Data Mining to Predict Mobility Outcomes for Older Adults Receiving Home Health Care

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Driven to Discover℠

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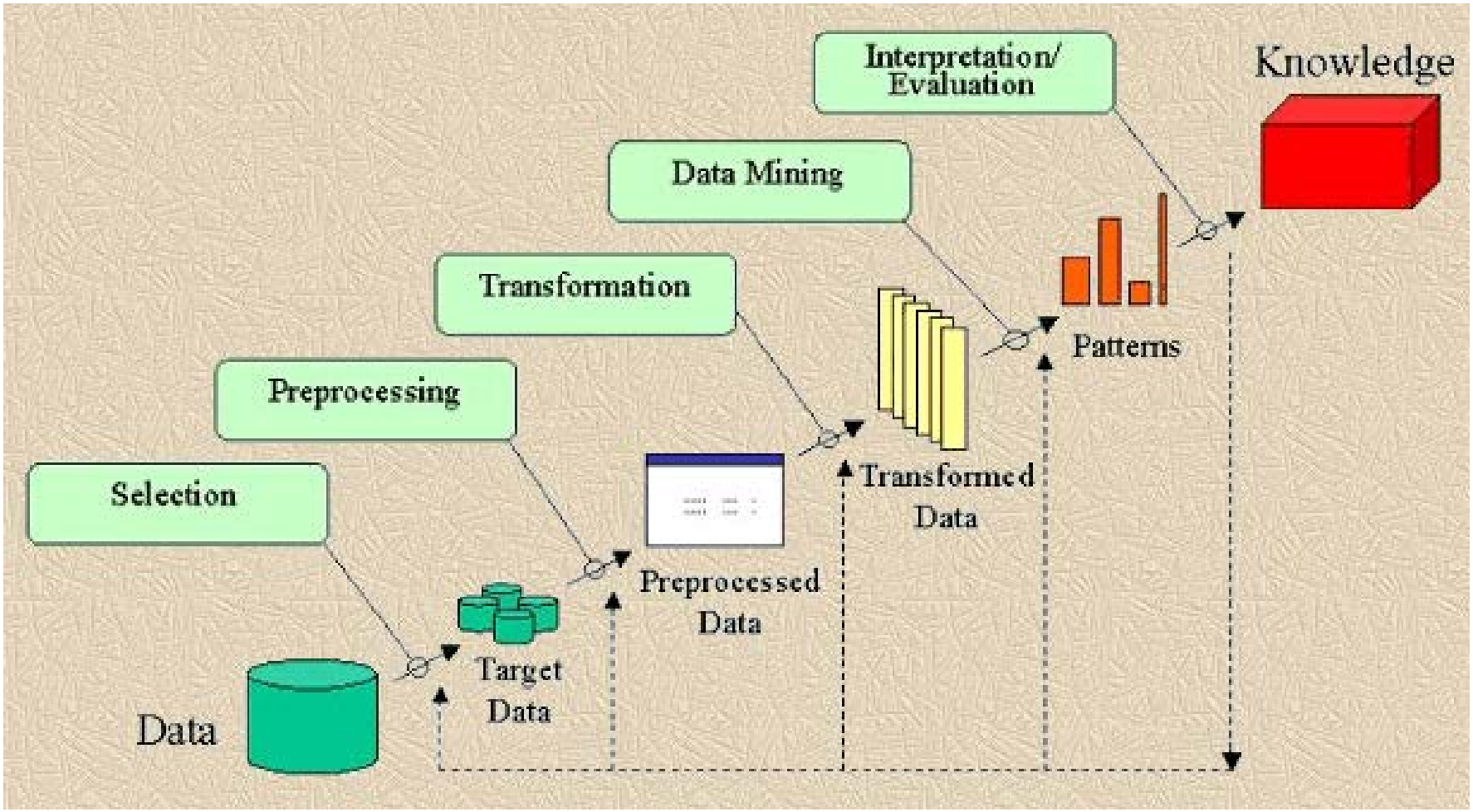
Problem

- In United States, 2010:
  - 4.9 million people required help to complete ADLs
  - 9.1 million people unable to complete IADLs [1]
- Home Healthcare (HHC)
  - Spending in 1980 increased from $2.4 billion to $17.7 billion today
  - Report improved mobility in 46.9% adults before discharge from HHC [2]
- Mobility is one component of functional status
  - Mobility affects functional status and functional disability
  - Less than one-third of older adults recover pre-hospital function [3]
  - Increased risk of falls in home, rehospitalization, disability, social isolation, loss of independence
  - Besides physical issues, also psychosocial issues, comorbidity and death

Purpose

- To discover patients and support system characteristics associated with the improved outcomes of mobility
- Find new factors associated with mobility besides current ambulation status during admission (OR = 5.96)
- In each subgroup of patients defined by current ambulation status during admission (1-5)
  - We started with group 2 and then compare the observations with other groups
- To compare the predictors across each patient subgroup to find the consistent biomarkers in all subgroups and specific factors in each subgroup

KDD Process



Fayyad UM, Piatetsky-Shapiro G, Smyth P, Uthurusamy R. Advances in knowledge discovery and data mining. Menlo Park, CA: AAI Press/ The MIT Press Press; 1996.

Data Selection

OASIS

- Standard assessment required for all Medicare and Medicaid patients
- Includes
  - Demographic and patient history information
  - Health status
  - Activities of daily living (ADLs) and instrumental activities of daily living (IADLs)
  - Medication and equipment management
  - Service utilization

Mobility (M0700 Ambulation/ Locomotion) Outcome

Score	Description
0	Able to independently walk on even and uneven surfaces and climb stairs with or without railings (i.e., needs no human assistance or assistive device).
1	Requires use of a device (e.g., cane, walker) to walk alone or requires human supervision or assistance to negotiate stairs or steps or uneven surfaces.
2	Able to walk only with the supervision or assistance of another person at all times.
3	Chairfast, unable to ambulate but is able to wheel self independently.
4	Chairfast, unable to ambulate and is unable to wheel self.
5	Bedfast, unable to ambulate or be up in a chair.

Selection Criteria

- Inclusion Criteria
  - Medicare certified agency – OASIS documentation
  - Minimum of two OASIS records representing an episode
  - Adult, non-maternity clients receiving skilled homecare services
  - No missing data to calculate a change from start to end of an episode for the outcome variables
  - Episode started and completed between 10/1/08 and 12/31/09
- Exclusion Criteria
  - Patients with no mobility problem on admission for outcome variables

Example of Creating a Data Set

Initial Data Set
808 agencies, 1,560,508 OASIS records, 888,243 patients

Reason for Removing Records	n
Incomplete episode records	464,485
Assessment outside study dates	125,886
Incorrect type of assessment	51,779
Masked or missing data	16,302
Duplicate records	2,748
Age < 18 or primary dx related to pregnancy/ complications	822

Final Data Set
785 agencies, 447,309 patients,
449,243 episodes of care, 0.6% re-admissions

Overall Steps

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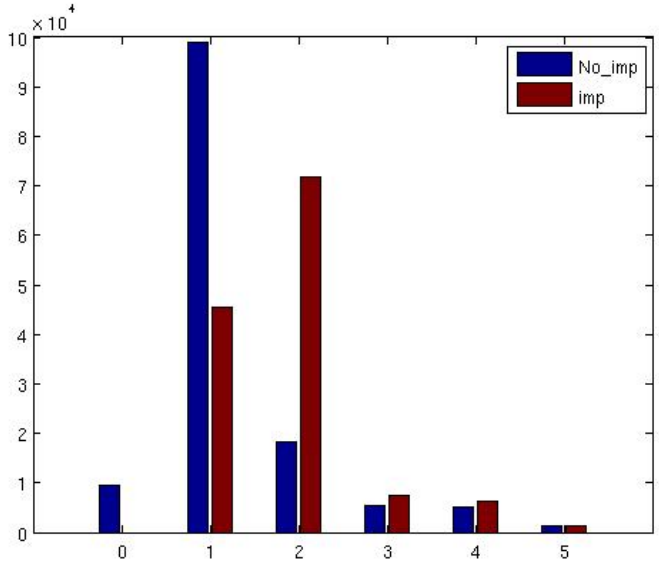
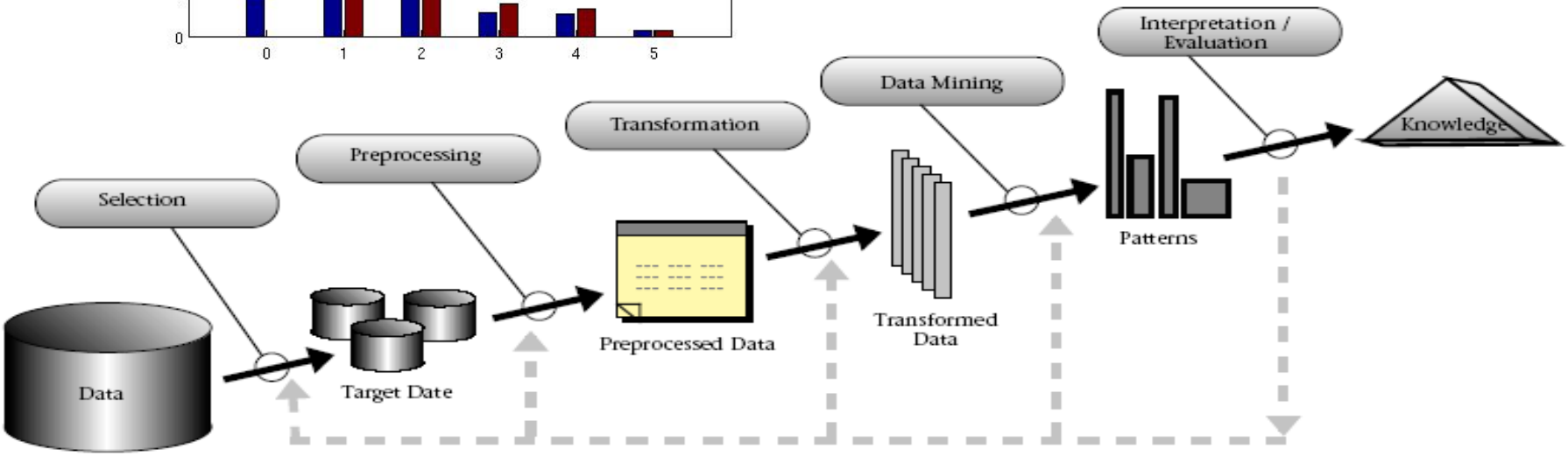




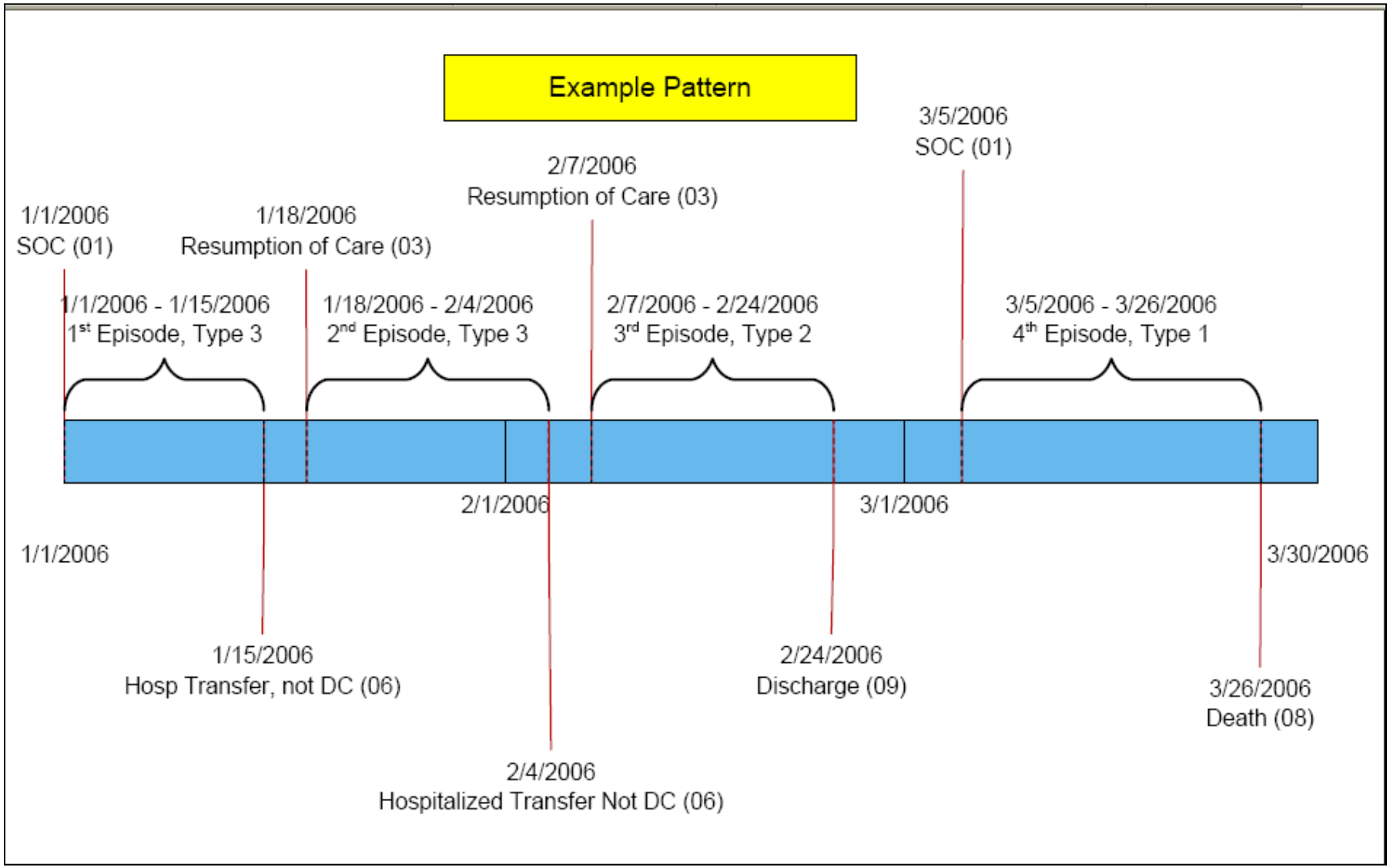
Fayyad, U., Piatetsky-Shapiro, G., & Smyth, P. (1996). From data mining to knowledge discovery in databases. *AI Magazine*, pp. 37 – 54. http://www.kdnuggets.com/gpspubs/aimag-kdd-overview-1996-Fayyad.pdf. P. 41

Data Preparation

Data Preparation

- De-identification of data
- Selecting correct assessment type
- Creating episodes of care
- Removing duplicate records
- Data quality
  - Valid Values
    - Ambulation measured from 0 – 5, but data includes 6 and 7
  - Missing data
    - Just plain incomplete
    - Skip patterns
- Data type needed for analysis

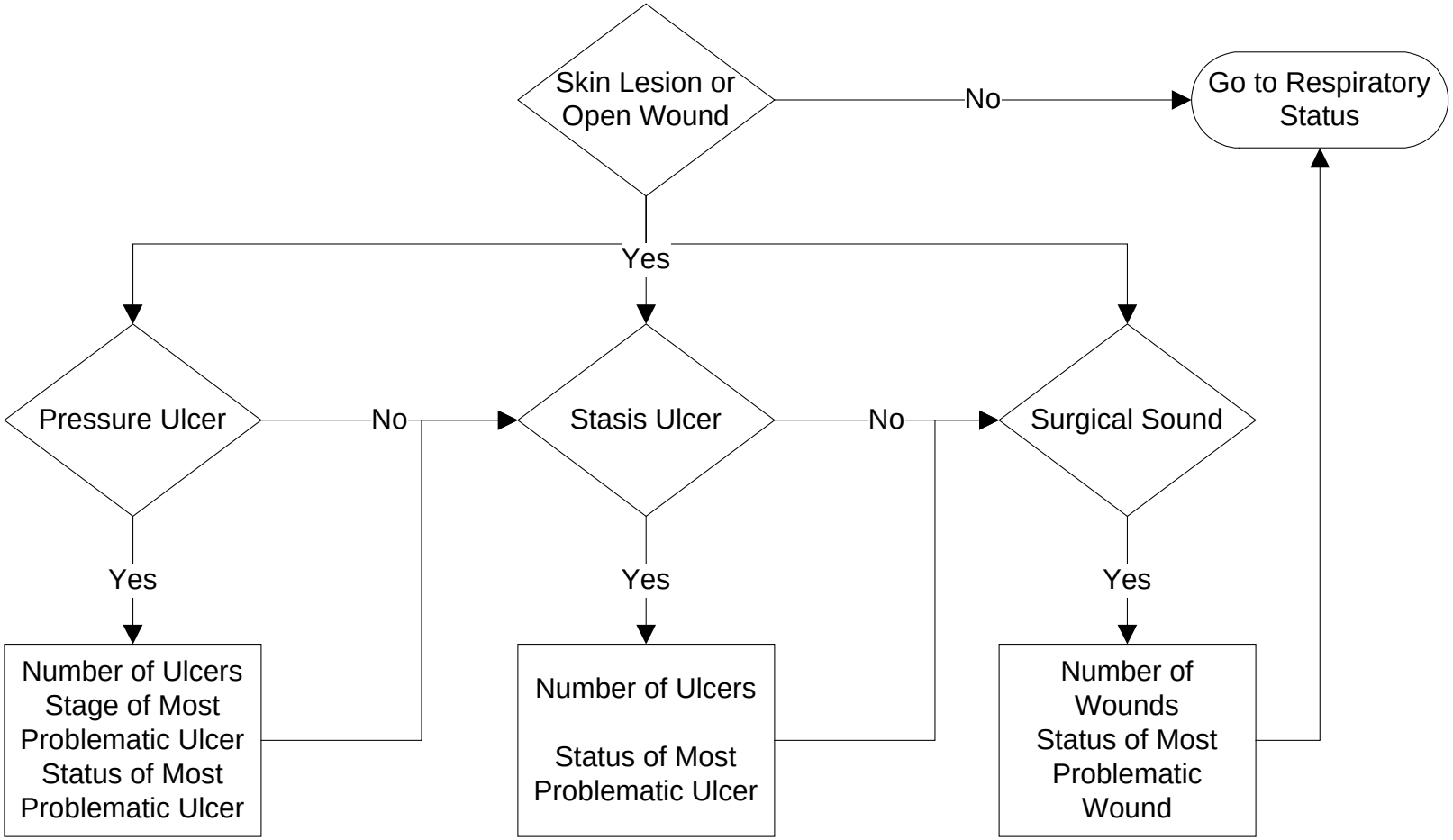
Unit of Analysis



Data Quality Issues

- Know the Strengths and Limitations of Your Data
- Documentation issues
    - Consistency of processes for documenting
    - Copy forward or copy/paste
    - Incomplete/ inappropriate data in the database
- Rules for data collection
    - Charting by exception
    - Rules i.e. the Joint Commission, CMS, billing
- Database / data model
    - Field type
    - Relationship of fields – how do you link data
- Patient outliers
- Data with too little variance

Figure 1. OASIS Integumentary Skip Pattern



Recoding Data

Stage of most problematic pressure ulcer

UK = Missing

NA = 0

1 - Stage 1 2 - Stage 2 3 - Stage 3 4 - Stage 4 NA - No observable pressure ulcer	0 No observable pressure ulcer 1 - Stage 1 2 - Stage 2 3 - Stage 3 4 - Stage 4

Data Transformation

- Create new variables
- Data reduction
- Format for to meeting assumptions for analyses
- Increase interpretability of results
- Decrease chaos

Creating Variables

- **Length of stay** = end date of episode – start date of episode + 1 day
  - M0090 Date of Assessment
  - We will need to look at distribution of this variable to determine categories and if there are any patients that are outliers that we might want to drop i.e. < 7 days or > 120 days
    1. < 30 days
    2. 30 – 59 days
    3. 60 – 89 days
    4. 90 – 120 days
    5. > 120 days

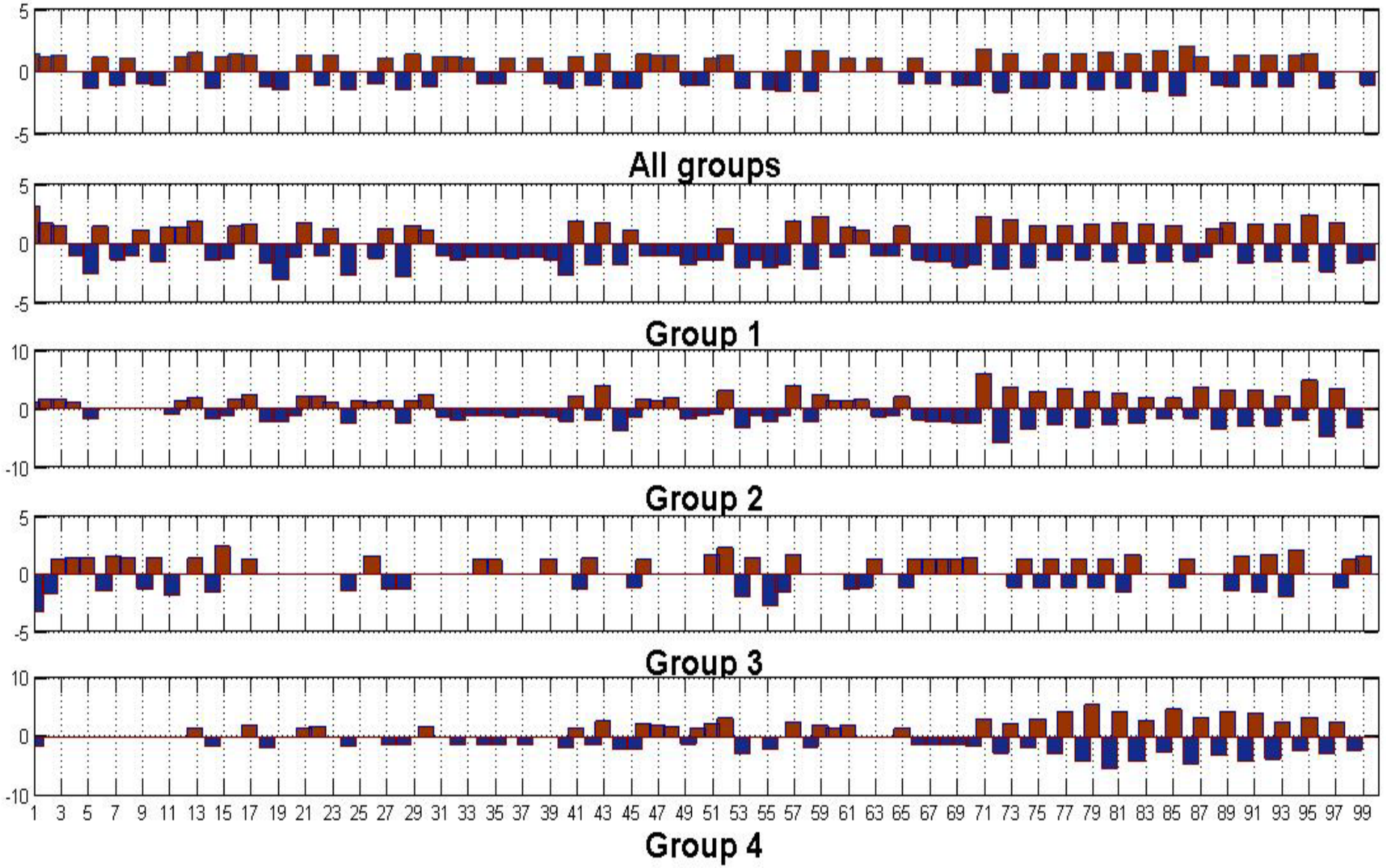
Transformation

- Clinical Classification Software
  - Primary diagnoses and then reduced into 51 smaller groups within 11 major categories
- Charlson Index of Comorbidity
  - Additional medical diagnoses
- Scales
  - Prognosis, Pain, Pressure Ulcer, Stasis Ulcer, Surgical Wound, Respiratory Status

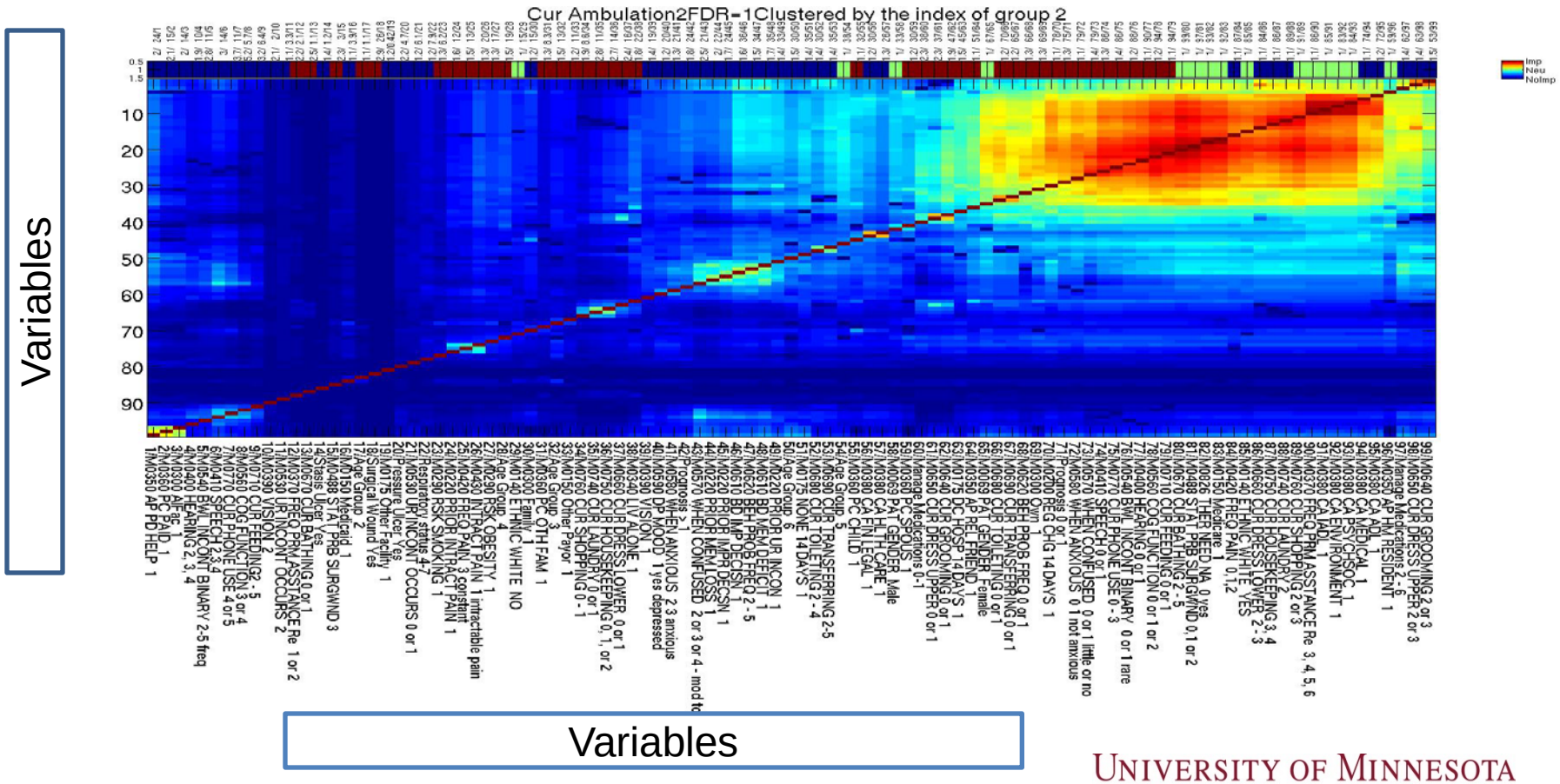
Data Mining Techniques

- We found the risk variables that are significantly associated with mobility outcome vary among the groups
- Group the single predictors based on whether they cover same or different patient group
  - Clustering
    - **Based on similarity of sample space**
    - **Not discriminative**
    - **High frequency variables got merged**
  - Pattern mining based approach
    - **Discriminative**
    - **Coherence (similarity of sample space)**

Subgroup Variability



Clustering Variables – Subgroup 2



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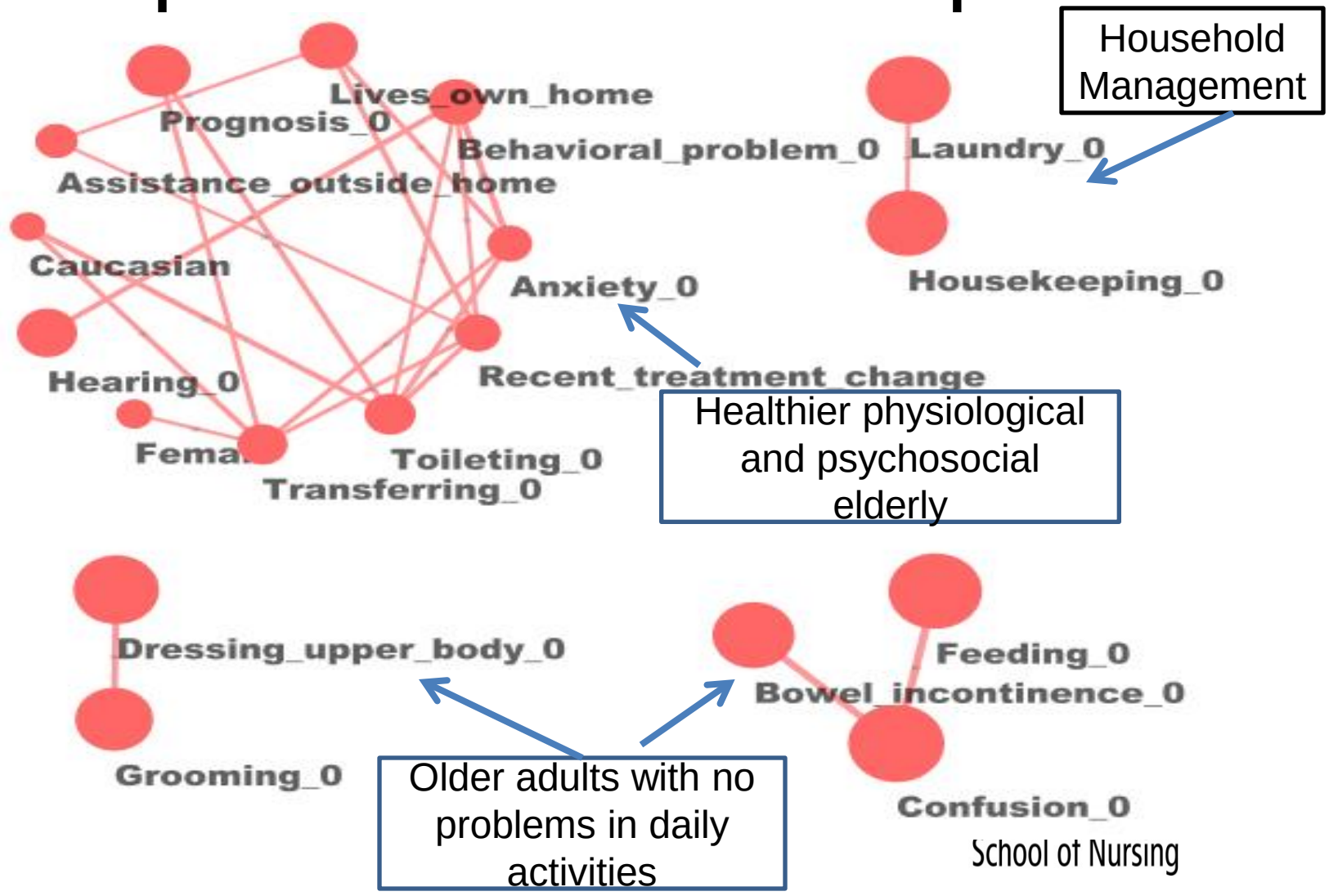
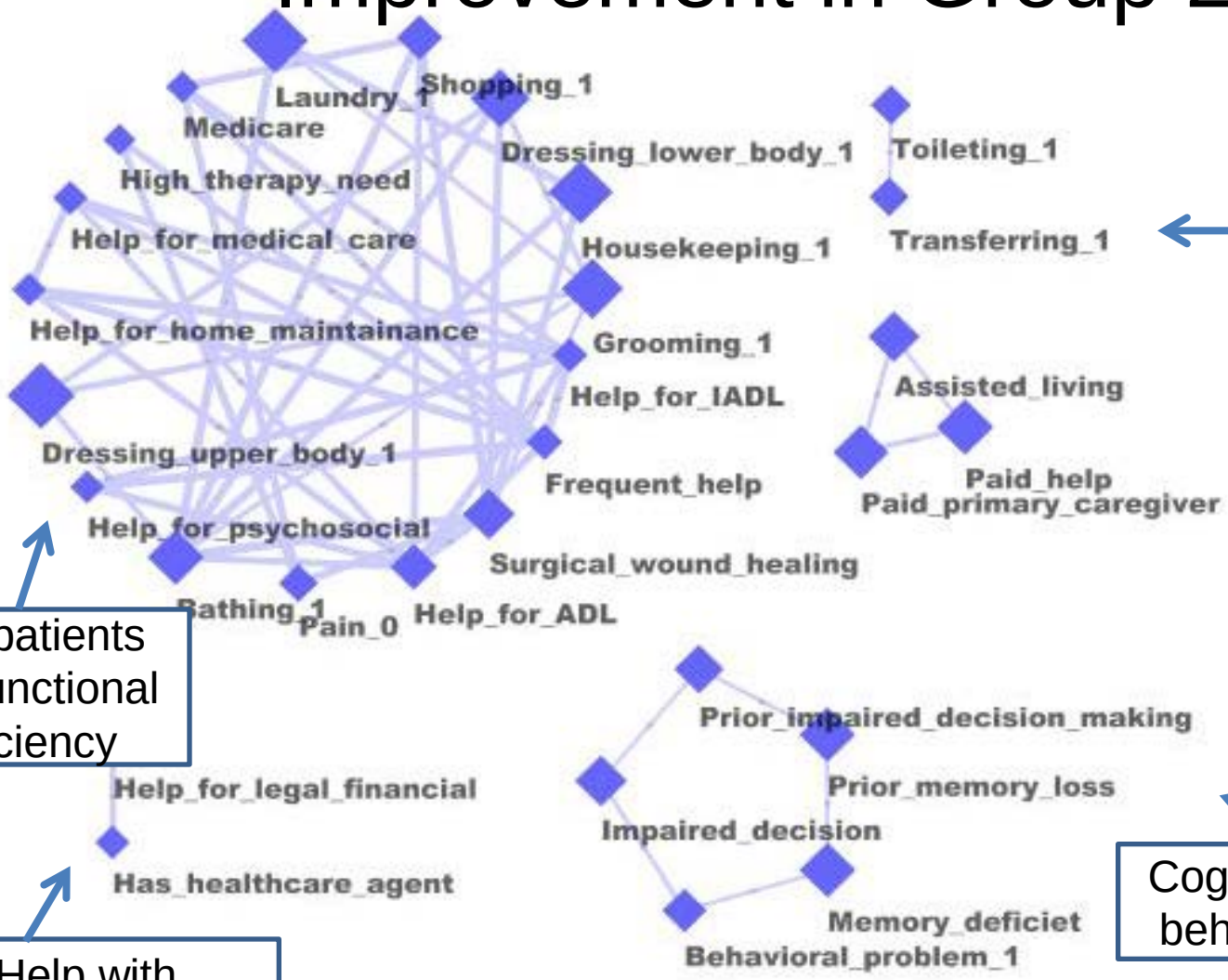
Patterns Associated with Improvement in Group 2



Patterns Associated with No Improvement in Group 2



Incapable to toilet and transfer

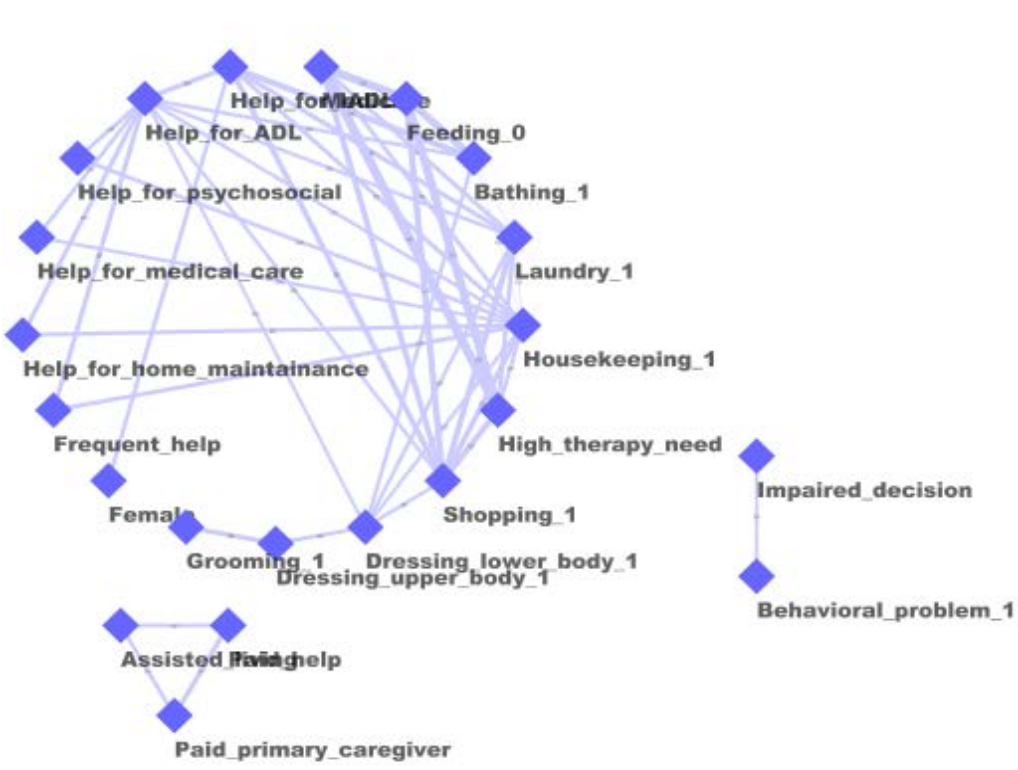
Paid Help

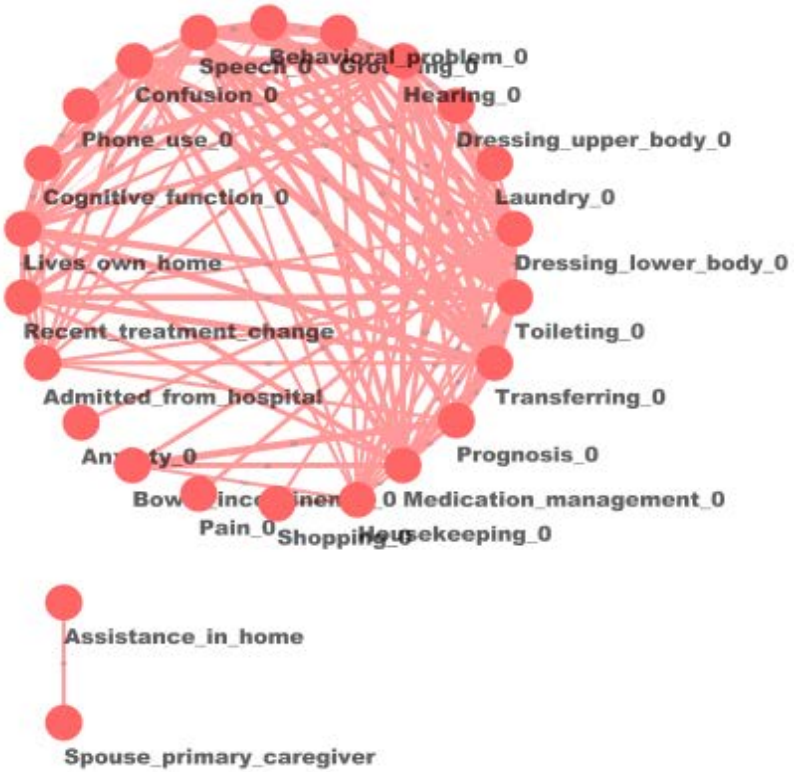
Frail patients with functional deficiency

Cognitive deficits and behavioral problems

Help with financial and legal matters

Patterns Associated with Mobility in Group 1





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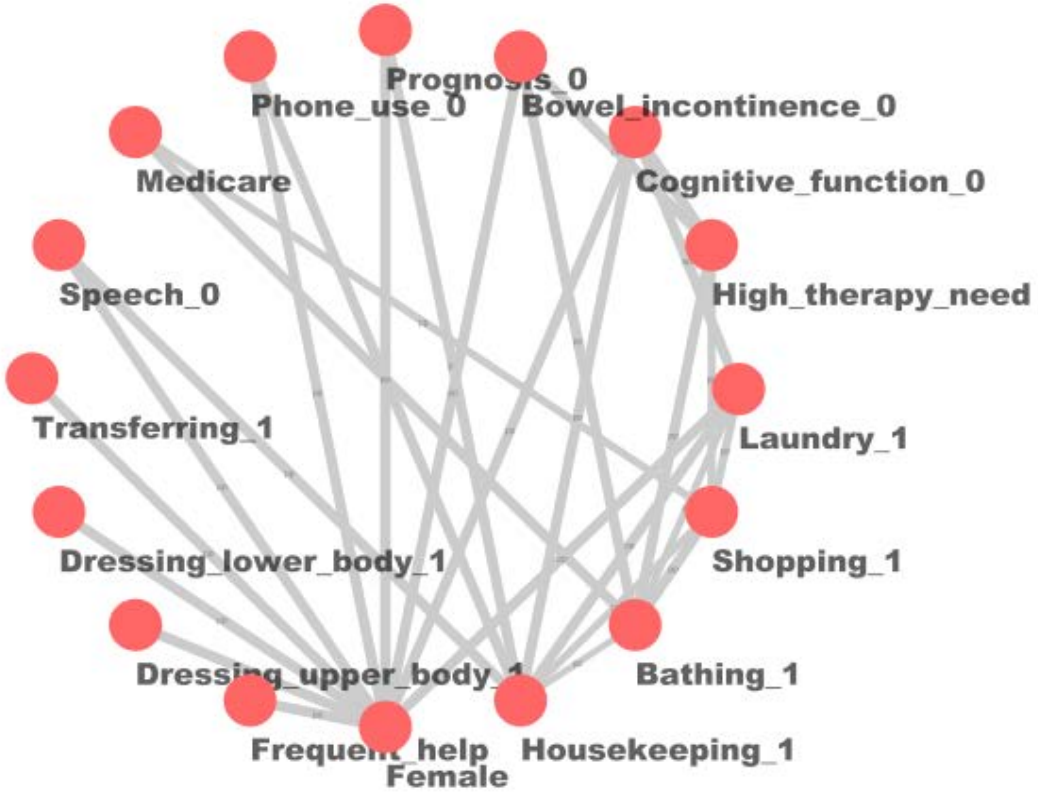
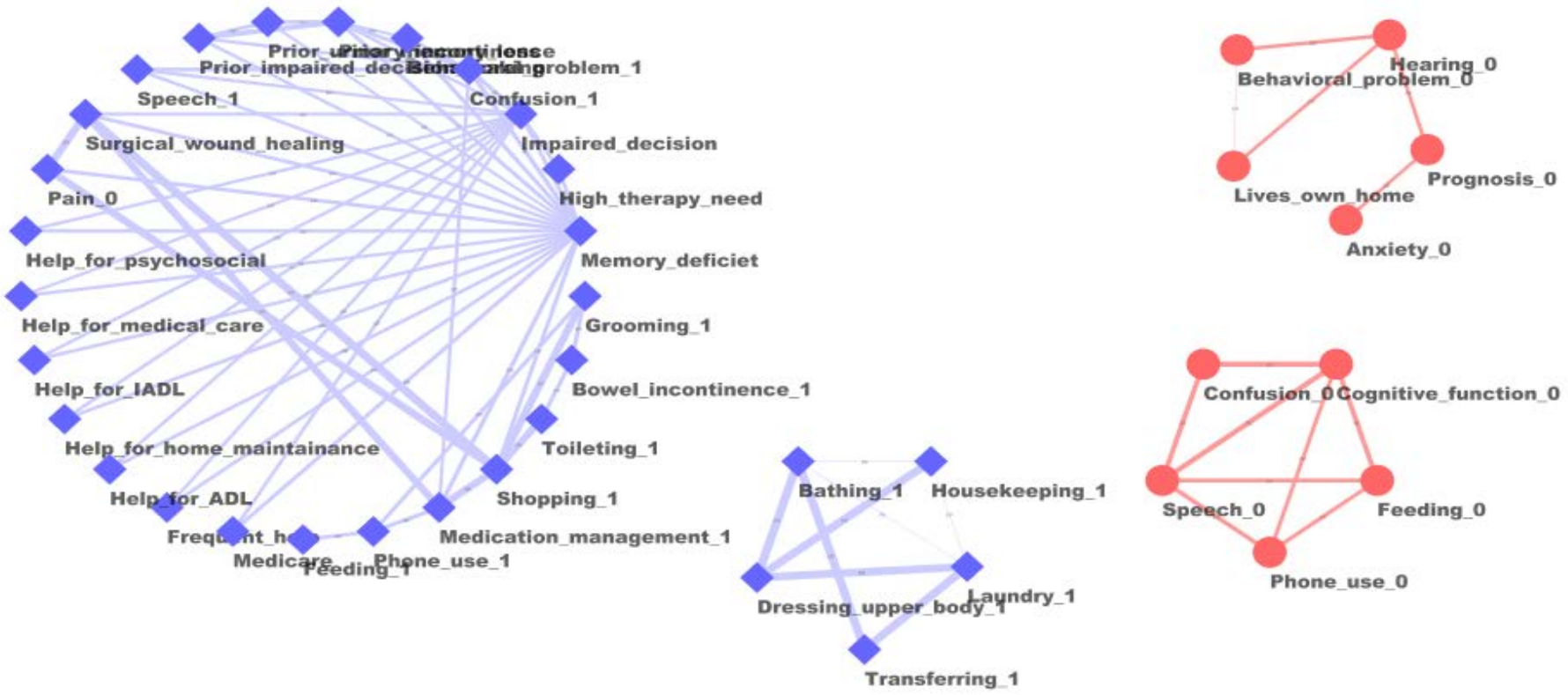
Patterns Associated with Mobility in Group 3



Patterns Associated with Mobility in Group 4



Discussion

- **Single variables may be less helpful** than patterns of variables – higher categories
- Limitation
  - Large national sample – but not random, may be bias in results
  - Missing interventions due to lack of standardization
  - Length of stay may vary and contribute to findings
- Results are knowledge discovery, not hypotheses testing
- Integrate diagnosis codes (icd-9) and nursing interventions in future to combine factors related to mobility

Discussion

- High prevalence of mobility limitations for HHC patients (97%)
- Mobility status at admission highest predictor of improvement
  - CMS outcome reporting controlling for this, but doesn't look at differences by mobility status
- Variations of predictors within subgroups
- Different clusters point to the need to tailor interventions for subgroups

Next Steps

- Make recommendation to CMS about findings
- Replicate with OASIS C – contains some interventions
- Combine hospital and home care data to determine predictors upstream

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