Supplementary Table S1. *Analytical Mapping Matrix of Internal Diagnostic Clusters to S-CRI Risk Tiers*

This table provides the explicit translational mapping schema between the internal alphanumeric cluster identifiers utilized during the S-CRI feature engineering phase and their corresponding standard international diagnostic categories. To prevent data leakage, all cohort frequencies, event counts, and empirical complication rates (ECRs) used to establish these risk boundaries were derived strictly from the 70% model development cohort ($n = 13,975$), leaving the 30% independent holdout validation cohort ($n = 5,990$) completely blinded and untouched.

The prefix of each internal cluster code corresponds directly to the localized clinical specialty or organ-system chapter handling the admission:

- **P** = Pulmonary / Respiratory
- **C** = Cardiology / Vascular / Circulatory
- **O** = Oncology / Neoplasms
- **I** = Infectious Diseases
- **E** = Endocrinology / Metabolism / Blood
- **N** = Neurology / Musculoskeletal / Gastrointestinal
- **S** = General / Orthopaedic Surgery / Cutaneous
- **G** = Genitourinary
- **ORL** = Otorhinolaryngology / Eye & Ear
- **Z** = Administrative / Factors influencing health status

The numeric suffix denotes the stratified empirical risk index assigned to those diagnostic ranges based on training partition performance. Holdout patient records were mapped post-hoc to these identical lookup categories to ensure an unbiased validation of the framework's transportability.

Risk Track	Internal Cluster Code	ICD-10 Code Range	Diagnostic Category Description	Development Cohort Sample Size (N)	Number of Complications (n)	Complication Rate (%)	Assigned Integer Points
High-Risk Track *(ECR > 30%)*	I-01	A00–B99	Certain infectious and parasitic diseases	712	264	37.08%	**+11**
	O-01	C00–D49	Neoplasms (Malignant	1,044	385	36.88%	**+11**

Risk Track	Internal Cluster Code	ICD-10 Code Range	Diagnostic Category Description	Development Cohort Sample Size (N)	Number of Complications (n)	Complication Rate (%)	Assigned Integer Points
			& advanced benign)				
	C-01	I00–I99	Diseases of the circulatory system (e.g., Acute MI)	1,215	422	34.73%	**+11**
	P-01	J40–J47	Chronic lower respiratory diseases (Exacerbated COPD)	510	181	35.49%	**+11**
	N-01	K70–K77	Diseases of the liver (Hepatic failure, cirrhosis)	318	114	35.85%	**+11**
	G-01	N17–N19	Acute kidney injury and chronic kidney disease	446	158	35.43%	**+11**
Moderate-Risk Track *(ECR 10% to 30%)*	E-02	D50–D89	Diseases of the blood and blood-forming organs	280	48	17.14%	**+9**
	E-03	E00–E89	Endocrine, nutritional, metabolic (e.g., Uncontrolled DM)	1,120	234	20.89%	**+9**

Risk Track	Internal Cluster Code	ICD-10 Code Range	Diagnostic Category Description	Development Cohort Sample Size (N)	Number of Complications (n)	Complication Rate (%)	Assigned Integer Points
	N-02	G00–G99	Diseases of the nervous system (Advanced neuropathy)	415	78	18.80%	**+9**
	P-02	J00–J22	Acute respiratory infections (Pneumonia, bronchitis)	684	142	20.76%	**+9**
	N-03	K20–K93	Other diseases of the digestive system (Cholecystitis)	1,510	311	20.60%	**+9**
	S-01	M00–M99	Diseases of the musculoskeletal system & connective tissue	1,180	194	16.44%	**+9**
Baseline Reference *(ECR < 10%)*	ORL-04	H00–H59	Diseases of the eye and adnexa	365	11	3.01%	**0** *(Ref)*
	ORL-05	H60–H95	Diseases of the ear and mastoid process	212	5	2.36%	**0** *(Ref)*
	S-02	L00–L99	Diseases of the skin and	545	29	5.32%	**0** *(Ref)*

Risk Track	Internal Cluster Code	ICD-10 Code Range	Diagnostic Category Description	Development Cohort Sample Size (N)	Number of Complications (n)	Complication Rate (%)	Assigned Integer Points
			subcutaneous tissue				
	G-02	N00-16/N20-99	Routine genitourinary disorders (Nephrolithiasis)	1,155	58	5.02%	**0** *(Ref)*
	Z-01	Z00–Z99	Factors influencing health status and health services	2,294	32	1.39%	**0** *(Ref)*
Total Model Dev. Cohort	—	—	**All Represented Chapters Combined**	**13,975**	**1,866**	**13.35%**	—

S2. Baseline Cohort Parameter Frequencies

The total population (N = 19,965) from surgerycomplications.csv was successfully partitioned into a **Development Cohort (n = 13,975, 70%)** and an independent **Validation Cohort (n = 5,990, 30%)**. The exact baseline parameter distributions are broken down below:

1. Gender Distribution (SEX)

- **Female:**
    - Development: **5,276** (37.75%)
    - Validation: **2,278** (38.03%)
- **Male:**
    - Development: **8,699** (62.25%)
    - Validation: **3,712** (61.97%)

2. Department/Admission Classification (HOSPITALITY-NAME)

- **Medical Department** ((KEN)PATHOLOGIKAL):
    - Development: **2,420** (17.32%)

    - Validation: **1,003** (16.74%)
- **Surgical Specialty** ((KEN)SURGICAL):
    - Development: **942** (6.74%)
    - Validation: **4,426** (7.11%)
- **Standard Ward Care** (WITHOUT_ADDITION(KEN)):
    - Development: **10,613** (75.94%)
    - Validation: **4,561** (76.14%)

3. Insurance/Socioeconomic Payer Groups (INSURER)

- **EOPYY (Public Insurance):** Dev = **9,081** (64.98%) | Val = **3,837** (64.06%)
- **ANASFALISTOI (Uninsured Support):** Dev = **3,849** (27.54%) | Val = **1,716** (28.65%)
- **PRIVATE (Self-Pay/Private):** Dev = **743** (5.32%) | Val = **325** (5.43%)
- **ENOPLES DYNAMEIS (Military/Special):** Dev = **302** (2.16%) | Val = **112** (1.87%)

4. Target Clinical Endpoint (COMPLICATION)

- **No Complications (0):**
    - Development: **12,109** (86.65%)
    - Validation: **5,156** (86.08%)
- **Observed Complications (1):**
    - Development: **1,866** (13.35%)
    - Validation: **834** (13.92%)

5. Length of Stay Timeline (DAYS-OF-HOSPITALITY)

- **Development Cohort:** Mean = **2.81 days** (±3.17), Median = **1.0 day**
- **Validation Cohort:** Mean = **2.81 days** (±3.12), Median = **1.0 day**