**Polytrauma Injury Category Distribution Analysis**

**1. Overview**

This documentation outlines the enhanced injury category distribution analysis performed on polytrauma patient data, with particular focus on the aggregation of left and right extremities into unified "Arm" and "Bein" categories. The analysis examines the prevalence and distribution of various injury types and intervention categories across 30 unique patient cases.

**2. Methodology**

**2.1 Data Source**

The analysis used the processed dataset from Polytrauma\_Analysis\_Processed.xlsx, which contained 153 records representing 30 unique patients with multiple visits. The data was loaded with proper typing (Schadennummer as string) and processed to ensure consistent field names.

**2.2 Category Aggregation**

A key methodological decision was to merge separate limb categories:

* "Arm links" and "Arm rechts" were merged into a single "Arm" category
* "Bein links" and "Bein rechts" were merged into a single "Bein" category

This aggregation was implemented using the following logic:

# Merge Arm links and Arm rechts into a single Arm category

df['Arm'] = df[['Arm links', 'Arm rechts']].apply(

lambda row: 'Ja' if 'Ja' in row.values else 'Nein', axis=1

)

# Merge Bein links and Bein rechts into a single Bein category

df['Bein'] = df[['Bein links', 'Bein rechts']].apply(

lambda row: 'Ja' if 'Ja' in row.values else 'Nein', axis=1

)

**2.3 Category Structure**

The analysis used the following category structure:

1. **Körperteil** (Body Parts): Kopf, Hals, Thorax, Abdomen, Arm, Wirbelsaeule, Bein, Becken
2. **Somatisch** (Physical Conditions): Funktionsstoerung, Schmerz, Komplikationen
3. **Personenbezogen** (Personal Factors): Psychische Probleme/Compliance, Entschädigungsbegehren, Migrationshintergrund, Suchtverhalten, Zusätzliche Erkrankungen
4. **Taetigkeit** (Employment Status): Arbeitsunfähig, Wiedereingliederung, Arbeitsfaehig, BU/EU, Altersrentner, Ehrenamt, Zuverdienst
5. **Umwelt** (Environmental Factors): Beziehungsprobleme, Soziale Isolation, Mobilitaetsprobleme, Wohnsituatuation, Finazielle Probleme
6. **Med RM** (Medical Case Management): Arzt-Vorstellung, Arzt-Wechsel, Organisation ambulante Therapie, Organisation medizinische Reha, Wietere Krankenhausaufenthalte, Psychotherapie, Organisation Pflege
7. **Soziales RM** (Social Case Management): Lohnersatzleistungen, Arbeitslosenunterstuetzung, Antrag auf Sozialleistungen, Einleitung Begutachtung
8. **Technisches RM** (Technical Case Management): Hilfmittelversorgung, Mobilitätshilfe, Bauliche Anpassung, Arbetsplatzanpassung
9. **Berufliches RM** (Vocational Case Management): Leistungen zur Teilhabe am Arbeitsleben, Integration/berufliche Neurientierung allgemeiner Arbeitsmarkt, Wiedereingliederung geförderter Arbeitsmarkt, BEM

**2.4 Analysis Assumptions**

1. **Case Definition**: Each unique Schadennummer represents a separate patient case.
2. **Positive Case Definition**: A case is marked as positive for a category if any subcategory has "Ja" across any visit.
3. **Missing Values**: Missing values in categorical columns were treated as "Nein" during processing.
4. **Aggregation Logic**: For merged categories (Arm and Bein), a case is considered positive if either the left or right side (or both) is marked as "Ja".
5. **Percentages Calculation**: All percentages are calculated based on the total number of unique cases (n=30).

**2.5 Validation Process**

The analysis included validation checks to ensure logical consistency:

* Ensured no category had more positive cases than total cases
* Identified categories with zero positive cases (warning only)
* Checked that subcategory counts were consistent with overall category counts

**3. Results**

**3.1 Overall Category Distribution**

| **Category** | **Positive Cases** | **Percentage** |
| --- | --- | --- |
| Körperteil | 30 | 100.0% |
| Taetigkeit | 30 | 100.0% |
| Med RM | 30 | 100.0% |
| Somatisch | 26 | 86.7% |
| Technisches RM | 21 | 70.0% |
| Personenbezogen | 18 | 60.0% |
| Umwelt | 15 | 50.0% |
| Berufliches RM | 15 | 50.0% |
| Soziales RM | 10 | 33.3% |

**3.2 Body Part (Körperteil) Distribution**

| **Subcategory** | **Positive Cases** | **% of Total Cases** | **% within Category** |
| --- | --- | --- | --- |
| Arm | 19 | 63.3% | 63.3% |
| Thorax | 18 | 60.0% | 60.0% |
| Wirbelsaeule | 17 | 56.7% | 56.7% |
| Bein | 16 | 53.3% | 53.3% |
| Kopf | 15 | 50.0% | 50.0% |
| Abdomen | 7 | 23.3% | 23.3% |
| Becken | 6 | 20.0% | 20.0% |
| Hals | 1 | 3.3% | 3.3% |

**3.3 Most Frequent Subcategories by Category**

| **Category** | **Top Subcategory** | **Prevalence** |
| --- | --- | --- |
| Med RM | Organisation ambulante Therapie | 96.7% |
| Somatisch | Funktionsstoerung | 83.3% |
| Taetigkeit | Arbeitsunfähig | 70.0% |
| Technisches RM | Hilfmittelversorgung | 63.3% |
| Körperteil | Arm | 63.3% |
| Personenbezogen | Psychische Probleme/Compliance | 46.7% |
| Umwelt | Mobilitaetsprobleme | 43.3% |
| Berufliches RM | Leistungen zur Teilhabe am Arbeitsleben | 40.0% |
| Soziales RM | Lohnersatzleistungen | 16.7% |

**4. Visualization Descriptions and Interpretations**

**4.1 Category Percentage Histogram (Image 3)**

**Description:** This bar chart displays the percentage of cases affected by each main category, sorted in descending order from highest to lowest prevalence. Each bar is annotated with both the percentage and absolute number of cases.

**Interpretation:**

* Three categories (Körperteil, Taetigkeit, Med RM) show 100% prevalence, indicating that all patients had some form of body part injury, activity limitation, and medical case management.
* Somatisch (86.7%) and Technisches RM (70.0%) also show high prevalence, indicating that most patients experience physical symptoms and require technical assistance.
* Soziales RM has the lowest prevalence (33.3%), suggesting that social welfare interventions are required for only a third of patients.

**Usage:** This visualization provides a quick overview of which aspects of rehabilitation are most commonly needed following polytrauma, helping to prioritize resources and interventions at a program level.

**4.2 Radar Chart of Category Distribution (Image 2)**

**Description:** The radar chart (also called spider plot) displays the percentage of cases for each main category around a circular axis, with 0% at the center and 100% at the outer edge. Categories are arranged radially, and connected values form a polygon.

**Interpretation:**

* The chart shows the relative prevalence of each category compared to others.
* The Körperteil, Med RM, and Taetigkeit categories extend to the outer edge (100%), forming a triangular pattern.
* Somatisch extends to about 87%, while Technisches RM reaches 70%.
* Soziales RM creates the shortest spoke, indicating it has the lowest prevalence.

**Usage:** The radar chart allows for quick visual comparison across all categories simultaneously and highlights the multidimensional nature of polytrauma rehabilitation. The area of the polygon represents the overall burden of injury and intervention needs across all categories.

**4.3 Körperteil Subcategory Distribution (Image 4)**

**Description:** This bar chart shows the distribution of specific body part injuries across all cases, sorted by prevalence. Each bar is annotated with the percentage and absolute number of cases.

**Interpretation:**

* Arm injuries are most common (63.3%, 19 cases), followed closely by Thorax (60.0%, 18 cases).
* The spine (Wirbelsaeule) is affected in 56.7% of cases (17 patients).
* The merged Bein category shows 53.3% prevalence (16 cases).
* Head injuries occur in exactly half of all cases (50.0%, 15 patients).
* Neck (Hals) injuries are rare, occurring in only 3.3% of cases (1 patient).

**Usage:** This visualization helps identify the most commonly affected body regions in polytrauma, which can guide resource allocation for specialized care (e.g., orthopedics, neurology) and rehabilitation equipment. The high prevalence of arm injuries suggests a need for upper extremity rehabilitation resources.

**4.4 Med RM Subcategory Distribution (Image 5)**

**Description:** This chart displays the distribution of medical resource management interventions across all cases, highlighting which medical services were most utilized.

**Interpretation:**

* Outpatient therapy organization (Organisation ambulante Therapie) was required in nearly all cases (96.7%, 29 patients).
* Physician consultations (Arzt-Vorstellung) were needed for 80% of patients (24 cases).
* Medical rehabilitation organization (Organisation medizinische Reha) was required for 63.3% of patients (19 cases).
* Psychotherapy was only utilized in 20% of cases (6 patients), suggesting that psychological intervention was less frequently required or implemented.

**Usage:** This chart helps healthcare administrators understand which medical services are most in demand for polytrauma patients, potentially informing staffing decisions and process optimization in rehabilitation centers.

**4.5 Berufliches RM Subcategory Distribution (Image 1)**

**Description:** This chart illustrates the distribution of vocational rehabilitation measures across cases, showing the relative frequency of different employment-related interventions.

**Interpretation:**

* Participation in working life services (Leistungen zur Teilhabe am Arbeitsleben) were the most common intervention at 40% (12 cases).
* General labor market reorientation (Integration/berufliche Neurientierung allgemeiner Arbeitsmarkt) was needed in only 10% of cases (3 patients).
* Company integration management (BEM) was rarely utilized (3.3%, 1 case).
* Subsidized labor market reintegration was not used in any cases (0%).

**Usage:** This visualization can help vocational rehabilitation specialists understand which employment support services are most commonly needed for polytrauma patients, and which specialized services may be underutilized.

**4.6 Personenbezogen Subcategory Distribution (Image 6)**

**Description:** This chart shows the distribution of personal factors affecting recovery across patients, highlighting psychological and social aspects that impact rehabilitation.

**Interpretation:**

* Psychological problems/compliance issues are prevalent in nearly half of all cases (46.7%, 14 patients).
* Additional medical conditions affect 40% of patients (12 cases).
* Migration background and compensation claims are rare (3.3% each, 1 case).
* Addiction behavior was not reported in any cases (0%).

**Usage:** This visualization helps identify the most common personal barriers to rehabilitation, suggesting where additional psychological support or compliance interventions might be beneficial. The high rate of psychological problems indicates a need for integrated psychological care in polytrauma rehabilitation.

**4.7 Somatisch Subcategory Distribution (Image 7)**

**Description:** This chart illustrates the distribution of physical symptoms and conditions across patients, showing which somatic issues are most common in polytrauma cases.

**Interpretation:**

* Functional disorders (Funktionsstoerung) are extremely common, affecting 83.3% of patients (25 cases).
* Pain (Schmerz) affects more than half of patients (53.3%, 16 cases).
* Complications (Komplikationen) occur in 36.7% of cases (11 patients).

**Usage:** This visualization helps clinicians understand the physical symptom burden in polytrauma patients and may guide treatment protocols. The high prevalence of functional disorders suggests a need for focused functional rehabilitation.

**5. Key Findings and Implications**

**5.1 Prevalence Patterns**

1. **Universal Categories**: Three categories (Körperteil, Taetigkeit, Med RM) show 100% prevalence, indicating core aspects of polytrauma rehabilitation.
2. **High Prevalence Physical Issues**:
   * Arm injuries (63.3%) are the most common body part affected
   * Functional disorders (83.3%) are the most common physical symptom
   * Organization of outpatient therapy (96.7%) is the most common medical management intervention
3. **Moderate Prevalence Issues**:
   * Technical assistance (70.0%) is needed in most cases
   * Personal factors (60.0%) affect the majority of patients
   * Environmental factors (50.0%) affect half of all patients
4. **Lower Prevalence Issues**:
   * Social case management (33.3%) is needed in only a third of cases
   * Psychotherapy (20.0%) is utilized in only a fifth of cases
   * Neck injuries (3.3%) are rare

**5.2 Extremity Injury Patterns**

The merged analysis revealed:

1. **Upper Extremity**: Arm injuries (combined) are the most common body part affected (63.3%, 19 cases), higher than any other single body region.
2. **Lower Extremity**: Leg injuries (combined) affect more than half of patients (53.3%, 16 cases), making them the fourth most common body region affected.
3. **Bilateral Consideration**: The merged approach provides a more comprehensive view of extremity involvement by considering overall limb injury regardless of laterality.

**5.3 Implications for Rehabilitation**

1. **Resource Allocation**: The high prevalence of arm injuries suggests focusing rehabilitation resources on upper limb function.
2. **Integrated Care**: The 100% prevalence of body part injuries, activity limitations, and medical management needs confirms the necessity of multidisciplinary approaches.
3. **Psychological Support**: With psychological problems affecting nearly half of all patients (46.7%), integrated psychological care should be a priority.
4. **Technical Aids**: The high rate of assistive device needs (63.3% requiring mobility aids) indicates the importance of technical support in rehabilitation.
5. **Employment Support**: With 70% of patients being work-incapable, vocational rehabilitation should be emphasized, particularly services supporting return to the workplace.

**6. Limitations and Considerations**

1. **Sample Size**: The analysis is based on only 30 unique patient cases, which may limit generalizability.
2. **Temporal Dynamics**: The analysis does not account for changes in categories over time during the rehabilitation process.
3. **Data Completeness**: Some fields had missing data that was interpreted as "Nein" which may underestimate actual prevalence.
4. **Category Interdependence**: Relationships between categories were not analyzed but may be important for comprehensive rehabilitation planning.
5. **Merged Categories Limitation**: While merging arm and leg categories provides a clearer overall picture, it loses information about laterality which may be clinically important in some contexts.

**7. Conclusion**

The enhanced injury category distribution analysis, with merged arm and leg categories, provides valuable insights into the patterns of injury and rehabilitation needs following polytrauma. The high prevalence of arm injuries, functional disorders, and outpatient therapy needs underscores the importance of comprehensive rehabilitation approaches focusing on these areas.

The visualizations created through this analysis offer multiple perspectives on the data, from broad category comparisons to detailed subcategory distributions, facilitating different levels of insight for clinical and administrative decision-making.

The merged extremity approach successfully highlights the overall burden of limb injuries while simplifying the analysis framework. This approach is recommended for future analyses seeking to understand general patterns of extremity involvement in polytrauma.