or_Black+Ot
her, family = binomial, data= logit_model_morse_fall_fin_narc_1)

summary(margins(logit_fit_fall_narc_1))
```

```
##                    factor     AME     SE       z      p   lower   upper
##  African_American_or_Black -0.0020 0.0068 -0.2910 0.7711 -0.0154  0.0114
##                        Age -0.0010 0.0004 -2.7439 0.0061 -0.0017 -0.0003
##                 GenderMale -0.0054 0.0055 -0.9983 0.3181 -0.0161  0.0052
##           Morse_Fall_Scale  0.0003 0.0001  2.1234 0.0337  0.0000  0.0006
##                      Other -0.0174 0.0079 -2.2071 0.0273 -0.0328 -0.0019
```

Logit Model Information 10.4.1 for Patients That Fell

The average partial effect indicates that for every increase in 1 for the Morse Fall Scale the probability of prescribing Opioids increases by 0.0003 on average and this is significant as p < .05.

10.5 Logit Model for Hypertension (Did Not Fall) Patients

```
logit_fit_narc_1 <- glm(Medications ~ Morse_Fall_Scale + Age + factor(Gender) + African_American_or_Black+Other,
family = binomial, data= logit_model_columns_fin_narc_1)

summary(margins(logit_fit_narc_1))
```

```
##                    factor     AME     SE       z      p   lower  upper
##  African_American_or_Black  0.0056 0.0676  0.0825 0.9343 -0.1268 0.1380
##                        Age -0.0038 0.0032 -1.2151 0.2243 -0.0100 0.0023
##                 GenderMale -0.0985 0.0657 -1.4988 0.1339 -0.2272 0.0303
##           Morse_Fall_Scale  0.0033 0.0016  2.0134 0.0441  0.0001 0.0065
##                      Other  0.1477 0.1755  0.8412 0.4002 -0.1964 0.4917
```

Logit Model Information 10.5.1 for Hypertension Patients

The average partial effect indicates that for every increase in 1 for the Morse Fall Scale the probability of prescribing Opioids increases by 0.0033 on average and this is significant as p < .05.

Opioids Without Fentanyl

11.1 Overview Logit Model

$$\Pr(y = 1 | Morse\_Fall\_Scale, Age, GenderMale, African\_American\_or\_Black, Other$$
$$= \Lambda(\beta_0 + \beta_1 Morse\_Fall\_Scale + \beta_2 GenderMale$$
$$+ \beta_3 African\_American\_or\_Black + \beta_4 Other$$

11.2 Medications

- Opioids
    - The opioids selected were: Hydromorphone, Acetaminophen, Morphine, Acetaminophen-oxycodone Acetaminophen-hydrocodone, Oxycodone, Tramadol, Methadone, Meperidine, Hydrocodone, Remifentanil.

11.3 Logit Model for All Patients

```
logit_fit_combined_narc_without_fentanyl_1 <- glm(Medications ~ Morse_Fall_Scale + Age + factor(Gender) + African
_American_or_Black+Other, family = binomial, data= logit_combined_data_narc_nofentanyl_1)

summary(margins(logit_fit_combined_narc_without_fentanyl_1))
```

```
##                     factor     AME     SE       z      p   lower   upper
##  African_American_or_Black -0.0526 0.0127 -4.1466 0.0000 -0.0775 -0.0277
##                        Age -0.0024 0.0006 -4.0671 0.0000 -0.0036 -0.0013
##                 GenderMale -0.0244 0.0121 -2.0103 0.0444 -0.0482 -0.0006
##           Morse_Fall_Scale  0.0026 0.0003  8.0180 0.0000  0.0020  0.0032
##                      Other -0.0235 0.0291 -0.8101 0.4179 -0.0805  0.0334
```

Logit Model Information 11.3.1 for All Patients

The average partial effect indicates that for every increase in 1 for the Morse Fall Scale the probability of prescribing Opioids (not including Fentanyl) increases by 0.0026 on average and this is significant as $p < .05$.

11.4 Logit Model for Patients That Fell

```
logit_fit_fall_narc_nofen_1 <- glm(Medications ~ Morse_Fall_Scale + Age + factor(Gender) + African_American_or_Bl
ack+Other, family = binomial, data= logit_model_morse_fall_fin_narc_nofen_1)

summary(margins(logit_fit_fall_narc_nofen_1))
```

```
##                     factor     AME     SE       z      p   lower   upper
##  African_American_or_Black -0.0036 0.0076 -0.4748 0.6349 -0.0186  0.0113
##                        Age -0.0010 0.0004 -2.7254 0.0064 -0.0017 -0.0003
##                 GenderMale -0.0071 0.0063 -1.1205 0.2625 -0.0195  0.0053
##           Morse_Fall_Scale  0.0005 0.0002  3.0469 0.0023  0.0002  0.0009
##                      Other -0.0188 0.0101 -1.8650 0.0622 -0.0386  0.0010
```

Logit Model Information 11.4.1 for Patients That Fell

The average partial effect indicates that for every increase in 1 for the Morse Fall Scale the probability of prescribing Opioids (not including Fentanyl) increases by 0.0005 on average and this is significant as $p < .05$.

11.5 Logit Model for Hypertension (Did Not Fall) Patients

```
logit_fit_narc_nofen_1 <- glm(Medications ~ Morse_Fall_Scale + Age + factor(Gender) + African_American_or_Black+O
ther, family = binomial, data= logit_model_columns_fin_narc_nofen_1)

summary(margins(logit_fit_narc_nofen_1))
```

```
##                     factor     AME     SE       z      p   lower   upper
##  African_American_or_Black  0.0065 0.0676  0.0958 0.9237 -0.1261  0.1390
##                        Age -0.0039 0.0032 -1.2340 0.2172 -0.0101  0.0023
##                 GenderMale -0.1332 0.0657 -2.0288 0.0425 -0.2619 -0.0045
##           Morse_Fall_Scale  0.0032 0.0016  1.9632 0.0496  0.0000  0.0064
##                      Other  0.1879 0.1761  1.0669 0.2860 -0.1573  0.5332
```

Logit Model Information 11.5.1 for Hypertension Patients

The average partial effect indicates that for every increase in 1 for the Morse Fall Scale the probability of prescribing Opioids (not including Fentanyl) increases by 0.0032 on average and this is significant as $p < .05$.

Potential Race Prescription Implications

In all models with statistically significant relationship ($p<.05$) as race changes from Caucasian or white to African American or Black the likelihood of administering Benzodiazepines or Opioids decreases. This finding is consistent for *Logit Model Information 7.3 For All Patients* regarding benzodiazepine without midazolam and opioids without fentanyl, *Logit Model Information 9.3 For All Patients* regarding benzodiazepine without midazolam, *Logit Model Information 11.3.1*

For All Patients regarding opioids without fentanyl. Several other models as well suggested the impact of race on prescription of benzodiazepines and fentanyl.

Summary

13.1 All Logit Model Information

Logit Model	Average Partial Effect MFS (Standard Error)
6.3 Logit Model for All Patients	0.0023* (0.0003)
6.4 Logit Model for Patients That Fell	0.0002* (0.0001)
6.5 Logit Model for Hypertension (Did Not Fall) Patients	0.0038* (0.0016)
7.3 Logit Model for All Patients	0.0026* (0.0003)
7.4 Logit Model for Patients That Fell	0.0005* (0.0002)
7.5 Logit Model for Hypertension (Did Not Fall) Patients	0.0037* (0.0016)
8.3 Logit Model for All Patients	-0.0000 (0.0005)
8.4 Logit Model for Patients That Fell	-0.0022* (0.0005)
8.5 Logit Model for Hypertension (Did Not Fall) Patients	-0.0009 (0.0014)
9.3 Logit Model for All Patients	0.0013* (0.0005)
9.4 Logit Model for Patients That Fell	-0.0001 (0.0006)
9.5 Logit Model for Hypertension (Did Not Fall) Patients	0.0002 (0.0010)
10.3 Logit Model for All Patients	0.0023* (0.0003)
10.4 Logit Model for Patients That Fell	0.0003* (0.0001)
10.5 Logit Model for Hypertension (Did Not Fall) Patients	0.0033* (0.0016)
11.3 Logit Model for All Patients	0.0026* (0.0003)

11.4 Logit Model for Patients That Fell	0.0005* (0.0002)
11.5 Logit Model for Hypertension (Did Not Fall) Patients	0.0032* (0.0016)

Table 13.1.1 All Logit Model Information

Discussion

Research Question (1) Revisited

Is the Morse Fall Scale Score used in administering benzodiazepines and opioids to patients?

Preliminary findings would suggest that the Morse Fall Scale Score is not utilized to decrease the likelihood of administering benzodiazepines and opioids to patients at highest risk of falling. This finding is based on the Logit Models built (see discussion on *Benzodiazepines for Patients That Fell Logit Model Findings* for the sole exception) with statistically significant findings ($p < .05$) that found as the Morse Fall Scale Score increased the likelihood, on average, increased of administering benzodiazepines and opioids. Patients that are at high risk of falling should have medications, as modifiable risk factors, adjusted appropriately. Indications from the Morse Fall Scale point in the direction that the risk level assessment is not used for benzodiazepines or opioids.

Research Question (2) Revisited

Does a difference in medication prescription exist between patients that have fallen and patients that have not fallen?

Preliminary findings would suggest that there are no large differences between prescriptions likelihoods with benzodiazepines and opioids when comparing patients that have

fallen and patients with hypertension that have not fallen. This potentially indicates that the Morse Fall Scale is not considered when prescribing in this setting.

Research Question (3) Revisited

Are there any other factors that impact the dispensation of benzodiazepines and opioids?

Preliminary findings would suggest that race may be a factor that impacts the dispensation of benzodiazepines and opioids. The data appear to show that African American or Black patients are not administered medications at the same level as those that are Caucasian or White. The administered medications studied were benzodiazepines and opioids. These same findings may also be present for individuals that are Asian, but more data would be needed for verification. In the combined dataset there were 1294 patients (69.4%) that were Caucasian or White, 486 patients (26.19%) that were African American or Black, and 76 patients (4.09%) classified as Other. The Logit models used Caucasian or White individuals as a base to compare the prescription of benzodiazepines and opioids to African American or Black patients. In all models that were statistically significant the data appear to highlight a difference in administration based on race.

Benzodiazepines for Patients That Fell Logit Model Findings

The *Logit Model Information 8.4.1 for Patients That Fell* was the only model that found that as the Morse Fall Scale Score increases there was a decrease in the likelihood to administer a medication, in this case benzodiazepines.

Conclusion

Research literature indicates that falls are often linked with unnecessary prescriptions, too long a duration of drug treatment, and the lack of drug reviews on repeated prescriptions (Bell, Steinsbekk, and Granas, 2015). Moreover, preliminary findings regarding benzodiazepines and opioids indicate the need to review drug prescription on a regular basis for elderly patients. Additionally, the Morse Fall Scale score and other fall risk assessment tools have data that should be used when administering, prescribing, and reviewing medications for patients.

Limitations

15.1 Project NeLL COVID-19 Issues

There were significant data server problems that limited access to data. These problems ranged from time delays in data reloading to needed data processing and cleaning from the host. Moreover, a large transition from a 100,000 initial sample of patients to 1,000,000 patients prevented access to the data. Additional system shutdowns and pull request time delays were other hurdles in receiving data.

15.2 Data Constraints

Due to data availability, there exist several constraints. Primarily, the sample of data has a lower weight to those that have not fallen. This was a result of the limited overlap of available data when merging patient information files together. Additionally, as a result of limited information controls and balance could not be accounted for to a high degree. Future analysis will also need validation of all specifications and patient merging.

Future Directions

16.1 Additional Data

The Project NeLL dataset continues to become more robust, and more data will be available as time progresses. This will allow it to be easier to pull data for more patients. Additionally, the access to the data will allow for better cleaned data that can be merged. More conditions related to both medications and control sets can be utilized with more patients.

16.2 Additional Analysis

There are several other drugs linked to falls that may have similar patterns. Additional model variations are possible with this dataset beyond the Logit Model. Moreover, sensitivity analysis can be conducted with drugs other than Fentanyl and Midazolam.

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