**Time-Based Analysis Documentation for Polytrauma Recovery**

**Overview**

The Time-Based Analysis will examine the relationship between visit timing patterns and recovery outcomes in polytrauma patients. While the previous Time Interval Analysis focused on problems identified during specific 3-month periods, this analysis will investigate how the timing, frequency, and spacing of clinical visits relate to healing duration.

**Objectives**

1. Analyze the relationship between first visit timing and overall healing duration
2. Investigate whether early intervention (first visit within 30 days) correlates with shorter healing
3. Examine how visit frequency patterns relate to healing outcomes
4. Analyze the impact of visit spacing (average time between visits) on recovery

**Assumptions**

1. **Definition of Healing Duration**: Healing duration is defined as the time from accident to last recorded visit, consistent with previous analyses.
2. **Early Intervention**: We assume that earlier first visits represent more prompt medical intervention, though the dataset doesn't specify the nature of each visit.
3. **Visit Spacing Relevance**: We assume that the time between visits reflects clinical decision-making about follow-up needs, though other factors (patient availability, scheduling constraints) may influence this.
4. **Visit Frequency Interpretation**: Higher visit frequency could indicate either (a) more intensive care for severe cases or (b) more responsive monitoring leading to better outcomes - both possibilities will be considered in the interpretation.
5. **Causality Limitations**: While correlations may be found, we cannot definitively establish causality between visit patterns and outcomes due to potential confounding variables.

**Methodology**

**Data Processing**

1. **Patient-Level Dataset**: Create a consolidated patient-level dataset with:
   * Healing duration (days from accident to last visit)
   * Days to first visit (from accident)
   * Total number of visits
   * Average days between visits
   * Variability in visit spacing (standard deviation)
   * Maximum gap between visits
2. **Early Intervention Categorization**:
   * Classify patients into early intervention (<30 days) and delayed intervention groups
   * Create additional thresholds (60 days, 90 days) for sensitivity analysis
3. **Visit Frequency Categorization**:
   * Low frequency: ≤3 visits
   * Medium frequency: 4-6 visits
   * High frequency: >6 visits

**Analytical Approaches**

1. **Correlation Analysis**:
   * Calculate Pearson's correlation between first visit timing and healing duration
   * Calculate correlation between visit frequency and healing duration
   * Calculate correlation between average visit spacing and healing duration
2. **Group Comparison**:
   * Compare healing duration between early vs. delayed intervention groups (t-test or Mann-Whitney U)
   * Compare outcomes across visit frequency categories (ANOVA)
3. **Regression Modeling**:
   * Simple regression of healing duration on days to first visit
   * Multiple regression including visit frequency and spacing metrics
4. **Visualization**:
   * Scatter plots with regression lines
   * Box plots comparing groups
   * Line plots showing individual patient visit patterns

**Anticipated Results**

Based on clinical literature and preliminary observations from previous analyses, we anticipate:

1. **First Visit Timing**: A positive correlation between days to first visit and healing duration - earlier intervention may lead to better outcomes.
2. **Visit Frequency**: Either:
   * Negative correlation (more visits = shorter healing) suggesting effective monitoring
   * Positive correlation (more visits = longer healing) suggesting more complex cases requiring more care
3. **Visit Spacing**: More consistent visit spacing (lower standard deviation) may correlate with better outcomes, suggesting adherence to follow-up protocols.
4. **Early Intervention Effect**: Patients seen within 30 days may show significantly shorter healing durations than those with delayed first visits.

**Interpretation Considerations**

Several patterns may emerge, requiring careful interpretation:

1. **Positive correlation between first visit delay and healing duration**:
   * Interpretation 1: Earlier intervention leads to better outcomes
   * Interpretation 2: More severe cases are seen earlier and also have longer recovery
2. **Positive correlation between visit frequency and healing duration**:
   * Interpretation 1: More complex cases require more visits
   * Interpretation 2: More frequent monitoring does not necessarily improve outcomes
3. **Negative correlation between visit frequency and healing duration**:
   * Interpretation 1: More intensive monitoring improves outcomes
   * Interpretation 2: Less severe cases require fewer visits and naturally recover faster
4. **Visit spacing patterns**:
   * Regular spacing may indicate adherence to protocols and structured follow-up
   * Irregular spacing may indicate responsive care adjusted to patient needs

**Integration with Previous Analyses**

The Time-Based Analysis will build upon and complement:

1. **Univariate Analysis**: Which identified key injury types affecting healing duration (head and abdominal injuries)
2. **Multivariate Analysis**: Which examined interactions between multiple injury types
3. **Time Interval Analysis**: Which examined problems identified during specific recovery periods

When interpreting results, particular attention will be paid to:

* Whether time-based factors remain significant when controlling for injury types
* If visit patterns differ for patients with the significant injury types identified in previous analyses
* Whether the near-significant time intervals (3, 6, and 8) from the Time Interval Analysis align with particular visit pattern effects

**Limitations**

1. **Sample Size**: Limited to 30 patients, which restricts statistical power, particularly for subgroup analyses
2. **Visit Purpose Ambiguity**: The dataset doesn't specify the purpose or content of each visit
3. **Confounding Variables**: Injury severity, treatment intensity, and patient compliance may confound relationships between visit patterns and outcomes
4. **Selection Bias**: Visit patterns may be determined by clinical judgment about patient needs, creating circular relationships with outcomes
5. **Healing Duration Definition**: Reliance on last visit as proxy for recovery completion may not perfectly reflect actual healing

**Expected Output**

1. **Consolidated Dataset**: Patient-level data with visit timing metrics
2. **Statistical Results**: Correlation coefficients, p-values, and effect sizes
3. **Visualizations**: Scatter plots, box plots, and patient visit timeline plots
4. **Summary Report**: Comprehensive interpretation of findings with clinical implications
5. **Integration Analysis**: How visit timing factors relate to previously identified significant factors

**Next Steps**

After completing this Time-Based Analysis, the final planned step is the Professional Reintegration Analysis, which will examine:

* Healing duration for patients with different work status outcomes
* Comparison between cases marked as "Arbeitsfaehig" vs. "Arbeitsunfähig" at final visits
* Whether vocational rehabilitation interventions correlate with healing time