Screening for Idiopathic Pulmonary Fibrosis with Comorbid Pattern Recognition in Electronic Health Records

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Screening for Idiopathic Pulmonary Fibrosis with Comorbid Pattern Recognition in Electronic Health Records

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Idiopathic pulmonary fibrosis (IPF) is an irreversible, debilitating, and ultimately lethal fibrosing interstitial lung disease (ILD) of unknown cause¹⁻³. The poor prognosis of IPF (mean survival less than 2-5 years post diagnosis⁴), combined with its worldwide prevalence greater than all but the most common cancers⁵, makes it a serious health problem. Thus, the need for early diagnosis is paramount. Currently, early screening is hampered by the absence of reliable screening tools, non-specific symptomology, a limited understanding of the phenotypic and genetic markers for early-stage IPF, and the potential need for invasive procedures for confirmatory diagnosis. In this study we introduce a new screening tool that requires no new diagnostic tests, may be universally administered, and does not necessarily require recognition of early symptoms by the patients or care providers. Applying novel pattern discovery algorithms on the detailed history of past medical encounters of individual patients, we leverage subtle comorbidity patterns to compute the Zero-burden Co-Morbidity Risk Score for IPF (ZCoR-IPF), which is expected to be widely, readily, rapidly and inexpensively applicable at points of care. Our algorithm is trained and validated on a large national insurance claims database (n=2,059,559). In out-of-sample validation, we demonstrate that ZCoR-IPF identifies IPF patients with an AUC approaching 84% at 4 years, $\approx 86\%$ at 3 years, $\approx 87\%$ at 2 years, and exceeding 88% at 1 year before conventional diagnosis. Our out-of-sample accuracy indicates that on average, we correctly predict the eventual IPF status 94 – 98 out of every 100 patients, with a positive predictive value $> 50\%$ irrespective of sex at a specificity of 99%. Maximum PPV and NPV achieved are $\geq 70\%$ and $\approx 98\%$ respectively. We investigate several important sub-populations, including high risk patients with known IPF co-morbidities, low risk patients who lack those indications, in older (> 65) and younger populations, in patients who already have a diagnosis of Chronic obstructive pulmonary disease (COPD), asthma or have cardiac disorders, and for patients who are never recorded to have experienced dyspnea and thus are at a higher risk of a missed diagnosis. High performance of the ZCoR-IPF score across clinically relevant situations suggests that it may aid providers to more selectively flag patients for detailed diagnostic evaluation, substantially improving patient outcomes and quality-of-life, as well as efficiency of healthcare resource utilization. Additionally, earlier diagnosis may improve the odds of disease modifying therapy, optimal timing of a lung transplantation, and accelerate access to interventions and palliative care^{6,7}.

IDIOPATHIC pulmonary fibrosis (IPF) is an irreversible, progressive, debilitating, and ultimately lethal fibrosing interstitial lung disease (ILD) of unknown cause¹⁻³. Before the introduction of the anti-fibrotics nintedanib and pirfenidone in 2014, the typical survival of patients with IPF was 2-5 years from the time of diagnosis⁴. This prognosis has been characterized as worse than most cancers⁵. Although the disease is considered rare, as of 2014, IPF had a greater worldwide prevalence than did all but seven most common cancers⁵. Over the past

decade, timely, efficient, and confident diagnosis of IPF has been recognized as a major public health challenge worldwide^{2,5,6,8–15}. In this study, we put forth a novel approach to predict future IPF diagnosis by algorithmically identifying subtle patterns in the time, nature and ordering of past medical encounters of individual patients.

Over the past decade, timely, efficient, and confident diagnosis of IPF has been recognized as a major public health challenge worldwide^{2,5,6,8–15}. Identifying IPF cases is a complex, multi-step, and often multi-year process^{6,11,13–17}. A usually necessary but not always sufficient condition is referral for high-resolution chest computed tomography (HRCT), often at an expert center^{6,11}. In most cases, such referral leads to eventual recognition of radiological or histological usual interstitial pneumonia (UIP), the hallmark of IPF, or of other radiological and/or histological signs associated with this disease, and serologic studies to rule-out of other forms of interstitial lung disease (ILD)^{2,6,11}. For such referral to happen, one or more of a number of scenarios must unfold: 1) Patients recognize the chronicity, progression, or both of respiratory symptoms and the resultant need for medical attention^{6,7,15,17}. 2) Health-care practitioners note the importance of these symptoms, of signs of possible fibrosis on auscultation, or of both^{5,18}. 3) Radiologists, not infrequently non-specialists in chest imaging, note incidental findings of interstitial lung abnormalities (ILA) or ILD on thoracic or abdominal CT^{10,14,19,20}. Alternatively, a pulmonologist or a HRCT referral may only take place²⁰, after an emergency room visit or hospitalization due to acute exacerbation of IPF¹⁵.

Hence, IPF diagnosis often entails multiple physician visits and repeated, sometimes invasive tests, and is often characterized by delay and misdiagnosis^{6,13,14}. Not infrequently, this situation pertains even after ILD is seen on CT or a pulmonologist has been consulted. For example, a retrospective analysis¹⁴ of two US academic medical center cohorts found around a quarter of patients with IPF or other forms of ILD to have waited ≥ 1 year after a CT finding of ILD to see a pulmonologist, while a Medicare claims study¹³ found that more than a third of patients saw a pulmonologist > 3 years before IPF diagnosis. A medical chart analysis¹⁰ and a patient survey⁶ suggested misdiagnosis rates approaching or exceeding 40%. Notably, 28% of respondents in a 600-patient survey⁶ reported that the burden of their journey to an IPF diagnosis contributed to a decision to apply for disability or to retire.

The difficulties in reliable early diagnosing IPF may be ascribed to several causes. First, the most common clinical symptoms of the disease^{7,17}, insidiously progressive chronic exertional dyspnea and/or chronic, often mild cough, are highly non-specific. These symptoms are easily attributed by patients to age or deconditioning⁶, or by physicians to more common cardio-respiratory diseases^{5,6,15,16}. Important risk factors for IPF, namely, older age, male sex, and cigarette smoking¹, are similarly “non-specific”. Second, there is still limited understanding and characterization of phenotypic and genetic findings associated with “early-stage IPF”¹⁰. Third, the current diagnostic hallmark of IPF, UIP on HRCT or histology², is a late-stage finding³. Moreover, UIP may be confirmed via relatively invasive procedures requiring specialized interpretation, *e.g.*, HRCT or surgical lung biopsy⁶. Lastly, no validated or easily-applicable screening modalities currently exist for IPF⁹.

In this study we introduce an innovative approach with the potential to ameliorate these key challenges: we introduce a tool that requires no new diagnostic tests, may be universally administered, and does not necessarily require recognition of early symptoms by the patients or care providers. Analyzing large databases of electronic health records via novel pattern discovery algorithms, we identify subtle co-morbidity incidence, timing, and sequence characteristics presaging IPF. Combining these discovered features with standard machine learning then leads to a powerful, accurate, automated screening tool based only on diagnostic codes that exist already in the patient’s past medical record. Here we report on the training and validation of our screening tool, the Pulmonary Fibrosis Co-Morbidity Risk Score (ZCoR-IPF), which is expected to be widely, readily, rapidly and inexpensively applicable at points of care.

MATERIALS AND METHODS

Data Source & Patient Selection

Our patient data comes from the Truven Health Analytics MarketScan[®] Commercial Claims and Encounters Database for the years 2003-2018²¹ (referred to as the Truven dataset). This US national database merges data contributed by over 150 insurance carriers and large self-insurance companies, and comprises over seven billion time-stamped diagnosis codes. The entire database tracks over 87 million patients for 1 to 15 years, reflecting a substantial cross-section of the US population. We select our cohort(s) from the Truven dataset in accordance with the inclusion/exclusion criteria described in Table I, ensuring that selected patients have at least three years of medical history recorded in the dataset. The geographical distribution of the patients in our selected cohort(s) is illustrated in Fig. 1a. Fig. 1b illustrates the age distribution at the time of IPF diagnosis (mean ≈ 68 years), which is consistent with the reported mean onset age for IPF (≈ 66 years⁴). We also

a. Geospatial distribution of positive cases

b. Distribution of onset age in the database

c. Risk of onset with age

d. CONSORT

Fig. 1: Statistical characteristics of the Truven database. Panel a shows where our patients originate from. The geospatial distribution is correlated with population density, as expected. Panel b illustrates the distribution of patient diagnostic ages in the database. Note that the mean age of onset compares favorably with the value reported in the literature (≈ 68 vs 66 years). Panel d shows the probability of diagnosis with age, taking into account the variation of the number of patients of a given age in the database (higher the age beyond 65, smaller the number of patients). Panel d shows patient selection via a CONSORT (Consolidated Standards of Reporting Trials) diagram.

note that observed risk of onset actually increases with age, which is computed as the number of IPF cases normalized by the total number of patients at the same age, as shown in Fig. 1c.

To view the task of predicting a future IPF diagnosis as a binary classification problem, we aim to categorize time-stamped sequences of diagnostic codes into positive and control categories, where the “positive” category refers to patients diagnosed with IPF 1 year (See Tables IV) from the point of screening. We also consider earlier screening upto 4 years before the actual diagnosis, as described later. The control cohort comprises patients who do not have any target codes in their records, within the next 2 years of the point of screening. For both groups, we base our predictions on the past 2 years of medical history. We consider approximately 42 million diagnostic codes (with over 46K unique codes) for both genders (See Table III for detailed enumeration) in this analysis, and ultimately identified $n = 2,059,559$ patients, with 53,407 patients in the positive group and

TABLE I: Inclusion/Exclusion, Positive/Control Criteria & Cohort Definitions

	Definitions
Inclusion/Exclusion Criteria	Age 48 - 90
	Has medical history spanning ≥ 3 yrs before target code [‡] (positive, See Tab. IV for list of target codes), or end of record (control)
Positive & Control Cohorts	Positive Cohort: Patients with at least one target code (Tab. IV)
	Control Cohort: Patients lacking any target code

*Medical records denote time stamped history of diagnostic codes

[‡]Target codes identify the target condition (IPF or Pulmonary Fibrosis without known cause)

TABLE II: Cohort Sizes

gender	age group	n	n_{positive}	n_{control}
M	45-55	226150	1870	224280
M	55-65	480104	9471	470633
M	65-75	157017	7999	149018
M	75-	72469	7464	65005
F	45-55	291111	2554	288557
F	55-65	580593	10467	570126
F	65-75	171022	7130	163892
F	75-	81093	6452	74641
Total		2059559	53407	2006152

TABLE III: Number of diagnostic codes used

gender	Number of codes	Number of unique codes	codes defining disease categories
M	17008378	22685	85016
F	25074255	23722	85016

TABLE IV: Target Codes: Description of ICD Codes(s) Used To Identify IPF diagnoses

ICD code	description
516.31	Idiopath pulmon fibrosis
J84.112	Idiopathic pulmonary fibrosis
J84.113	Idiopathic non-specific interstitial pneumonitis
J84.111	Idiopathic interstitial pneumonia not otherwise specified
J84.1	Pulmonary fibrosis unspecified
J84.10	Pulmonary fibrosis unspecified
J84.11	Idiopathic interstitial pneumonia not otherwise specified

2,006,152 patients in the control group. The cohort sizes are described in Table II.

The diagnostic codes specifically for IPF are 516.31 (ICD9) and J84.112 (ICD10). We use a somewhat broader definition, including five additional ICD10 codes that indicate a diagnosis of pulmonary fibrosis without a known cause (See Table IV). This broadened definition of our target reduces the impact of erroneous coding and diagnostic uncertainties for IPF, and does not violate the key characteristics of a pulmonary fibrosis diagnosis for which no clear causal mechanism (such as toxic exposure) could be established.

Importantly, we do not pre-select or reject any diagnostic or prescription code based on its known or suspected comorbidity with IPF. To investigate if our predictive performance changes substantially for patients who are at “high risk” based on known co-morbidities, we also evaluate our performance within a high risk and a low risk sub-cohort. The high risk sub-cohort comprises patients with one or more of the diagnoses enumerated in Table V, which identify the top known co-morbidities²². The low risk sub-cohort comprises patients who are not at high risk as specified by the previous condition. Our results for the low risk sub-cohort is of particular significance, as these patients are at a higher risk of being not diagnosed early. Additionally, we investigate the applicability of ZCoR-IPF in patients 1) for whom IPF diagnosis might be confounded due a preexisting condition such as COPD, any heart condition, or asthma (See SI-Table III for cohort definition codes), and 2) for whom the absence of any indication of dyspnea reduces the odds of IPF suspicion and might delay diagnosis (See SI-Table II for codes that are absent in this cohort).

TABLE V: High risk comorbidities which define our high-risk cohort*

ICD code	description
K21.9	Gastro-esophageal reflux disease without esophagitis
K21	Gastro-esophageal reflux disease with esophagitis without bleeding
I27.20	Pulmonary hypertension unspecified
I27.0	Primary pulmonary hypertension
J44.9	Chronic obstructive pulmonary disease unspecified
G47.33	Obstructive sleep apnea (adult) (pediatric)

* Low-risk patients who lack these diagnoses before IPF diagnosis (positive cohort) or anywhere in their medical history (control cohort).

TABLE VI: Predictive performance of ZCoR-IPF for different subpopulations

sex	cohort	spec.	sens.	PPV	acc	NPV	PPV [‡]	NPV [‡]	AUC
Female	All patients	95%	0.60	0.23	0.94	0.99	0.70	0.98	0.887±0.006
Female	All patients	99%	0.42	0.52	0.98	0.99	0.70	0.98	0.887±0.006
Male	All patients	99%	0.38	0.54	0.97	0.98	0.71	0.98	0.883±0.005
Male	All patients	95%	0.55	0.25	0.94	0.99	0.71	0.98	0.883±0.005
Female	COPD/Cardiac/Asthma*	95%	0.57	0.30	0.94	0.98	0.68	0.98	0.865±0.000
Female	COPD/Cardiac/Asthma*	99%	0.41	0.62	0.97	0.98	0.68	0.98	0.865±0.000
Male	COPD/Cardiac/Asthma*	99%	0.35	0.62	0.96	0.97	0.69	0.97	0.848±0.000
Male	COPD/Cardiac/Asthma*	95%	0.51	0.31	0.93	0.98	0.69	0.97	0.848±0.000
Male	age 65+	99%	0.29	0.47	0.97	0.98	0.56	0.97	0.795±0.010
Male	age 65+	95%	0.44	0.21	0.94	0.98	0.56	0.97	0.795±0.010
Female	age 65+	95%	0.49	0.19	0.94	0.99	0.54	0.98	0.822±0.011
Female	age 65+	99%	0.32	0.46	0.97	0.98	0.54	0.98	0.822±0.011
Male	age < 65	95%	0.54	0.24	0.94	0.99	0.80	0.98	0.842±0.011
Female	age < 65	99%	0.45	0.54	0.98	0.99	0.73	0.99	0.859±0.010
Female	age < 65	95%	0.58	0.22	0.94	0.99	0.73	0.99	0.859±0.010
Male	age < 65	99%	0.41	0.57	0.97	0.98	0.80	0.98	0.842±0.011
Male	high risk	95%	0.58	0.40	0.93	0.98	0.69	0.97	0.884±0.000
Male	high risk	99%	0.39	0.70	0.96	0.97	0.69	0.97	0.884±0.000
Female	high risk	99%	0.38	0.65	0.96	0.97	0.64	0.98	0.894±0.000
Female	high risk	95%	0.61	0.36	0.93	0.98	0.64	0.98	0.894±0.000
Female	low risk	99%	0.32	0.22	0.99	0.99	0.70	0.99	0.852±0.000
Female	low risk	95%	0.48	0.07	0.95	1.00	0.70	0.99	0.852±0.000
Male	low risk	95%	0.50	0.09	0.95	0.99	0.72	0.99	0.853±0.000
Male	low risk	99%	0.31	0.24	0.98	0.99	0.72	0.99	0.853±0.000
Female	no dyspnea	99%	0.29	0.23	0.98	0.99	0.71	0.99	0.842±0.000
Female	no dyspnea	95%	0.49	0.09	0.95	0.99	0.71	0.99	0.842±0.000
Male	no dyspnea	95%	0.48	0.10	0.94	0.99	0.87	0.99	0.823±0.000
Male	no dyspnea	99%	0.31	0.29	0.98	0.99	0.87	0.99	0.823±0.000

* The cohort of COPD/Cardiac events/Asthma comprises patients with one of these conditions (See SI-Table III), and is designed to investigate ZCoR-IPF effectiveness under such preexisting diagnoses.

† The cohort of “no dyspnea” comprises patients lacking any record of dyspnea and related conditions (See SI-Table II), and investigates ZCoR-IPF effectiveness under situations aggravating missed diagnosis risk.

‡ Maximum PPV and NPV achieved by ZCoR-IPF

Modeling & Prediction

The significant diversity of diagnostic codes, along with the sparsity of codes per patient (0.49 to 0.55 per week diagnostic per patient on average) makes this a difficult learning problem. We proceed by partitioning the disease spectrum into 51 broad categories, *e.g.* infectious diseases, immunologic disorders, and endocrinal disorders (See SI Tab. I for a detailed enumeration of these categories). Some of these categories comprises a relatively large number of diagnostic codes aligning roughly with the categories defined within the ICD framework²³. The remaining categories represent groups of one or more codes that might have some known or suspected association with pulmonary disorders. Each of the diagnostic categories yield a single time series over weeks

a. Receiver Operating Characteristic curves

b. Precision Recall curves

c. Feature importances for broad categories of co-morbidities

Fig. 2: Predictive performance of ZCoR-IPF for IPF diagnosis 1 year in future. Panels a and b show the out-of-sample ROC and precision-recall curves for diagnosis 1 year from the point of screening. We achieve AUCs $> 88\%$ for both sexes, with sensitivity $> 55\%$ at 95% specificity. The PPV achieved is $\approx 50\%$ for females and 45% for males at 99.7% specificity for patients who have at least one respiratory diagnosis with past two years of ZCoR-IPF screening. Panels c and d show the top 20 comorbidity categories sorted in the order of inferred importance in estimating risk. Importantly, the comorbidities modulate risk differentially by sex, although the patterns are broadly similar, *e.g.*, respiratory disorders are the most important co-morbid factor, and other factors such as known IPF high co-morbidities (See Tab;e V), cardiovascular issues, infections, hypertensive abnormalities appear in both males and females, with altered ranking.

(each week being identified as having a value '0' for no code corresponding to the diagnostic category, or '1' if some code is present, and '2' if a diagnostic code from any of the other categories is present). We refer to the individual diagnostic categories as a phenotype in the sequel, since they are observable characteristics of the patients. Once we have defined these diagnosis phenotypes, each patient is represented by 51 sparse stochastic

a. Survival function lower bounds

b. Cumulative hazard function upper bounds

c. Lower bound on mean survival time

d. Risk vs age (Time to diagnosis: 4 years)

e. AUC trade-off for earlier screening

Fig. 3: Survival function, hazard rate improvements, and predictive performance for early screening. Panel a shows the estimated lower bounds on the survival function at two specificity levels (90 and 95%), and panel b the estimated upper bounds on hazard rates. The lower (upper) bounds are estimated due to the often missing information on actual deaths. Nevertheless, the last diagnostic record in a patient's history is a lower bound on the survival time, allowing us to calculate the plots shown above. Panel c shows the variation of the mean survival time as a function of the specificity at which ZCoR-IPF is operated. The baselines shown are calculated from our patient database, and is somewhat lower to what is reported in the literature (2-3 years median post-diagnosis). This is expected since our estimate is a lower bound. We have a clear advantage for even high specificities. Panel d illustrates the variation of estimated raw risk as a function of age for screening four years from actual recorded diagnosis of IPF, showing that risk increases almost linearly with age for the patients eventually diagnosed with IPF. Finally, panel e shows the degradation of out-of-sample AUC as we attempt to screen earlier, stepping back from the time of current diagnosis (in absence of ZCoR-IPF screening). Note that starting from $\approx 88\%$ AUC at 1 year to diagnosis the performance degrades somewhat to $\approx 85\%$ for screening at 4 years to diagnosis.

time series of events, which are compressed into specialized Hidden Markov Models known as Probabilistic Finite Automata²⁴. These models are inferred separately for each phenotype, for each sex, and for the control and the positive cohorts, to identify the distinctive average patterns emerging at the population level. Thus, we infer $51 \times 2 \times 2 = 204$ PFSA models in total in this study. Our inference algorithm (See Supplementary Text, Section XI) for these models do not presuppose a fixed structure, and is able to work with non-synchronized and variable length data streams. Variation in the structure and parameters of these inferred models between the positive and control groups delineate the estimated risk of an IPF diagnosis at the population level. Given these models, and the history of a specific patient, we can then quantify the likelihood of this patient's particular history being generated by the control PFSA models as opposed to the positive models. We refer to this likelihood difference as the sequence likelihood defect (SLD)²⁵, which is the one of the key informative features in our approach. The SLD is a novel concept, involving the generalization of the notion of KL divergence²⁶ between probability distributions to a generalized divergence between possibly non-iid stochastic processes (See Supplementary text, Section V).

In addition to the phenotype specific Markov models, we use a range of engineered features that reflect various aspects of the patient-specific diagnostic histories, referred to as the “sequence features”, “p-scores”, and “rare scores”. The sequence features include the ratio of number of weeks with the codes of a given phenotype to the total number of weeks in sequence, the ratio of number of weeks with the codes of a given phenotype to the

number of weeks with any diagnosis code recorded and the length of the longest uninterrupted subsequence of weeks with the codes of a given phenotype (See Table VII for complete list of such features). The p-scores and the rare scores encode prevalence characteristics of individual diagnostic codes (see Supplementary text Section ??). Ultimately, we compute a total of 667 features for each patient, which is then used to train a network of standard gradient boosting classifiers²⁷ aiming to map individual patients to a raw risk score. We randomly choose 75% of our patients for training with the rest held-out as a validation set. More details of the predictive pipeline are given in the Supplementray text, Section ??.

Raw Risk & Relative Risk

Our predictive pipeline produces a continuous estimate of the raw risk score of an IPF diagnosis in future. Thus, our raw risk estimate is a continuous number, and we must choose a decision threshold to make crisp predictions, *i.e.*, if the raw risk is greater than this calibrated threshold then the individual patient is predicted to be in the positive category. In this study, we select this threshold by maximizing the F_1 -score, defined as the harmonic mean of sensitivity and specificity, to make a balanced trade-off between Type 1 and Type 2 errors. The *relative risk* is then defined as the ratio of the raw risk to the decision threshold, and a value > 1 indicates a predicted future IPF diagnosis.

Performance Measurement

We measure our performance using standard metrics including the Area Under the receiver-operating characteristic curve (AUC), sensitivity, specificity and the Positive Predictive Value (PPV). We also report accuracy (acc, See Table VI), which is the probability of a correct prediction (positive or control).

Feature Importance & Comorbidity Spectra

Beyond the demonstrated predictive performance (see Results), calculation of the ZCoR-IPF score offers insights into the comorbid associations of IPF that might actually have predictive value. Estimating the relative importance of the features used is crucial for sanity checks, as well as for insights into the underlying causal mechanisms. We compute the relative importance of the features by estimating the mean change in the raw risk via random perturbation of a particular feature: this is the “feature importance” shown in Fig. 2c for the different diagnostic categories. which illustrates that respiratory disorders are the most important diagnostic category modulating the ZCoR-IPF score.

Importantly, all of our features are based on data already available in the past medical records. We do not demand results from specific tests, or look for specific demographic, bio-molecular, physiological and other parameters; *we use what we get* in the diagnostic history of patients, which presents un-structured sequence of labels pertaining to the ICD and the prescription codes, and is typically prone to noise, coding errors and sparsity. Our ability to effectively work with uncurated data and achieve high out-of-sample predictive performance showcases the immediate clinical applicability with zero additional burden to patients and providers.

In addition to the patient-specific predictions, we compute the statistically significant log-odds ratio of specific ICD codes occurring in the true positive vs the true negative patient sets. We call these the comorbidity spectra (See Fig. 4). Removing the false positives and the false negatives from consideration in computing the comorbidity spectra allows us to uncover patterns — at the level of individual codes — that are most representative of the patient risk. Importantly, the comorbidity spectra are based on individual codes, as opposed to the feature importances shown in Fig. 2c, which consider aggregated impact of all features that are based on the broad disease categories. Every disorder listed in the co-morbid spectra obviously do not all appear in a single patient, but the idea here is that the codes with high log-odds ratio are significantly more likely in positive cohort. The comorbidity spectra, so named because of disease-category specific color coding, offers unique insight into the predictive co-morbidity burden of IPF.

RESULTS

In this study we demonstrate three key results: 1) high out-of-sample predictive performance for identifying a future IPF diagnosis via leveraging subtle comorbidity patterns recorded in the past medical history of individual patients. 2) the ability of our models to maintain high predictive performance for an eventual diagnosis further into future, upto 4 years. And 3) ability to perform effectively under common confounders, such as a preexisting diagnosis of COPD, asthma or heart disease, or the absence of any indication of dyspnea in the past.

Our main prediction results are presented in Fig. 2a-b, which illustrate the ROC and the precision-recall curves respectively (for screening one year before current diagnosis), shown separately for males and females. As noted in the legend of these panels, our out-of-sample predictive performance is $> 88\%$ AUC irrespective of the sex of the patient, with $> 55\%$ sensitivity at 95% specificity (55% for males and 60% for females). At 99% specificity, we obtain a positive predictive value (PPV) of 52% for females and 54% for males, with sensitivities at 42% and 38% respectively. At these values we obtain an accuracy (denoted as “acc”) of $\approx 94 - 98\%$ (See Table VI) which indicates the overall fraction of correct predictions. The PPV achieved by ZCoR-IPF at maximum accuracy is 70% for females and 71% for males, with a corresponding Negative Predictive Value (NPV) of 98%.

Thus, to summarize: our predictive pipeline detects about 55-60 out of every 100 patients who will be diagnosed with IPF in 1 year, if we operate at 95% specificity. If we wish to operate at the higher specificity of 99%, then out of 100 positive flags we have about 50-52 true positives. The accuracy metric indicates that we are correctly identify the risk status (positive or control) for approximately 94-98 out of 100 patients, irrespective of sex, highlighting the potentially high clinical significance of the ZCoR-IPF score.

From the inferred relative importance of the features (See Fig. 2d-e), we conclude, as expected, that respiratory disorders in the past are the most important modulators of risk, followed by known or suspected IPF comorbidities, metabolic diseases, cardiovascular abnormalities and diseases of the eye. Infections also feature in the top 20 co-morbidities shown in these panels. Importantly while there are sex differences, the overall pattern of the relative importance ranking remains substantially invariant between males and females. With some exceptions, many of these patterns are not particularly surprising; the contribution of this study is to bring them together systematically to realize an accurate risk estimate via the ZCoR-IPF score.

A key metric to evaluate the potential impact of the ZCoR-IPF score is to estimate the expected change in the survival functions via a Kaplan-Meier (KM) analysis²⁸, and the corresponding change in the mean survival time. The standard KM analysis is specifically designed to handle scenarios with incomplete observations, *e.g.* not knowing the exact time of death for all patients, but merely a lower bound on their survival times. This is particularly useful in our case, since we found that insurance claims often do not record deaths, with expired patients simply dropping off the database. This creates uncertainty on if the patient had actually expired, or if he or she simply dropped insurance, or got dropped from the database for some other reason. Nevertheless, the time over which they are observed in the database is clearly a lower bound on their survival. With this mind, we construct the survival plots shown in Fig. 3a-b, which represents lower bounds on the survival function (panel a) and upper bounds on the hazard rate (panel b), shown along with 95% confidence bounds. Note that since we can operate our predictors at different specificity-sensitivity trade-offs, we get different curves if we vary the specificity. The survival functions are notably similar across the two sexes. Panel c shows the variation of lower bound on the mean survival times, compared with the baseline currently observed in the database; even at 95% specificity we boost the lower bound on mean survival time from around 100 weeks to approach 180-200 weeks. It is crucial to note that these survival analyses do not take into account the possibility of actually prolonging life via clinical interventions when we push back the time of the diagnosis; thus in actuality we expect the survival times to be markedly better to what is shown in Fig. 3a-c.

Our predictive performance expectedly degrades as we predict earlier, and this is illustrated in Fig. 3e. Importantly however, the degradation is slow enough that we can use ZCoR-IPF with acceptable reliability to predict diagnoses four years into the future. To illustrate how the ZCoR-IPF risk varies over patient age, we estimate the distribution of the scores over the positive and the control cohorts in Fig. 3d. Note that for patients for whom we eventually diagnosed, the risk almost linearly increases with age.

While these results demonstrate the importance of the diverse features used in our approach, understanding the seat of this predictive power is important. The feature importances discussed earlier (Fig. 2d-e) identify the relative impact of broad disease categories. Importantly, to evaluate the feature importance of a specific diagnostic category, we sum the importance of all features based on that category, not just the presence or absence of individual diagnoses. The latter aspect is investigated via the co-morbidity spectra for out-of-sample patients, shown in Figs. 4 separately for males and females. We find that the important co-morbidities are diverse, vary with the sex of the patients, but is clearly dominated by respiratory disorders, followed by diseases of the cardiovascular and circulatory systems. Again, while many of these patterns are expected at the population level, design of the personalized ZCoR-IPF score is not immediately obvious.

Since IPF co-morbidities have been investigated in the literature, a relevant question here is if our performance is dramatically better in sub-cohorts defined by the presence of these high risk diagnoses in the past (defined in Table V). The results are tabulated in Table VI, showing that our performance in the high risk sub-cohort is more or less comparable with full cohort performance. The AUCs achieved for the low risk cohort is somewhat lower ($> 85\%$ for males and females), but still acceptably high. Thus, even within the low risk patients, we still

detect 48 out of every 100 patients who are going to have a diagnosis in 1 year.

DISCUSSION

The present study describes the development and performance of ZCoR-IPF in a large US commercial claims database. Our key finding is that in both men and women ages 48-90 years ($n=1345$, $n=1191$, respectively), ZCoR-IPF accurately identifies IPF cases 1-4 years sooner than occurred in a variety of everyday community or academic practice settings during 2003-2018: at 208 weeks (4 years) before IPF diagnosis, ZCoR-IPF would have predicted that classification with an AUC approaching 84%, at 156 weeks (3 years) before diagnosis, with an AUC of $\approx 86\%$, at 104 weeks (2 years) with $\approx 87\%$, and at 52 weeks (1 year) before diagnosis, with an AUC approaching 88%, regardless of the patient's sex (Fig. 3e). Importantly, ZCoR-IPF achieves such results non-invasively, inexpensively, and almost instantaneously, since it relies only on diagnostic data already in the patient's electronic medical record, and runs on existing information technology infrastructure. Also of note, ZCoR-IPF expands the data available to both primary care practitioners and expert IPF diagnosticians. The score reflects a sophisticated, highly-detailed automated analysis of comorbidities, considering more than 600 features related to the incidence, timing of individual diagnostic codes. ZCoR-IPF thus supplements information currently used to evaluate and diagnose IPF, which focuses mainly on respiratory signs and symptoms, pulmonary function, and the radiographic and histologic appearance of the lung^{1,2,29}. Adding comorbidity as a new dimension of assessment, albeit in much simpler fashion³⁰, is an approach that has proved fruitful in COPD management³¹.

ZCoR-IPF may be expected to contribute in two main ways to increase timeliness and ease of IPF identification. First, ZCoR-IPF might serve as a screening tool to aid primary care physicians, radiologists, or pulmonologists to more selectively flag patients for referral for HRCT, referral to a pulmonologist, or both. Presently, the leading candidates for such flagging would be patients with one or more of chronic dyspnea, chronic cough, and/or chronic "Velcro crackles" on auscultation, restrictive ventilatory patterns on pulmonary function tests, or incidental ILA or ILD on chest or abdominal CT^{5,7,10,14,17,18,20,32}. As these are relatively large groups, ZCoR-IPF might be applied to help distinguish individuals who require immediate referral versus those who require increased surveillance, versus those who require less frequent follow-up. ZCoR-IPF might be an especially useful tool in patients with ILA, since while these findings might reflect an early stage of the disease, only some 0.5%–2% of this group will ever develop IPF^{10,33}. Indeed, given the severity and actionability of the IPF diagnosis, the frequency of smoking history among patients with IPF¹, and the non-invasive nature, applicability, speed, and low cost of ZCoR-IPF, this tool might be applied in primary care to screen smokers or former smokers for increased surveillance or evaluation for IPF. The feasibility, diagnostic yield, cost-effectiveness, and ultimately, effect on patient outcomes of using ZCoR-IPF in these screening settings merit prospective evaluation.

Second, ZCoR-IPF might serve as a diagnostic aid for pulmonologists, radiologists, pathologists, or multidisciplinary teams in cases showing abnormalities suggestive of, or associated with IPF, but not UIP on HRCT or histopathology. These cases are relatively frequent: roughly half of patients histopathologically diagnosed with IPF lack classic CT findings associated with the disease¹⁰. Hence ZCoR-IPF might help patients without UIP on HRCT to avoid more invasive tests, especially surgical lung biopsy^{2,34}, and/or may increase clinicians' diagnostic confidence. The effect of ZCoR-IPF use as a diagnostic aid on healthcare resource utilization and on diagnostic confidence in IPF classification also warrants prospective assessment.

ZCoR-IPF also might speed recruitment and decrease costs of clinical trials of new therapies for IPF and other progressive fibrosing ILD. The tool might do so by allowing more confident inclusion in study samples of patients with provisional IPF diagnoses.

Improving IPF screening and diagnosis may offer considerable opportunity to substantially enhance patient outcomes and quality-of-life, as well as efficiency of healthcare resource utilization. First and foremost, earlier, more efficient and confident diagnosis should enable timelier access to anti-fibrotic treatment, which slows but does not reverse disease. Evidence of similar effect sizes across a spectrum of IPF severity suggests that starting anti-fibrotics earlier in the course of disease may better preserve lung function³⁵. Notably, in patients with IPF, each year's delay following an initial CT scan in referral to a specialized ILD center has been shown to be associated with a 2.94% (95% CI: 0.86–5.03%) increase in pulmonary fibrosis extent on chest CT¹⁴.

Conversely, more prompt and firm IPF diagnosis should spare patients unneeded or harmful treatments, *e.g.*, corticosteroids, as well as unneeded diagnostic tests and healthcare visits^{1,6,11–16,36}. Earlier identification also should allow more prompt referral for lung transplantation, the only current cure for the disease. Such referral is recommended immediately upon IPF diagnosis, since evaluation for eligibility and waits for graft availability may take months or years; starting this process when younger and less ill may allow patients to avoid disqualification for advanced age or frailty^{1,6}. In the meanwhile, quicker IPF diagnosis will accelerate patients' access to interven-

tions that may improve lung function and quality-of-life, namely supplemental oxygen, pulmonary rehabilitation, and palliative care^{6,7}, as well as to clinical trials.

Development and use of a risk score for IPF diagnosis that is based on comorbidities aligns well with the longstanding appreciation of multimorbidity as characteristic of patients with IPF²². Indeed, a chart review at a German tertiary referral center³⁷ (N=272) found 58% of patients with IPF to have 1–3 comorbidities, 30% to have 4–7 comorbidities, and only 12% to have no concomitant illness. The high prevalence of comorbidities in patients with IPF presumably stems from shared risk and pathogenetic factors among IPF and the other conditions, *e.g.*, male gender, cigarette smoking, or aging accelerated by genetic mutations resulting in telomere shortening³⁷. Additionally, some comorbid conditions may be hypothesized to be induced by IPF symptoms, *e.g.*, depression, some to contribute to IPF pathogenesis, *e.g.*, gastroesophageal reflux (GER)²⁷, while others may at least in some instances represent common mis-diagnoses in patients with IPF, *e.g.*, COPD, asthma, or pneumonia^{6,15,16}.

Strengths and limitations of our work here should be noted. Foremost among the former is our use of detailed “real-world” data from large databases (n=2536 cases, n=450,461 controls) collected over more than a decade throughout the United States or at an academic tertiary referral center in a major US metropolitan area. The huge overall sample size gives ZCoR-IPF robust statistical power to capture subtle patterns of comorbidity that would be indiscernible even in traditional multicenter cohorts³³. As well, the size and scope of the databases increase likelihood that our findings are generalizable throughout the United States, and, indeed, elsewhere.

Conversely, use of administrative claims databases has certain disadvantages. Absent patient-level case validation, the most important of these is potential lack of accuracy in the ICD-9 and ICD-10 coding for IPF and related diagnoses^{38,39}. A relatively small (n=150 validated cases) patient-level case validation study of another, smaller administrative claims database (Kaiser Permanente) suggested that more than half of IPF codes might be incorrectly applied, including roughly a quarter of cases that appeared to lack even findings of ILD³⁹. Arguably, use of data including both patients with IPF and patients with other ILD might minimally affect clinical relevance of our score, given the emerging concept of “progressive chronic fibrosing ILD”. Under this concept, subgroups of patients with IPF (which progresses at heterogeneous rates from case-to-case) and subgroups of patients with other ILD, *e.g.*, idiopathic non-specific interstitial pneumonia, hypersensitivity pneumonitis, systemic sclerosis-associated ILD, or rheumatoid arthritis-associated ILD, may have similar phenotypes and disease behavior, and should perhaps be managed similarly, with early initiation of anti-fibrotic therapy^{3,40,41}. However, inclusion of patients without ILD among our IPF cases would of course be expected to decrease the accuracy and utility of ZCoR-IPF. It would be desirable to perform case validation studies in our databases, which might provide data enabling ZCoR-IPF to be fine-tuned.

Other disadvantages of our use of a commercial insurance administrative database may include excess proportions, relative to those seen in specialist clinical practice, of females, and of less severe cases of both sexes. In other claims database studies, these differences respectively have been attributed to a greater tendency of women than men to seek medical attention⁴², and to a tendency of older and sicker patients to migrate from commercial to government insurance plans⁴³. Interestingly, one may speculate that miscoding of soft tissue or rheumatologic diseases with an ILD component as IPF may be more prevalent among females, as are those disorders themselves.³⁶ Additionally, commercial claims databases contain at best highly limited information on signs and symptoms of disease that are insufficiently severe or impactful to be considered a discrete diagnosis, *e.g.*, dyspnea, cough, or rales. These databases also provide a paucity of data regarding the results of biochemical or imaging investigations. Nor do claims data capture often important lifestyle variables such as smoking, alcohol consumption, exercise, or diet⁴³.

Conclusion

We developed and validated ZCoR-IPF, a risk score for IPF capable of identifying with high accuracy this diagnosis 1-4 years before it occurred in everyday practice conditions in community and academic settings across the United States. This score provides clinicians with detailed data on comorbidity patterns to distinguish patients with IPF from those without the disease, a strategy of particular interest given the well-acknowledged predominance of multimorbidity in patients with IPF. Thus ZCoR-IPF supplements the functional and morphological data regarding the lung that have been the mainstay in evaluating potential IPF cases. ZCoR-IPF has the advantages of considering only diagnostic data already in the patient’s electronic medical record, of running on current information technology infrastructure, and of operating inexpensively and almost instantaneously at the point of care. Hence ZCoR-IPF holds promise as a screening tool for primary care practitioners, pulmonologists, and radiologists to use in patients with early signs and/or symptoms of IPF or those at elevated risk for that disease. As well, ZCoR-IPF may offer utility as a diagnostic aid to pulmonologists, radiologists, pathologists,

and multidisciplinary teams in cases with radiological and/or histopathological suggestions, but not the classical radiological and/or histopathological picture of IPF. The effect of ZCoR-IPF on speed, accuracy, and confidence of IPF diagnosis, on health care resource utilization, and ultimately, on patient outcomes, should be assessed prospectively.

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ICD Class

a. Male Pulmonary Fib.

b. Female Pulmonary Fib.

Fig. 4: Co-morbidity Spectrum (males). Disorders that increase the odds of the patient being a “true positive” vs a “true negative”. Such disorders (ranked according to the log-odds ratio) are more likely to be found in patients who are in the positive cohort. Comparing **panel a** with **panel b**, we note that these odds change from males to females, but as expected the patterns are broadly similar, with over-representation of respiratory disorders.

TABLE VII: Feature Definitions (Total number of features used: 667)

feature name	explanation	n_{features}
feature-phenotype scores relative to phenotype score	Mean p-score of feature-phenotype codes within sequence divided by general p-score of feature-phenotype	51
feature-phenotype scores relative to whole score	Mean p-score of feature-phenotype codes within sequence divided by mean p-score of all codes in the record	51
aggregation score	aggregation of the p-scores in the record	9
high scores proportion	proportion of codes with very high p-scores among all codes in the record	1
low scores proportion	proportion of codes with very low p-scores among all codes in the record	1
dynamics of mean score	mean p-score of second half of the record divided by mean p-score of first half of the record	1
dynamics of st.dev score	standard deviation of p-scores of second half of the record divided by standard deviation of p-scores of first half of the record	1
dynamics of score range	range of p-scores of second half of the record divided by range of p-scores of first half of the record	1
dynamics of score skew	skew of p-scores of second half of the record divided by skew of p-scores of first half of the record	1
aggregation relative to phn score	aggregation of all feature-phenotype 's mean scores divided by corresponding general p-score of feature-phenotype	6
aggregation relative to whole score	aggregation of all feature-phenotype 's mean scores divided by mean p-score of all codes in the record	6
feature-phenotype proportion	Ratio of number of weeks with the codes of a given phenotype to the total number of weeks in sequence	51
feature-phenotype prevalence	Ratio of number of weeks with the codes of a given phenotype to the number of weeks with any diagnosis code recorded	51
feature-phenotype first incident	Time interval from observation date to the first phenotype code, normalized by record length	51
feature-phenotype last incident	Time interval from observation date to the last phenotype code, normalized by record length	51
feature-phenotype mean position	Mean time position of phenotype codes in the record, normalized by record length	51
feature-phenotype streak	Length of the longest uninterrupted subsequence of weeks with the codes of a given phenotype recorded	51
Max/Mean/Std/Range intermission	Maximum/Mean/Standard Deviation/Range of the lengths of subsequences of consequent weeks with codes	4
Max/Mean/Std cluster	Maximum/Mean/Standard Deviation of the lengths of subsequences of consequent weeks without codes	3
Max/Std/Range prevalence	Maximum/Standard Deviation/Range of the phenotype prevalences	3
Density of DX Record	Proportion of weeks in a record observed where at least one DX code was recorded	1
feature-phenotype	Sequence Likelihood Defect for a given phenotype	51
feature-phenotype neg llk [†]	Negative LogLikelihood score for a given phenotype	51
feature-phenotype pos llk [#]	Positive LogLikelihood score for a given phenotype	51
feature-phenotype llk ratio	Ratio of Positive to Negative LogLikelihood score for a given phenotype	51
Max Δ	Mean Sequence Likelihood Defect	1
Std Δ	Standard Deviation of Sequence Likelihood Defects	1
Range Δ	Range of Sequence Likelihood Defects	1
Mean neg llk	Mean Negative LogLikelihood score	1
Range neg llk	Range of Negative LogLikelihood score	1
Std. deviation neg llk	Standard Deviation of Negative LogLikelihood score	1
Mean pos llk	Mean Positive LogLikelihood score	1
Range pos llk	Range of Positive LogLikelihood score	1
Std. deviation pos llk	Standard Deviation of Positive LogLikelihood score	1
Mean llk ratio	Mean LogLikelihood score ratio	1
Range llk ratio	Range of LogLikelihood score ratio	1
Std. deviation llk ratio	Standard Deviation of LogLikelihood score ratio	1
predicted risk from pfsa model	predicted risk from pfsa model	1
predicted risk from seq model	predicted risk from seq model	1
predicted risk from pscore model	predicted risk from pscore model	1
predicted risk from rare model	predicted risk from rare model	1
age at screening	Patient age at the moment of the screening	1

*feature: Corresponds to the ICD disease categories, or sets of diagnostic codes tracked, or medications tracked either as individual active ingredients or as sets e.g. antidepressants

[†] Δ : Sequence Likelihood Defect (See SI text Sec V)

[‡] neg loglikelihood: loglikelihood of observed sequence being generated by the model inferred from control (See Methods)

[#] pos loglikelihood: loglikelihood of observed sequence being generated by the model inferred from positive (See Methods)

Supplementary Text: Screening for Idiopathic Pulmonary Fibrosis with Comorbid Pattern Recognition in Electronic Health Records

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I. DETAILED MATHEMATICAL APPROACH

II. Time-series Modeling of Diagnostic History

Individual diagnostic histories can have long-term memory¹, implying that the order, frequency, and comorbid interactions between diseases are important for assessing the future risk of our target phenotype. We analyze patient-specific diagnostic code sequences by first representing the medical history of each patient as a set of stochastic categorical time-series — one each for a specific group of related disorders — followed by the inference of stochastic models for these individual data streams. These inferred generators are from a special class of Hidden Markov Models (HMMs), referred to as Probabilistic Finite State Automata (PFSA)². The inference algorithm we use is distinct from classical HMM learning, and has important advantages related to its ability to infer structure, and its sample complexity (See Supplementary text, Section XI). We infer a separate class of models for the positive and control cohorts, and then the problem reduces to determining the probability that the short diagnostic history from a new patient arises from the positive as opposed to the control category of the inferred models.

III. Inference & Event Periods

We train our predictive pipeline with all diagnostic codes that are recorded in the past 2years from the point at which a prediction is made. This period from which we use data to train our pipeline is called the “inference window”. Our aim is to make predictions on the occurrence of the target diagnostic codes at 1year from the end of the inference window. For patients in the control cohort, we make sure that no target code appears for 2years after the end of the inference window. Additionally, when making predictions further into the future (upto 4 years, as described in the main text), we always make sure that the control group has no target codes for 1 year after the predicted time of diagnosis, *i.e.*, if we are making a prediction of a diagnosis 4 years in future, then control group patients are chosen to have no diagnosis in at least next 5 years.

IV. Step 1: Partitioning The Human Disease Spectrum

We begin by partitioning the human disease spectrum into 51non-overlapping categories. Each category is defined by a set of diagnostic codes from the International Classification of Diseases, Ninth Revision (ICD9) (See Table SI-I for description of the categories used in this study). For this study, we ended up using 17008378 and 25074255 diagnostic codes for males and females respectively (22685 and 23722 unique codes) spanning both ICD9 and ICD10 protocols (using ICD10 General Equivalence Mappings (GEMS)³ equivalents where necessary), from a total 2,059,559 patients. Transforming the diagnostic histories to report only the broad categories reduces the number of distinct codes that the pipeline needs to handle, thus improving statistical power.

Our categories largely align with the top-level ICD9 categories, with small adjustments, *e.g.* bringing all infections under one category irrespective of the pathogen or the target organ. We do not pre-select the phenotypes; we want our algorithm to seek out the important patterns without any manual curation of the input data.

For each patient, the past medical history is a sequence $(t_1, x_1), \dots, (t_m, x_m)$, where t_i are timestamps and x_i are ICD9 codes diagnosed at time t_i . We map individual patient history to a three-alphabet categorical time series z^k corresponding to the disease category k , as follows. For each week i , we have:

$$z_i^k = \begin{cases} 0 & \text{if no diagnosis codes in week } i \\ 1 & \text{if there exists a diagnosis of category } k \text{ in week } i \\ 2 & \text{otherwise} \end{cases} \quad (1)$$

The time-series z^k is observed in the inference period. Thus, each patient is represented by 43 mapped trinary series.

V. Step 2: Model Inference & The Sequence Likelihood Defect Δ

The mapped series, disease-category, and IPF diagnosis-status are considered to be independent sample paths, and we want to explicitly model these systems as specialized HMMs (PFSAs). We model the positive and the control cohorts and each disease category separately, ending up with a total of 86 HMMs at the population level (43 categories, 2 IPF status categories: positive and control). Each of these inferred models is a PFSA; a directed graph with probability-weighted edges, and acts as an optimal generator of the stochastic process driving the sequential appearance of the three letters (as defined by Eq. (1)) corresponding to disease category, and IPF status-type (See Section XI in the Supplementary text for background on PFSA inference).

To reliably infer the IPF status-type of a new patient, *i.e.*, the likelihood of a diagnostic sequence being generated by the corresponding IPF status-type model, we generalize the notion of Kullback-Leibler (KL) divergence^{4,5}

between probability distributions to a divergence $\mathcal{D}_{\text{KL}}(G||H)$ between ergodic stationary categorical stochastic processes⁶ G, H as:

$$\mathcal{D}_{\text{KL}}(G||H) = \lim_{n \rightarrow \infty} \frac{1}{n} \sum_{x:|x|=n} p_G(x) \log \frac{p_G(x)}{p_H(x)} \quad (2)$$

where $|x|$ is the sequence length, and $p_G(x), p_H(x)$ are the probabilities of sequence x being generated by the processes G, H respectively. Defining the log-likelihood of x being generated by a process G as :

$$L(x, G) = -\frac{1}{|x|} \log p_G(x) \quad (3)$$

The cohort-type for an observed sequence x — which is actually generated by the hidden process G — can be formally inferred from observations based on the following provable relationships (See Supplementary Text Section XI, Theorem 6 and 7):

$$\lim_{|x| \rightarrow \infty} L(x, G) = \mathcal{H}(G) \quad (4a)$$

$$\lim_{|x| \rightarrow \infty} L(x, H) = \mathcal{H}(G) + \mathcal{D}_{\text{KL}}(G||H) \quad (4b)$$

where $\mathcal{H}(\cdot)$ is the entropy rate of a process⁴. Importantly, Eq. (4) shows that the computed likelihood has an additional non-negative contribution from the divergence term when we choose the incorrect generative process. Thus, if a patient is eventually going to be diagnosed with IPF, then we expect that the disease-specific mapped series corresponding to her diagnostic history be modeled by the PFSA in the positive cohort. Denoting the PFSA corresponding to disease category j for positive and control cohorts as G_+^j, G_0^j respectively, we can compute the *sequence likelihood defect* (SLD, Δ^j) as:

$$\Delta^j \triangleq L(G_0^j, x) - L(G_+^j, x) \rightarrow \mathcal{D}_{\text{KL}}(G_0^j||G_+^j) \quad (5)$$

With the inferred PFSA models and the individual diagnostic history, we estimate the SLD measure on the right-hand side of Eqn. (5). The higher this likelihood defect, the higher the similarity of diagnosis history to that of women with IPF.

VI. Step 3: Risk Estimation Pipeline With Semi-supervised & Supervised Learning Modules

The risk estimation pipeline operates on patient specific information limited to the available diagnostic history in the inference period, and produces an estimate of the relative risk of IPF, with an associated confidence value. To learn the parameters and associated model structures of this pipeline, we transform the patient specific data to a set of engineered features, and the feature vectors realized on the positive and control sets are used to train a gradient-boosting classifier⁷. The complete list of 667 features used is provided in Tab. VII in the main text.

We need two training sets: one to infer the models, and one to train the classifier with features derived from the inferred models. Thus, we do a random 3-way split of the set of unique patients into *feature-engineering* (25%), *training* (25%) and *test* (50%) sets. We use the feature-engineering set of ids first to infer our PFSA models (*unsupervised model inference in each category*), which then allows us to train the gradient-boosting classifier using the training set and PFSA models (*classical supervised learning*), and we finally execute out-of-sample validation on the test set. Fig. 2c in the main text shows the top 20 features ranked in order of their relative importance (relative loss in performance when dropped out of the analysis).

VII. THRESHOLD SELECTION ON ROC CURVE

Once the ROC curve has been computed, we must choose a decision threshold to trade-off true positive rate and false positive rate. In situations where the number of negatives vastly outnumber the number of positives (which is the case in our problem), it is better to base this trade-off on a measure that is independent of the number of true negatives. The two popular measures considered in the literature are accuracy and the F1-score:

$$\text{accuracy} = \frac{t_p + t_n}{t_p + f_p + f_n + t_n} \quad (6)$$

$$\text{F1} = \frac{2t_p}{2t_p + f_p + f_n} \quad (7)$$

The F1-score is the same as accuracy where the number of true negatives is the same as the number of true positives, thus partially correcting for the class imbalance.

The selection of the threshold may also be dictated by the current practice of ensuring high specificities in screening tests. Thus, the most relevant clinically operating point is either the one corresponding to 95%

specificity, which is highlighted in Fig. 2a in the main text, or even higher specificities due to the low prevalence of IPF (See Table VI in the main text).

VIII. NOTE ON RECIEVER OPERATING CHARACTERISTICS (ROC) AND PRECISION-RECALL CURVES

The ROC curve is a plot between the False Positive rate (FPR) and the True Positive Rate (TPR), and the area under the ROC curve (AUC) is often used as a measure of classifier performance. For the same of completeness, we introduce the relevant definitions:

In the following P denotes the total number of positive samples (number of patients who are eventually diagnosed), and N denotes the total number of negative samples (number of patients in the control group).

Definition 1. True positive rate, true negative rate, false positive rate, positive predictive value (**PPV**), and prevalence (ρ) are defined as:

$$TPR = \frac{t_p}{P} = \frac{t_p}{t_p + f_n} \quad (8)$$

$$TNR = \frac{t_n}{N} = \frac{t_n}{t_n + f_p} \quad (9)$$

$$FPR = 1 - TNR \quad (10)$$

$$PPV = \frac{t_p}{t_p + f_p} \quad (11)$$

$$\rho = \frac{P}{N + P} \quad (12)$$

where as before t_p, t_n, f_p, f_n are true positives, true negatives, false positives, and false negatives respectively.

Note that TPR is also referred to as **recall** or **sensitivity**, and PPV is also referred to as **precision**. True negative rate is also known as **specificity**.

A **precision-recall curve**, or a PPV-sensitivity curve is a plot between PPV and TPR.

Denoting sensitivity by s , and specificity by c , it follows that:

$$PPV = \frac{t_p/P}{t_p/P + (f_p/N)(N/P)} = \frac{TPR}{TPR + ((N - t_n)/N)(N/P)} \quad (13)$$

$$\Rightarrow PPV = \frac{s}{s + (1 - c)(\frac{1}{\rho} - 1)} \quad (14)$$

Thus, we note that for a fixed specificity and sensitivity, the PPV depends on prevalence. Indeed, it is clear from the above argument that PPV decreases with decreasing prevalence, and vice versa.

IX. EFFECT OF CLASS IMBALANCE

ROC curves are generally assumed to be robust to class imbalance. Note that if we assume that patient outcomes are independent (which is well-justified in the case of a non-communicable condition, particularly in large databases), then t_p should scale linearly with the total number of positives P , implying:

$$TPR = \frac{t_p}{P} = \frac{t'_p}{P'} \quad (15)$$

implying that with different sizes of the set of positive samples (or negative samples), the ROC curve remains unchanged. In particular, note that even if the prevalence is very small (say 0.01%), we cannot cheat to boost the AUC by labeling all predictions as negative, or stating that risk is always zero: in that case, our P is very small, but our $t_p = 0$ strictly, implying that our $TPR = 0$, thus leading to a zero AUC. We can cheat to boost the accuracy (See the previous section), but not the AUC.

Note that while relative class sizes or imbalance does not affect the ROC (under the assumption that true positives and true negatives scale with the number of positives and negatives), very small absolute sample sizes might still result in poor performance of the model.

The precision-recall curves do get affected by class imbalance, or the prevalence, as shown by Eq (14). However, in diagnostic analysis, they are important since we are generally less interested in the number of true negatives; the ratio of false positives to the total number of positive recommendations by the algorithm is much more relevant, *i.e.*, the PPV or the precision.

X. GENERATING PFSA MODELS FROM SET OF INPUT STREAMS WITH VARIABLE INPUT LENGTHS

Our PFSA reconstruction algorithm² is distinct from standard HMM learning. We do not need to pre-specify structures, or the number of states in the algorithm, and all model parameters are inferred directly from data. Additionally, we can operate either with 1) a single input stream, or 2) a set of input streams of possibly varying lengths which are assumed to be different and independent sample paths from the unknown stochastic generator we are trying to infer. At an intuitive level, we use the input data to infer the length of histories one must remember to estimate the current state, and predict futures for the process being modeled. Thus, we do not step through the symbol streams with a pre-specified model structure, and avoid the need to have equal-length inputs. More details of the algorithm are provided in the next section.

The ability to model a set of input streams of varying lengths is particularly important, since medical histories of different patients are typically of different lengths.

XI. PROBABILISTIC FINITE STATE AUTOMATA INFERENCE

XII. Probabilistic Finite-State Automaton

Let Σ be a finite alphabet of symbols with size $|\Sigma|$. The set of sequences of length d over Σ is denoted by Σ^d . The set of finite but unbounded sequences over Σ is denoted by Σ^* , the Kleene star operation⁸, i.e. $\Sigma^* = \bigcup_{d=0}^{\infty} \Sigma^d$. We use lower case Greek, for example σ or τ , for symbols in Σ , and lower case Latin, for example x or y , for sequences of symbols, i.e. $x = \sigma_1\sigma_2 \dots \sigma_n$. We use $|x|$ to denote the length of x . The empty sequence is denoted by λ .

We denote the set of strictly infinite sequences over Σ by Σ^ω , and the set of strictly infinite sequences having x as prefix by $x\Sigma^\omega$. Let $\mathcal{S} = \{x\Sigma^\omega : x \in \Sigma^*\} \cup \{\emptyset\}$, we can verify that $\mathcal{S}$ is a semiring⁹ over Σ^ω . We use $\mathcal{F}$ to denote the sigma algebra generated by $\mathcal{S}$.

Definition 2 (Stochastic Process over Σ). *A stochastic process over a finite alphabet Σ is a collection of Σ -valued random variables $\{X_t\}_{t \in \mathbb{N}}$ indexed by positive integers¹⁰.*

We are specifically interested in processes in which the X_t s are not necessarily independently distributed.

Definition 3 (Sequence-Induced Measure and Derivative). *For a process $\mathcal{P}$, let $Pr_{\mathcal{P}}(x)$ or simply $Pr(x)$ denote the probability $\mathcal{P}$ producing a sample path prefixed by x . The **measure** μ_x **induced by a sequence** $x \in \Sigma^*$ is the extension⁹ to $\mathcal{F}$ of the premeasure defined on the semiring $\mathcal{S}$ given by*

$$\forall x, y \in \Sigma^*, \mu_x(y\Sigma^\omega) \triangleq \frac{Pr(xy)}{Pr(x)}, \text{ if } Pr(x) > 0 \quad (16)$$

*For any $d \in \mathbb{N}$, the **d -th order derivative** of a sequence x , written as ϕ_x^d , is defined to be the marginal distribution of μ_x on Σ^d , with the entry indexed by y denoted by $\phi_x^d(y)$. The first-order derivative is called the **symbolic derivative** and is denoted by ϕ_x for short.*

Definition 4 (Probabilistic Nerode Equivalence and Causal States¹¹). *For any pair of sequences $x, y \in \Sigma^*$, x is equivalent to y , written as $x \sim y$, if and only if either $Pr(x) = Pr(y) = 0$, or $\mu_x = \mu_y$. The equivalence class of a sequence x is denoted by $[x]$ and is called a **causal state**¹². The cardinality of the set of causal states is called the **probabilistic Nerode index**, or the Nerode index for simplicity.*

We can see from the definition that causal states captures how the history of a process influences its future. Since the probabilistic Nerode equivalence is right invariant, it gives rise naturally to an automaton structure introduced below.

Definition 5 (Probabilistic Finite-State Automaton (PFSA)). *A PFSA G is defined by a quadruple $(Q, \Sigma, \delta, \tilde{\pi})$, where Q is a finite set, Σ is a finite alphabet, $\delta : Q \times \Sigma \rightarrow \Sigma$ is called the transition map, and $\tilde{\pi} : Q \rightarrow \mathbf{P}_\Sigma$, where $\mathbf{P}_\Sigma$ is the space of probability distributions over Σ , is called the transition probability. The entry of $\tilde{\pi}(q)$ indexed by σ is denoted by $\tilde{\pi}(q, \sigma)$.*

Definition 6 (Transition and Observation Matrices). *The transition matrix Π is the $|Q| \times |Q|$ matrix with the entry indexed by q, q' , written as $\pi_{q, q'}$, satisfying*

$$\pi_{q, q'} \triangleq \sum_{\{\sigma \in \Sigma \mid \delta(q, \sigma) = q'\}} \tilde{\pi}(q, \sigma) \quad (17)$$

and the observation matrix $\tilde{\Pi}$ is a $|Q| \times |\Sigma|$ matrix with the entry indexed by q, σ equaling $\tilde{\pi}(q, \sigma)$.

We note that both Π and $\tilde{\Pi}$ are stochastic, i.e. non-negative with rows summing up to 1.

Definition 7 (Extension of δ and $\tilde{\pi}$ to Σ^*). For any $x = \sigma_1 \dots \sigma_k$, $\delta(q, x)$ is defined recursively by

$$\delta(q, x) \triangleq \delta(\delta(q, \sigma_1 \dots \sigma_{k-1}), \sigma_k) \quad (18)$$

with $\delta(q, \lambda) = q$, and $\tilde{\pi}(q, x)$ is defined recursively by

$$\tilde{\pi}(q, x) \triangleq \prod_{i=1}^k \tilde{\pi}(\delta(q, \sigma_1 \dots \sigma_{i-1}), \sigma_i) \quad (19)$$

with $\tilde{\pi}(q, \lambda) = 1$.

Definition 8 (Strongly Connected PFSA). We say a PFSA is strongly connected if the underlying directed graph is strongly connected¹³. More precisely, a PFSA $G = (Q, \Sigma, \delta, \tilde{\pi})$ is strongly connected if for any pair of distinct states q and $q' \in Q$, there is an $x \in \Sigma^*$ such that $\delta(q, x) = q'$.

We assume all PFSA in the discussions in the sequel are strongly connected if not specified otherwise. For strongly connected PFSA G , there is a unique probability distribution over Q that satisfies $\mathbf{v}^T \Pi = \mathbf{v}^T$. This is the **stationary distribution**^{14,15} of G and is denoted as ρ_G , or ρ if G is understood.

Definition 9 (Γ -Expression). We can encode the information contained in δ and $\tilde{\pi}$ by a set of $|Q| \times |Q|$ matrices $\Gamma = \{\Gamma_\sigma | \sigma \in \Sigma\}$, where

$$\Gamma_\sigma|_{q, q'} \triangleq \begin{cases} \tilde{\pi}(q, \sigma) & \text{if } \delta(q, \sigma) = q', \\ 0 & \text{if otherwise.} \end{cases} \quad (20)$$

Γ_σ is called **event-specific transition matrix**, with the event being that σ is current the output. Γ_σ can also be extended to arbitrary $x \in \Sigma^*$ by defining $\Gamma_x = \prod_{i=1}^k \Gamma_{\sigma_i}$ with $\Gamma_\lambda = I$.

Definition 10 (Sequence-Induced Distribution on States). For a PFSA $G = (Q, \Sigma, \delta, \tilde{\pi})$ and a distribution ρ_0 on Q , the **distribution on Q induced by a sequence x** is given by $\rho_{G, \rho_0}^T(x) = \left[\rho_0^T \Gamma_x \right]$ with $\rho_{G, \rho_0}(\lambda) = \rho_0$. The entry indexed by $q \in Q$ of the vector $\rho_{G, \rho_0}(x)$ is written as $\rho_{G, \rho_0}(x, q)$. When $\rho_0 = \rho_G$, the stationary distribution of G , we write $\rho_{G, \rho_0}(x)$ as $\rho_G(x)$, or simply as $\rho(x)$, if G is understood.

Definition 11 (Stochastic Process Generated by a PFSA). Let $G = (Q, \Sigma, \delta, \tilde{\pi})$ be a PFSA and let ρ_0 be a distribution on Q , the Σ -valued stochastic process $\{X_t\}_{t \in \mathbb{N}}$ generated by G and ρ_0 satisfies that X_1 follows the distribution ρ_0 and X_{t+1} follows the distribution $\rho_{G, \rho_0}(X_1 \dots X_t)$ for $t \in \mathbb{N}$.

For the rest of this paper, we will assume $\rho_0 = \rho_G$ if not specified otherwise. We can show that, when initialized with ρ_G , the process generated by a PFSA G is stationary and ergodic. We also note the, for the process generate by G , we have $\phi_x = \rho_G(x)^T \tilde{\Pi}$. Since $\rho_G(\lambda) = \rho_G$, the symbolic derivative of the empty sequence ϕ_λ is the stationary distribution on the symbols.

Definition 12 (Synchronizable PFSA and Synchronizing Sequence). A **synchronizing sequence** is a finite sequence that sends an arbitrary state of the PFSA to a fixed state¹⁶. To be more precise, let $G = (Q, \Sigma, \delta, \tilde{\pi})$ be a PFSA, we say a sequence $x \in \Sigma^*$ is a synchronizing sequence to a state $q \in Q$ if $\delta(q', x) = q$ for all $q' \in Q$. A PFSA is **synchronizable** if it has at least one synchronizing sequence. Given a sample path generated by a PFSA, we say the PFSA is **synchronized** if a synchronizing sequence transpires in the sample path.

Definition 13 (Equivalence and Irreducibility). Two PFSA G and H are **equivalent** if they generate the same stochastic process. A PFSA G is said to be **irreducible**, if there is not another PFSA with smaller state set that is equivalent to G .

Definition 14. Consider a PFSA G over state set Q . For a give $\varepsilon > 0$, we say a sequence x is a ε -synchronizing sequence to a state $q \in Q$ if

$$\|\rho_G(x) - \mathbf{e}_q\|_\infty \leq \varepsilon. \quad (21)$$

While there exists PFSA that is not synchronizable, we can show that an irreducible PFSA always has an ε -synchronizing sequence for some state q for arbitrarily small $\varepsilon > 0$. Moreover, we can show that as length increases, sequences produced by PFSA become uniformly ε -synchronizing. These two are the underpinning properties for the inference algorithm of PFSA (See Alg. 1), because they imply that ϕ_x can be used to approximate $\tilde{\pi}(q)$ if x are properly prefixed and long enough.

Definition 15 (Joint ε -Synchronizing Sequence). Let G and H be two PFSA over state sets Q_G and Q_H , respectively. For a fixed ε , a sequence x is said to be **jointly ε -synchronizing** to $(q, r) \in Q_G \times Q_H$ if x is

ε -synchronizing to q and to r simultaneously. We define

$$\Sigma_{\varepsilon,(q,r)}^d \triangleq \{x \in \Sigma^d : x \text{ jointly } \varepsilon\text{-synchronizing to } (q, r)\} \quad (22)$$

Definition 16 (Joint Pair of States). Let G and H be two PFSA over state sets Q_G and Q_H , respectively. Define

$$p_G(q, r) \triangleq \lim_{d \rightarrow \infty} p_G \left(\Sigma_{\varepsilon,(q,r)}^d \right) \quad (23)$$

A pair of states $(q, r) \in Q_G \times Q_H$ is called a **G -joint pair** of states if $p_G(q, r) > 0$. We also define

$$Q_G \triangleq \{(q, r) \in Q_G \times Q_H : (q, r) \text{ is a } G\text{-joint pair}\} \quad (24)$$

The inference algorithm for PFSA is called **GenESeSS** for Generator Extraction Using Self-similar Semantics. With an input sequence x and a hyperparameter ε , **GenESeSS** outputs a PFSA in the following three steps: 1) approximate an almost synchronizing sequence; 2) identify the transition structure of the PFSA; 3) calculate the transition probabilities of the PFSA. See Alg. 1² for details.

Algorithm 1: GenESeSS

Data: A sequence x over alphabet Σ , $0 < \varepsilon < 1$
Result: State set Q , transition map δ , and transition probability $\tilde{\pi}$
 /* **Step One: Approximate ε -synchronizing sequence** */
 1 Let $L = \lceil \log_{|\Sigma|} 1/\varepsilon \rceil$;
 2 Calculate the **derivative heap** $\mathcal{D}_\varepsilon^x$ equaling $\{\hat{\phi}_y^x : y \text{ is a sub-sequence of } x \text{ with } |y| \leq L\}$;
 3 Let $\mathcal{C}$ be the convex hull of $\mathcal{D}_\varepsilon^x$;
 4 Select x_0 with $\hat{\phi}_{x_0}^x$ being a vertex of $\mathcal{C}$ and has the highest frequency in x ;
 /* **Step Two: Identify transition structure** */
 5 Initialize $Q = \{q_0\}$;
 6 Associate to q_0 the **sequence identifier** $x_{q_0}^{\text{id}} = x_0$ and the probability vector $d_{q_0} = \hat{\phi}_{x_0}^x$;
 7 Let $\tilde{Q}$ be the set of states that are just added and initialize it to be Q ;
 8 **while** $\tilde{Q} \neq \emptyset$ **do**
 9 Let $Q_{\text{new}} = \emptyset$ be the set of new states;
 10 **for** $(q, \sigma) \in \tilde{Q} \times \Sigma$ **do**
 11 Let $x = x_q^{\text{id}}$ and $d = \hat{\phi}_{x\sigma}^x$;
 12 **if** $\|d - d_{q'}\|_\infty < \varepsilon$ **for some** $q' \in Q$ **then**
 13 Let $\delta(q, \sigma) = q'$;
 14 **else**
 15 Let $Q_{\text{new}} = Q_{\text{new}} \cup \{q_{\text{new}}\}$ and $Q = Q \cup \{q_{\text{new}}\}$;
 16 Associate to q_{new} the sequence identifier $x_{q_{\text{new}}}^{\text{id}} = x\sigma$ and the probability vector $d_{q_{\text{new}}} = d$;
 17 Let $\delta(q, \sigma) = q_{\text{new}}$;
 18 Let $\tilde{Q} = Q_{\text{new}}$;
 19 Take a strongly connected subgraph of the labeled directed graph defined by Q and δ , and denote the vertex set of the subgraph again by Q ;
 /* **Step Three: Identify transition probability** */
 20 Initialize counter $N[q, \sigma]$ for each pair $(q, \sigma) \in Q \times \Sigma$;
 21 Choose a random starting state $q \in Q$;
 22 **for** $\sigma \in \Sigma$ **do**
 23 Let $N[q, \sigma] = N[q, \sigma] + 1$;
 24 Let $q = \delta(q, \sigma)$;
 25 Let $\tilde{\pi}(q) = \|(N[q, \sigma])_{\sigma \in \Sigma}\|$;
 26 **return** $Q, \delta, \tilde{\pi}$;

XIII. THEORETICAL DEVELOPMENT OF SEQUENCE LIKELIHOOD DEFECT

Definition 17 (Entropy Rate and KL Divergence). By *entropy rate* of a PFSA, we mean the entropy rate of the stochastic process generated by the PFSA¹⁷. Similarly, by *KL divergence* of two PFSA, we mean the KL divergence between the two processes generated by them¹⁸. More precisely, we have

$$\mathcal{H}(G) = - \lim_{d \rightarrow \infty} \frac{1}{d} \sum_{x \in \Sigma^d} p(x) \log p(x) \quad (25)$$

and the KL divergence

$$\mathcal{D}_{KL}(G \parallel H) = \lim_{d \rightarrow \infty} \frac{1}{d} \sum_{x \in \Sigma^d} p_G(x) \log \frac{p_G(x)}{p_H(x)} \quad (26)$$

whenever the limits exist.

Theorem 1 (Closed-form Formula for Entropy Rate and KL Divergence). *The entropy rate of a PFSA $G = (\Sigma, Q, \delta, \tilde{\pi})$ is given by*

$$\mathcal{H}(G) = \sum_{q \in Q} \wp_G(q) \cdot h(\tilde{\pi}(q)) \quad (27)$$

where $h(\mathbf{v})$ is the based-2 entropy of the probability vector $\mathbf{v}$.

Consider two PFSA $G = (Q_G, \Sigma, \delta_G, \tilde{\pi}_G)$ and $H = (Q_H, \Sigma, \delta_H, \tilde{\pi}_H)$ with μ_G being absolutely continuous with respect to μ_H . Let Q_c be the set of G -joint pairs of states, we have

$$\mathcal{D}_{KL}(G \parallel H) = \sum_{(q,r) \in Q_c} p_G(q, r) \mathcal{D}_{KL}(\tilde{\pi}_G(q) \parallel \tilde{\pi}_H(r)) \quad (28)$$

Definition 18 (Log-likelihood). *Let $x \in \Sigma^d$, the log-likelihood¹⁷ of a PFSA G generating x is given by*

$$L(x, G) = -\frac{1}{d} \log p_G(x) \quad (29)$$

The calculation of log-likelihood is detailed in Alg. 2.

Algorithm 2: Log-likelihood

Data: A PFSA $G = (\Sigma, Q, \delta, \tilde{\pi})$ and a sequence x over alphabet Σ

Result: Log-likelihood $L(x, G)$ of G generating x

- 1 Calculate the state transition matrix Π and observation $\tilde{\Pi}$;
 - 2 Calculate the stationary distribution over states $\wp_G$ of G from Π ;
 - 3 Calculate the stationary distribution of alphabet $\phi_\lambda^T = \wp_G^T \tilde{\Pi}$;
 - 4 Initialize $\mathbf{p}$ by $\wp_G$ and $\mathbf{q}$ by ϕ_λ ;
 - 5 Let $L = 0$;
 - 6 **for** i from 1 to $|x|$ **do**
 - 7 Let σ be the i -th entry of x ;
 - 8 Let $L = L - \log \mathbf{q}|_\sigma$;
 - 9 Let $\mathbf{p}^T = \llbracket \mathbf{p}^T \Gamma_\sigma \rrbracket$ where Γ_σ is defined in 9;
 - 10 Let $\mathbf{q}^T = \mathbf{p}^T \tilde{\Pi}$;
 - 11 **return** $L/|x|$;
-

Theorem 2 (Convergence of log-likelihood). *Let G and H be two reduced PFSA, and let $x \in \Sigma^d$ be a sequence generated by G . Then we have*

$$L(x, H) \rightarrow \mathcal{H}(G) + \mathcal{D}_{KL}(G \parallel H) \quad (30)$$

in probability as $d \rightarrow \infty$.

Proof. We first notice that

$$\sum_{x \in \Sigma^d} p_G(x) \log \frac{p_G(x)}{p_H(x)} = \sum_{x \in \Sigma^{d-1}} \sum_{\sigma \in \Sigma} p_G(x) \wp_G(x) \tilde{\Pi}_G \Big|_\sigma \log \frac{p_G(x) \wp_G(x) \tilde{\Pi}_G \Big|_\sigma}{p_H(x) \wp_H(x) \tilde{\Pi}_H \Big|_\sigma} \quad (31)$$

$$= \sum_{x \in \Sigma^{d-1}} p_G(x) \log \frac{p_G(x)}{p_H(x)} + \underbrace{\sum_{x \in \Sigma^{d-1}} p_G(x) \sum_{\sigma \in \Sigma} \wp_G(x) \tilde{\Pi}_G \Big|_\sigma \log \frac{\wp_G(x) \tilde{\Pi}_G \Big|_\sigma}{\wp_H(x) \tilde{\Pi}_H \Big|_\sigma}}_{D_d} \quad (32)$$

By induction, we have $\mathcal{D}_{KL}(G \parallel H) = \lim_{d \rightarrow \infty} \frac{1}{d} \sum_{i=1}^d D_i$, and hence by Cesàro summation theorem¹⁹, we have $\mathcal{D}_{KL}(G \parallel H) = \lim_{d \rightarrow \infty} D_d$. Let $x = \sigma_1 \sigma_2 \dots \sigma_n$ be a sequence generated by G . Let $x^{[i-1]}$ is the truncation of x at the $(i-1)$ -th symbols, we have

$$-\frac{1}{n} \sum_{i=1}^n \log \wp_H(x^{[i-1]}) \tilde{\Pi}_H \Big|_{\sigma_i} = \underbrace{\frac{1}{n} \sum_{i=1}^n \log \frac{\wp_G(x^{[i-1]}) \tilde{\Pi}_G \Big|_{\sigma_i}}{\wp_H(x^{[i-1]}) \tilde{\Pi}_H \Big|_{\sigma_i}}}_{A_{x,n}} - \underbrace{\frac{1}{n} \sum_{i=1}^n \log \wp_G(x^{[i-1]}) \tilde{\Pi}_G \Big|_{\sigma_i}}_{B_{x,n}} \quad (33)$$

Since the stochastic process G generates is ergodic, we have

$$\lim_{n \rightarrow \infty} A_{x,n} = \lim_{d \rightarrow \infty} D_d = \mathcal{D}_{\text{KL}}(G \parallel H) \quad (34)$$

and $\lim_{n \rightarrow \infty} B_{x,n} = \mathcal{H}(G)$. $\square$

XIV. PIPELINE OPTIMIZATION: HYPER-TRAINING, TRAINING, & VALIDATION

Our pipeline comprises a network of individually trained light gradient boosting machine (LGBM)²⁰ classifiers that focus on complementary aspects of the problem, and operate on different categories of input features as described next. Importantly, some of these features need to be generated non-trivially from the raw data, and these *feature generators* have parameters that need to be trained as well (or comprise models that need to be inferred). We call this inference of the feature-generators as **hyper-training**. Importantly, this is different from the more common notion of hyper-parameters. Hyper-parameters are one or more variables whose scalar values are commonly tuned by grid-search or via some meta-heuristics to optimize classifiers, whereas hyper-training produces generators of features, not simply a set of numbers.

Hyper-training & Training

Trinary Quantization of Medical Histories: The medical histories are mapped into trinary disease-phenotype-specific data-streams to enable generation of some of the features described below, as outlined in Section IV (Step 1).

Feature Categories: The features used in the pipeline maybe categorized as follows:

PFSA scores: The PFSA scores are computed on the basis of the inferred PFSA models as described in the previous sections. The generation of the PFSA models from the trinary data-streams is the first hyper-training step. These scores consist of the negative and positive log-likelihood of a phenotype-specific quantized medical history being generated by the PFSA models for the positive cohort and the control cohort of sex-stratified patients, and the corresponding sequence likelihood defects (See Section ??). Recall that PFSAs are specialized HMMs, and these measures encode the dynamics of the underlying processes, and are sensitive to the ordering, and frequency of the codes at the resolution of the disease phenotypes. Also, recall that diseases pheonotypes are broad categories of diagnostic codes, and that we generate PFSA models for each category, and separately for the sexes and the positive cohort and the control cohorts).

Prevalence scores (p-scores): The p-scores focus on individual diagnostic codes, and we create a dictionary of the ratio of relative prevalence of each code (relative to the set of all codes present) in the positive category (for each sex) to the control category. This is the second hyper-training step. In the later steps of the pipeline, we use dictionary look ups to map codes to their p-scores, and also their aggregate measures such as mean, median, and variance to train a downstream LGBM.

Rare scores: These scores consist of a subset of p-scores which correspond to codes with particularly high and low relative prevalences ($p\text{-score} > 2$ or $< .5$). Thus, this feature category depends on the p-score dictionary generated in the second hyper-training step.

Sequence scores: Sequence scores are relatively straight-forward statsitcal measures such as mean, median, variance, time since last occurrence *etc.* on the trinary phenotype-specific sex-stratified histories. No hyper-training is required for the generation of the sequence features.

Thus we require three splits of the training dataset. The first split is used to carry out hyper-training of the PFSA models and the p-score dictionary. The second split is used to train the score-category specific LGBMs, one for each feature category. And the third split is used to train the final LGBM that takes inputs from the outputs of the four LGBMs in the previous layer. The network layout is shown in Fig. 1.

Validation

In validation, or actual prediction of patient fate, we use the trinary mapping, generate the features using the PFSA models and the p-score dictionary, and calculate the raw-risk via the trained LGBM network. The relative score is then obtained by a choice of the operating point reflecting the specificity/sensitivity trade-off discussed before.

A. Hyper-training

B. Pre-aggregation training

C. Aggregation training

D. Validation and Operation

SI-Fig. 1: Schematic of prediction pipeline. Panels A, B and C show the sequential training steps, namely the hyper-training of the PFSA models and the p-score dictionary, the pre-aggregation training of the four LGBM models, and the aggregation training of the final LGBM model respectively. Panel D shows the configuration of the trained pipeline in operation. In the training steps, the filled box represents the component being trained in that step.

Data Splits: Training and Validation Hold-out

All eligible patients are randomly split into the Training set ($\approx 75\%$ of data) and the Test set ($\approx 25\%$ of data). The Training set is then split into 3 subsets: 1) The hyper-training set (See Fig. 1A) is used to train PFSA models p-score dictionary, 2) the second split (referred to as the pre-aggregation split, see Fig. 1B) is used to train the four feature-category specific LGBMs, and 3) the final split (referred to as the aggregation split, see Fig. 1C) is used to train the aggregate LGBM which uses outputs from the trained LGBMs in the previous layer. This trained pipeline is then validated on the held out validation split ($\approx 25\%$ of data).

SI-Table I: Disease Categories With Detailed Set of ICD Codes Used

	Description	
250	250.00 250.20 250.61 250.81 E11.29 250.92 250.91 E10.8 E10.69 250.23 250.33 250.22 250.83 250.62 E10.40 250.32 250.63 250.43 250.02 250.72 250.80 250.31 250.13 250.41 250.21 E11.40 250.71 E10.11 E10.620 E11.8 250.90 250.42 250.10 E10.21 E11.641 E11.01 E11.311 250.30 250.51 E11.9 E11.65 250.53 250.82 E10.39 250.50 250.70 E10.29 E10.65 250.60 E11.51 250.12 E10.311 250.73 250.01 250.11 250.03 E11.00 E10.51 E10.10 250.40 250.93 E11.39 E11.69 250.52 E11.21 E10.9 E11.620	
272	E78.0 R78.81 E78.2 272.9 272.6 E75.21 E78.89 P35.0 272.5 272.3 E78.9 771.1 E78.5 272.4 E78.3 771.89 E78.6 771.5 A33 272.8 E88.1 272.2 771.2 P35.2 P39.1 771.3 272.1 771.4 P36.9 771.81 P35.1 E78.1 771.82 771.6 P38.9 P39.3 771.83 272.0 P39.8 771.0 771.7 272.7 P39.0 P37.5	
401	B90.2 M86.642 B76.8 B58.81 M90.829 123.0 136.4 B37.1 117.4 122.3 M62.3 126.2 B60.11 M62.89 122.4 114.4 B35.0 133.8 138 123.1 115.00 B73.1 B74.8 B81.2 128.8 728.82 728.3 B48.8 B35.2 139.0 116.2 B65.8 B37.81 730.91 117.7 B65.3 B39.5 B94.0 B88.2 M90.869 B67.39 115.94 730.00 127.3 730.21 B75 728.85 125.2 730.25 B37.3 134.9 133.9 M90.839 131.01 B83.9 B65.0 136.29 122.2 B66.8 114.9 B66.2 730.81 M90.849 115.10 B38.89 B40.9 M62.838 130.1 730.94 B35.5 B74.4 M86.639 117.8 137.2 127.9 730.27 B37.6 122.5 B58.9 115.03 I32 B58.89 122.6 730.98 115.99 B46.9 730.13 112.9 730.95 B59 A07.8 B67.4 M46.30 123.6 112.89 B37.84 M86.179 136.5 115.14 B36.0 730.77 730.36 111.0 B38.2 B80 730.38 130.9 121.5 B37.0 730.82 730.32 B83.1 112.1 122.8 M89.659 M62.81 110.4 730.03 117.5 111.3 B81.1 M86.619 728.10 127.8 128.9 B88.8 130.2 M86.19 730.29 137.3 136.3 730.24 136.9 728.81 110.6 121.2 B76.1 M46.20 B37.9 B74.3 A59.00 B66.1 112.5 730.19 115.13 111.1 728.0 B35.1 B78.9 117.0 730.22 B85.2 H32 M86.60 M62.00 M86.20 730.17 112.84 730.18 B38.0 B71.9 728.12 B79 B60.2 M89.619 M86.149 B37.5 A59.9 730.09 B38.1 B67.7 126.3 M90.879 728.6 111.8 B35.6 123.4 M61.10 121.1 B72 730.76 730.15 730.39 B37.7 112.83 730.75 117.2 M89.669 B36.8 728.71 B71.0 B71.8 A59.8 B48.0 110.9 B65.9 M35.7 127.7 730.96 401.9 B44.9 M62.82 B65.1 L94.6 730.88 B68.1 M60.10 B68.9 B86 112.81 114.0 728.2 131.9 120.9 131.8 M89.679 137.4 130.4 730.33 117.1 133.0 130.0 121.4 B37.2 A59.03 123.5 B85.1 M86.9 112.2 139.1 123.9 B38.4 129 123.2 728.5 B88.9 M61.40 730.31 J17 B36.2 B81.0 132.9 M72.4 134.1 132.0 B39.2 134.8 126.0 B67.5 132.2 M24.20 115.04 123.3 115.05 B68.0 110.0 B36.3 B85.0 B87.9 115.01 730.26 126.8 110.5 121.6 730.01 730.30 130.8 B83.4 728.19 728.11 B67.69 B90.9 B94.1 M86.669 728.89 730.12 401.1 B67.8 B58.2 124 730.28 121.0 110.8 D86.9 132.1 A59.09 M90.819 111.2 730.07 B66.4 I10 125.7 130.3 B39.9 B85.3 728.84 730.04 A59.01 134.0 B38.9 115.12 B36.1 136.8 M60.009 128.1 121.8 B85.4 M90.80 A59.02 730.10 112.4 B39.3 117.9 730.06 M72.2 B82.9 B66.5 139.8 137.1 B42.0 B48.1 115.09 B67.90 401.0 B94.8 137.0 M86.169 130.5 M86.139 131.09 115.02 M61.00 125.1 120.1 128.0 M89.69 728.87 M86.659 730.16 B35.3 M86.129 116.1 120.0 122.0 730.37 730.72 730.85 B74.0 M86.119 M86.69 136.21 728.88 B39.4 B38.3 120.8 M86.159 730.78 728.13 730.80 B82.0 B36.9 B37.82 B43.9 B58.3 122.9 728.79 730.35 730.11 115.91 M89.629 B81.8 115.19 B90.8 M72.0 132.3 B65.2 127.4 M90.859 730.02 125.0 114.5 111.9 117.3 730.89 730.83 M86.18 B49 M62.9 730.90 B70.0 110.3 115.90 B66.0 110.1 131.02 M72.6 126.9 730.87 730.23 135 M62.50 110.2 134.2 M61.9 B69.9 M86.68 114.3 125.5 B45.0 M35.2 B74.9 M61.59 B77.9 M89.60 B70.1 730.34 116.0 125.6 127.2 B67.1 728.9 B81.4 B90.0 730.08 M89.639 B60.8 B89 120.2 M62.10 728.86 B37.89 B58.09 136.0 122.7 127.1 B90.1 730.71 G02 114.2 M60.20 730.84 730.86 730.99 112.85 114.1 730.92 730.20 M89.649 125.9 115.93 127.0 136.1 117.6 730.05 730.73 115.11 121.3 M86.679 B35.8 M86.629 730.14 B76.0 B83.0 M90.89 127.5 B83.8 121.9 123.8 126.1 B58.1 112.3 B41.0 730.74 728.83 B47.0 B37.49 125.3 B91 130.7 131.00 B58.01 B74.1 730.70 127.6 B66.3 B67.0 B66.9 I39 112.0 120.3 730.79 730.93 B48.2 728.4 115.15 131.03 122.1 730.97 112.82 118 115.92 125.4 M89.68 B67.31 B88.0 B35.9 M90.88 115.95	
414-0	I25.810 414.04 I25.10 414.00 414.03 414.05 I25.811 414.07 414.06 414.01 I25.812 414.02	
414	477.2 493.81 J67.2 495.6 414.9 J67.0 J30.1 I25.82 477.9 495.5 493.22 D69.2 287.33 I25.9 J67.7 414.2 414.19 287.8 I25.811 493.92 493.90 J45.20 493.82 D69.42 495.7 D69.49 493.20 I25.3 J67.5 287.32 414.11 D69.1 J45.21 D69.6 495.4 287.1 I25.83 477.0 493.02 J67.1 D69.3 J67.3 495.9 493.21 495.2 414.00 I25.41 287.2 287.5 495.8 493.11 J45.902 J45.990 287.9 I25.89 I25.812 J30.0 414.02 495.1 J44.9 J44.0 477.1 414.3 493.01 D69.8 495.3 414.03 287.30 J45.991 J44.1 414.8 287.4 287.0 J45.901 414.07 287.39 J67.4 414.01 493.91 287.31 414.06 495.0 D69.9 J67.6 414.10 477.8 414.05 493.12 J67.9 J30.5 414.04 I25.810 I25.10 493.00 493.10 J30.2 D69.0 I25.42 414.12 J30.81 J45.22 J45.909 D69.41 J67.8	
461	461.0 461.9 461.2 J01.90 461.8 461.3 J01.00 J01.20 461.1 J01.40 J01.30 J01.10	
530-8	530.81 530.86 530.87 K21.9 K22.8 K94.32 K94.33 530.85 K22.70 J86.0 530.83 530.89 530.82 530.84	
530	772.4 776.8 P59.29 P56.0 530.7 K20.8 P59.0 530.21 776.7 P61.2 P50.3 P57.0 P52.0 773.0 772.13 774.5 772.10 P60 772.12 774.6 530.12 530.89 P58.8 P54.3 K22.8 K22.3 530.13 P59.8 P54.5 P61.1 530.87 530.9 774.1 K20.0 P57.8 P61.3 772.14 772.5 530.82 530.10 530.6 P61.6 774.31 P54.9 P55.1 K21.0 P52.21 530.3 773.4 776.2 774.0 P10.3 P54.8 530.81 K22.10 773.5 K94.32 776.5 776.4 772.3 P61.8 776.6 K22.2 P61.9 P55.8 772.8 776.1 P51.8 773.3 530.85 P61.5 530.11 K22.6 K22.9 P52.3 772.9 530.19 772.0 P59.9 530.5 774.2 K22.5 774.7 772.6 773.2 774.39 P53 P59.3 K22.0 776.3 776.0 P52.22 774.4 530.0 530.86 774.30 K22.0 P54.4 530.84 P52.1 530.4 P55.0 K94.33 K22.4 773.1 772.2 772.11 K21.9 530.20 K20.9 P61.0 K22.11 J86.0 530.83 776.9	
719	M12.349 R78.81 M25.18 M12.239 719.58 719.97 719.04 M25.459 771.1 719.03 719.22 719.39 719.52 M12.369 719.62 M25.879 719.89 M25.60 719.98 M12.30 719.66 M12.29 771.4 719.32 M25.429 719.26 719.93 M25.519 719.56 M25.80 719.94 M25.48 M25.649 719.96 M25.073 771.0 771.7 M12.379 719.43 M25.9 719.49 719.81 M79.646 719.95 M12.359 M25.539 R26.2 M25.069 719.29 719.12 M12.329 M12.39 M25.029 M25.08 719.61 719.7 719.54 771.5 719.18 719.20 719.17 719.07 719.41 M12.259 719.01 M25.469 719.28 719.23 719.09 719.87 M25.569 M25.40 P35.1 771.82 M12.319 719.16 719.55 P39.3 771.83 M12.229 M12.20 719.86 R29.4 M25.00 719.30 P39.8 719.34 719.64 P39.0 719.83 719.63 719.53 R29.898 719.84 P35.0 719.68 M25.559 719.19 719.24 719.44 771.89 M12.279 719.42 719.35 719.15 719.08 719.36 719.91 719.99 719.57 M25.669 719.13 P35.2 P39.1 771.3 M25.50 M25.619 M25.579 719.11 719.05 M25.439 M25.419 M25.659 771.6 M25.869 719.80 M25.10 M25.629 719.69 M12.38 M25.673 M25.839 719.40 M25.639 719.02 M25.049 719.60 M25.859 719.31 M12.249 719.90 719.37 M25.119 M12.219 719.46 719.48 M25.039 719.50 M25.019 719.38 719.47 719.59 719.88 M25.059 719.14 M25.829 A33 719.67 719.10 719.33 719.45 719.25 719.65 771.2 M12.339 M25.449 P36.9 771.81 719.82 P38.9 M12.269 719.85 M12.28 719.27 M25.849 719.00 719.06 719.51 719.21 M25.529 M25.473 719.92 P37.5	
722	772.4 722.10 776.8 P59.29 P56.0 P59.0 M50.30 776.7 722.0 P61.2 M51.24 M46.40 P50.3 P57.0 772.81 M46.47 P52.0 773.0 772.13 M51.46 774.5 772.10 P60 722.39 722.11 772.12 774.6 P58.8 P54.3 M50.20 M51.06 722.73 722.4 722.32 P59.8 P54.5 P61.1 774.1 722.71 P57.8 722.72 P61.3 772.14 772.5 M51.9 722.31 P61.6 774.31 P54.9 P55.1 M46.45 P52.21 773.4 776.2 M51.26 722.52 774.0 P10.3 P54.8 773.5 776.5 776.4 772.3 P61.8 776.6 722.30 P61.9 P55.8 772.8 776.1 722.51 P51.8 M50.90 773.3 P61.5 P52.3 722.6 772.9 722.83 772.0 P59.9 774.2 M51.04 774.7 M50.00 772.6 773.2 774.39 722.90 P53 P59.3 776.3 776.0 P52.22 774.4 774.30 M51.44 P54.4 722.92 P52.1 P55.0 M96.1 722.91 773.1 772.2 722.70 M51.34 772.11 722.2 M51.36 722.93 722.82 P61.0 722.80 776.9	
723	P05.9 764.00 764.96 M43.6 723.3 764.98 P05.12 764.04 P05.04 764.14 764.94 P05.18 P05.05 M53.0 764.27 723.8 723.4 P05.03 M53.1 P05.11 723.0 764.20 M54.02 764.93 764.03 764.24 P05.10 764.08 764.15 764.10 P05.13 764.16 P05.16 P05.02 723.7 M67.88 764.06 764.91 P05.01 764.19 764.11 723.5 764.13 P05.2 P05.17 764.05 764.22 764.17 764.90 M53.82 P05.14 764.99 P05.08 P05.07 764.02 764.97 764.29 P05.15 M54.2 764.07 764.28 764.26 M48.02 764.92 P05.06 764.21 723.9 764.95 764.12 764.25 764.23 764.18 764.01 M54.12 764.09 723.2 723.1 723.6 P05.00	

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724		B90.2 M86.642 B76.8 B58.81 M90.829 123.0 136.4 B37.1 117.4 122.3 M62.3 M54.08 126.2 B60.11 M62.89 122.4 114.4 B35.0 133.8 138 123.1 115.00 B73.1 B74.8 B81.2 128.8 728.82 728.3 B48.8 B35.2 139.0 116.2 B65.8 B37.81 730.91 117.7 B65.3 B39.5 B94.0 B88.2 M90.869 B67.39 115.94 730.00 127.3 730.21 B75 728.85 125.2 730.25 B37.3 134.9 133.9 M90.839 131.01 B83.9 B65.0 136.29 122.2 B66.8 724.79 B66.2 724.1 114.9 730.81 M90.849 115.10 B38.89 B40.9 M62.838 130.1 730.94 B35.5 B74.4 M86.639 117.8 137.2 127.9 730.27 B37.6 122.5 B58.9 115.03 132 B58.89 122.6 730.98 115.99 B46.9 730.13 112.9 730.95 724.02 B59 A07.8 B67.4 M46.30 123.6 112.89 B37.84 M86.179 136.5 115.14 724.3 B36.0 730.77 730.36 724.2 111.0 B38.2 B80 730.38 130.9 121.5 B37.0 730.32 B83.1 112.1 122.8 M89.659 M62.81 110.4 730.03 M43.27 117.5 111.3 B81.1 M86.619 728.10 127.8 724.6 128.9 B88.8 130.2 M86.19 730.29 137.3 136.3 730.24 M53.2X8 136.9 728.81 724.09 110.6 121.2 B76.1 M46.20 B37.9 B74.3 A59.00 B66.1 112.5 730.19 115.13 111.1 728.0 B35.1 B78.9 117.0 730.22 B85.2 H32 M86.60 M53.3 M62.00 M86.20 730.17 112.84 730.18 B38.0 B71.9 728.12 B79 B60.2 M89.619 M86.149 M54.89 B37.5 A59.9 730.09 B38.1 B67.7 126.3 M90.879 728.6 111.8 B35.6 123.4 M61.10 121.1 B72 730.76 730.15 730.39 B37.7 112.83 730.75 117.2 M89.669 B36.8 728.71 B71.0 B71.8 A59.8 B48.0 110.9 B65.9 M35.7 127.7 730.96 B44.9 M62.82 B65.1 L94.6 730.88 B68.1 M60.10 B68.9 B86 112.81 114.0 728.2 131.9 120.9 131.8 M89.679 137.4 M48.06 130.4 730.33 117.1 133.0 130.0 121.4 B37.2 A59.03 123.5 B85.1 M86.9 724.71 112.2 139.1 724.70 M48.00 123.9 B38.4 129 123.2 728.5 B88.9 M61.40 730.31 J17 B36.2 B81.0 132.9 M72.4 134.1 132.0 B39.2 M53.9 134.8 126.0 M48.08 B67.5 132.2 M24.20 115.04 123.3 115.05 B68.0 110.0 B36.3 B85.0 B87.9 115.01 730.26 126.8 110.5 121.6 730.01 730.30 130.8 B83.4 728.19 M54.5 728.11 B67.69 724.8 B90.9 B94.1 M86.669 728.89 730.12 B67.8 B58.2 124 730.28 121.0 110.8 B86.9 132.1 A59.09 M90.819 111.2 730.07 B66.4 125.7 130.3 B39.9 B85.3 728.84 730.04 A59.01 134.0 B38.9 115.12 B36.1 724.00 136.8 M60.009 128.1 121.8 B85.4 M90.80 A59.02 730.10 112.4 B39.3 117.9 730.06 M72.2 B82.9 B66.5 139.8 137.1 B42.0 B48.1 115.09 B67.90 B94.8 137.0 M86.169 130.5 M86.139 131.09 115.02 M61.00 125.1 120.1 128.0 M89.69 728.87 M86.659 730.16 B35.3 M86.129 116.1 120.0 122.0 730.37 730.72 730.85 B74.0 M86.119 M86.69 136.21 728.88 B39.4 B38.3 120.8 M86.159 730.78 728.13 730.80 B82.0 B36.9 B37.82 B43.9 B58.3 122.9 728.79 730.35 730.11 115.91 M89.629 B81.8 115.19 B90.8 M72.0 132.3 724.4 B65.2 127.4 M90.859 730.02 125.0 114.5 111.9 117.3 730.89 730.83 M86.18 B49 B70.0 730.90 M62.9 110.3 115.90 B66.0 110.1 131.02 M72.6 M54.6 126.9 730.87 730.23 135 M62.50 110.2 134.2 M61.9 B69.9 M86.68 114.3 125.5 B45.0 M35.2 B74.9 M61.59 B77.9 M89.60 B70.1 730.34 M48.04 116.0 125.6 127.2 B67.1 728.9 B81.4 B90.0 730.08 M89.639 B60.8 B89 120.2 M62.10 728.86 B37.89 B58.09 136.0 122.7 127.1 B90.1 730.71 724.01 G02 114.2 M60.20 730.84 730.86 730.99 112.85 114.1 730.92 730.20 M89.649 125.9 115.93 127.0 136.1 117.6 730.05 730.73 115.11 121.3 M86.679 B35.8 M86.629 730.14 B76.0 B83.0 M54.14 M90.89 127.5 B83.8 121.9 123.8 126.1 B58.1 112.3 B41.0 724.9 730.74 728.83 B47.0 B37.49 125.3 B91 130.7 131.00 B58.01 724.5 B74.1 M54.30 730.70 127.6 B66.3 B67.0 B66.9 139 112.0 120.3 730.79 730.93 B48.2 728.4 115.15 131.03 122.1 730.97 112.82 118 115.92 125.4 M89.68 B67.31 B88.0 B35.9 M90.88 115.95
729		729.0 M79.89 M79.9 R25.2 729.72 M79.609 729.4 M79.4 M79.0 M79.A29 729.2 729.31 M79.A19 M79.A3 729.92 729.6 729.73 M60.9 729.1 729.90 M72.9 M79.2 M79.5 M79.81 729.91 729.30 M79.3 729.79 729.39 729.82 M70.98 M79.A9 729.81 729.71 729.99 729.89 729.5 R29.898
780		780.51 772.4 776.8 P59.29 P56.0 P59.0 780.97 G47.20 780.59 R68.83 776.7 R44.3 P61.2 780.2 R40.20 P50.3 P57.0 780.57 G47.30 G47.10 R52 R42 780.72 772.13 773.0 P52.0 780.4 774.5 772.10 P60 780.55 772.12 780.94 774.6 780.53 P58.8 P54.3 R50.83 780.96 G47.8 R56.01 P59.8 R50.82 P54.5 P61.1 774.1 P57.8 780.95 P61.3 772.14 772.5 R53.82 R40.3 780.92 R40.4 780.52 P61.6 774.31 P54.9 P55.1 R45.84 R53.1 780.60 P52.21 R53.2 R41.82 G47.9 R68.12 773.4 776.2 774.0 P10.3 P54.8 R41.3 780.99 773.5 776.5 776.4 772.3 R61 P61.8 F51.8 780.62 776.6 R68.81 P61.9 P55.8 772.8 776.1 P51.8 780.93 773.3 P61.5 780.39 P52.3 R68.0 772.9 772.0 P59.9 774.2 780.03 R68.11 780.79 774.7 772.6 780.91 773.2 774.39 R56.9 G47.00 P53 R50.81 P55.3 780.1 776.3 776.0 P52.22 780.65 774.4 780.64 R50.9 774.30 780.50 P54.4 P52.1 P55.0 780.32 773.1 780.58 780.8 R56.00 780.31 772.2 777.81 780.63 780.71 R59 780.02 780.54 780.56 780.01 R40.0 R45.83 780.61 P61.0 780.09 776.9
782		R17 782.62 R23.2 782.7 R22.9 R60.9 782.1 R21 R20.3 782.9 782.2 R23.8 782.61 782.8 782.5 R23.4 782.4 782.3 R23.0 R23.1 782.0 R23.3
784		772.4 784.49 R49.21 776.8 P56.0 P59.29 P59.0 776.7 784.91 P61.2 R22.1 784.40 P50.3 P57.0 P52.0 773.0 772.13 774.5 784.51 772.10 R04.1 P60 R49.0 772.12 774.6 P58.8 P54.3 R47.01 R06.7 784.43 R48.0 784.61 P59.8 P54.5 P61.1 R49.9 774.1 R48.1 P57.8 P61.3 772.14 772.5 R49.8 R07.0 P61.6 774.31 P54.9 P55.1 P52.21 773.4 776.2 774.0 P10.3 P54.8 784.60 784.59 784.0 773.5 776.5 776.4 772.3 P61.8 F51.8 780.62 776.6 R68.81 P61.9 P55.8 772.8 776.1 P51.8 780.93 773.3 P61.5 780.39 P52.3 R68.0 772.9 772.0 P59.9 774.2 780.03 R68.11 780.79 774.7 772.6 780.91 773.2 774.39 R56.9 G47.00 P53 R50.81 P55.3 780.1 776.3 776.0 P52.22 774.4 774.30 784.7 784.2 P54.4 P52.1 R49.1 P55.0 773.1 784.1 772.2 784.42 774.1 R51 R47.1 R04.0 R48.9 R09.82 P61.0 776.9
785		787.3 787.22 R57.9 R11.0 R13.13 777.3 787.04 R09.89 P78.9 787.91 785.9 R19.2 787.02 777.1 787.4 R19.4 785.2 P77.3 R00.0 787.7 787.03 I96 R13.11 P76.2 R57.0 P77.9 785.0 787.29 R13.19 785.1 P76.1 R59.9 R13.10 P77.2 777.6 777.51 P78.89 777.2 R19.5 R01.1 787.1 P78.2 787.21 787.5 R13.12 777.9 785.4 777.53 R19.11 R13.14 R19.7 P78.0 R57.8 777.52 787.6 787.20 R11.14 777.50 R11.2 R11.10 785.6 R00.2 R65.21 R14.1 777.8 787.99 R01.2 785.50 787.01 P76.0 785.3 787.24 P77.1 785.59 785.52 787.23 R12 777.4 785.51
786-0		477.2 493.81 J67.2 495.6 R06.2 J67.0 J30.1 R06.82 477.9 786.09 493.22 495.5 D69.2 287.33 J67.7 287.8 493.92 493.90 J45.20 493.82 D69.42 495.7 D69.49 493.20 786.06 J67.5 287.32 R06.9 D69.1 J45.21 D69.6 786.04 495.4 786.05 287.1 477.0 493.02 J67.1 D69.3 R06.02 J67.3 786.02 495.9 493.21 495.2 287.2 R06.81 287.5 495.8 493.11 786.01 J45.902 J45.990 287.9 J30.0 786.00 495.1 J44.9 J44.0 477.1 493.01 786.07 D69.8 495.3 287.30 J45.991 J44.1 R06.3 287.4 287.0 R06.4 J45.901 R06.01 J67.4 287.39 493.91 786.03 287.31 R06.00 495.0 D69.9 J67.6 477.8 493.12 J67.9 J30.5 493.00 493.10 J30.2 D69.0 J30.81 J45.22 J45.909 D69.41 J67.8
786-5		R78.81 786.50 P35.0 771.1 771.89 771.5 A33 R07.89 786.52 771.2 P35.2 R07.2 P39.1 771.3 771.4 P36.9 771.81 P35.1 771.82 771.6 P38.9 R07.9 P39.3 771.83 R07.1 P39.8 786.59 771.0 771.7 786.51 P39.0 P37.5
786		786.2 477.2 493.81 J67.2 495.6 R06.2 R05 J67.0 J30.1 R09.89 R06.82 786.9 477.9 R07.2 786.09 493.22 495.5 D69.2 287.33 J67.7 R07.1 287.8 786.8 493.92 493.90 J45.20 493.82 D69.42 495.7 J67.5 493.20 786.06 D69.49 287.32 R06.9 D69.1 J45.21 D69.6 786.04 495.4 786.05 287.1 477.0 493.02 J67.1 R07.89 D69.3 786.52 786.7 R06.02 J67.3 786.02 495.9 493.21 495.2 287.2 R06.81 287.5 495.8 493.11 786.01 J45.902 J45.990 287.9 J30.0 786.00 495.1 J44.9 J44.0 477.1 R22.2 493.01 R06.89 786.07 D69.8 495.3 R06.6 287.30 J45.991 J44.1 R06.3 287.4 287.0 R06.4 J45.901 R06.01 J67.4 287.39 493.91 786.03 287.31 R06.00 495.0 D69.9 J67.6 477.8 786.4 493.12 J67.9 J30.5 493.00 493.10 J30.2 R07.9 D69.0 786.59 J30.81 J45.22 J45.909 D69.41 J67.8
787		R14.1 787.22 787.3 R11.0 R13.13 787.29 787.1 R13.19 787.04 787.21 787.5 R13.12 787.99 R13.10 787.91 R19.11 R13.14 787.01 R19.2 787.02 R19.7 787.24 787.23 787.6 787.20 787.4 R11.14 R12 R19.4 R11.2 R19.5 R11.10 787.7 787.03 R13.11
789		R19.33 789.61 789.05 R10.10 R19.36 789.39 789.36 R19.09 789.45 789.06 R10.811 R10.32 R19.02 789.49 R19.01 789.02 R19.34 789.9 R19.06 R10.812 789.67 R10.815 R19.30 R10.13 R19.05 789.35 R10.817 R10.31 789.69 R19.07 R19.35 789.37 789.44 R10.83 789.34 789.01 R10.11 R18.8 789.31 789.65 R19.37 789.33 789.09 789.59 789.41 789.7 R16.0 789.46 R18.0 789.60 R19.00 789.04 789.62 R10.9 789.32 789.40 R10.33 R10.819 R10.813 789.66 789.43 R10.816 789.07 R10.814 R16.1 789.00 R10.84 R19.03 789.64 789.03 789.30 789.47 R19.31 789.63 789.1 R19.8 789.2 R19.32 789.42 R19.04 R10.12 789.51
790		P11.4 R78.81 767.8 767.6 P12.2 P13.0 790.93 R97.2 790.22 790.92 790.95 790.99 790.8 P13.4 767.19 P11.5 767.11 790.09 E07.81 P11.3 R70.0 767.3 R71.0 P12.0 R79.81 767.5 P15.9 R79.82 R71.8 790.7 767.7 P52.8 790.5 P14.0 767.4 R79.1 790.94 790.4 R78.89 R74.8 R74.0 767.2 790.1 R73.09 790.91 P15.8 767.9 790.01 790.21 790.6 767.0 790.29 R73.01 R78.0 B34.9 790.3 R73.02
794-3		764.92 P05.06 P05.9 764.00 764.21 764.96 764.19 P05.11 794.31 764.11 764.20 764.13 P05.2 P05.17 764.05 764.93 764.22 764.03 764.95 764.17 764.90 764.24 P05.10 P05.14 764.99 P05.08 764.08 794.30 764.98 P05.07 764.12 764.15 P05.12 764.25 764.04 764.10 P05.04 764.14 764.02 764.94 P05.18 764.16 764.23 764.97 764.29 764.18 R94.30 P05.05 P05.13 764.01 P05.15 764.27 764.07 764.09 P05.16 764.28 P05.02 R94.31 764.06 764.26 P05.03 794.39 764.91 R94.39 P05.01 P05.00
794		787.3 787.22 R11.0 R13.13 777.3 794.14 R94.4 787.04 P78.9 794.11 787.91 794.16 R19.2 794.09 787.02 R94.120 794.12 794.13 777.1 794.6 787.4 R19.4 P77.3 787.7 R94.130 787.03 R13.11 R94.2 P76.2 794.31 P77.9 R94.01 787.29 R13.19 P76.1 R13.10 794.8 P77.2 R94.111 R94.09 777.6 R94.131 777.51 P78.89 R94.113 794.2 R94.112 777.2 R94.31 794.39 R19.5 R90.81 787.1 P78.2 787.21 787.5 R13.12 777.9 777.53 R19.11 R13.14 794.17 R19.7 P78.0 R94.8 794.02 777.52 787.20 787.6 R11.14 794.4 794.5 777.50 R11.2 R11.10 R94.39 794.19 R14.1 794.01 R94.118 R94.6 794.10 777.8 787.99 R94.121 787.01 794.30 P76.0 R94.110 787.24 R94.30 P77.1 R94.5 787.23 794.7 R94.7 794.00 794.9 R12 777.4 794.15
Allergic		477.2 493.81 T50.995A J67.2 495.6 T78.03x 372.14 J67 J67.0 M13.89 J30.1 995.63 995.65 558.3 T45.0X1A M13.859 716.27 D29.30 D29.1 L27.2 477.9 495.5 493.22 D69.2 T78.00x 287.33 995.60 J45.31 J45.51 D29.20 J67.7 T78.09xA D29.22 M13.80 J30.9 T78.08x 287.8 H10.45 B44.81 716.20 995.61 T78.05xA 493.92 693.1 493.90 T78.40x J45.20 493.82 J45.40 D69.42 495.7 J67.5 493.20 D69.49 J45.32 287.32 708.0 H65.11 995.64 D69.1 J45.21 D69.6 M13.819 716.23 495.4 995.67 287.1 T78.08xA T78.00xA 477.0 493.02 525.66 T78.02xA J67.1 D69.3 T78.04x T78.2xxA D29.4 716.25 T78.07xA 716.26 T78.07x M13.888 J67.3 495.9 J45.30 493.21 477.495.2 995.62 T78.40xA 995.27 287.2 495.8 495.287.5 995.0 493 T78.05x L50.0 493.11 J45.902 D29.0 J45.990 287.9 J45 D29.21 J30.0 963.0 495.1 D29.32 L25.9 J44.9 J44.0 477.1 M13.879 493.01 J45.41 T50.995 J45.998 692.9 M13.849 995.66 D69.8 995.69 T78.04xA J30 495.3 M13.869 287.30 J45.991 J44.1 995.3 287.4 J45.52 287.0 381.06 716.21 J45.901 J67.4 287.39 493.91 373.32 287.31 T78.06xA J30.89 287 K08.55 K52.2 D29.31 J45.50 495.0 J67.6 D69.9 D29.8 T78.02x 716.24 477.8 381.05 D29.493.12 T78.03xA J67.9 716.22 T78.2xx J30.5 999.4 493.00 M13.829 T78.01x T78.06x 493.10 518.8 716.28 J30.2 H01.119 995.68 M13.839 D69.0 T78.09x 381.04 D29.9 T78.01xA 716.29 J30.81 J45.22 J45.42 T45.0X1 J45.909 D69.41 J67.8
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Cardiovascular		<p>I35.0 I48.0 I25.728 444.8 P29.38 I94 I63.212 402.00 I70.669 440.30 I89.9 I60.9 I20.1 413.9 I24.1 I80.3 415.1 I77.811 785.9 I69.319 I69.339 I82.529 R04.1 429.6 G43.619 I82.503 I82.611 I70.512 I75.011 I69.834 I70.628 K64.9 I89.0 I21.09 428.42 447.5 442.8 I70.792 454.0 I70.318 I50.83 I70.744 405.0 426.2 455 I70.442 455.3 I82.B29 I12 415 433.8 I69.320 I27.81 444.2 I70.735 I82.602 I67.89 441.4 425.4 I35.9 I70.693 I69.234 I65.23 427.2 I70.244 I49.02 I82.91 P29.89 I70.719 I69.131 I36.8 I60.8 I60.11 442.82 I69.852 I75.029 438.22 I69.120 I70.641 I60.2 426.51 I70.302 417.9 I63.012 R04.2 R00.2 427.31 I25.718 I05.8 I70.791 I89.426 50 I63.349 I49.49 444.89 I63.213 I83.12 I77.0 I82.433 I70.608 P29 I47.1 428 I70.348 I82.C29 I82.532 I69.322 I63.311 I65.03 I82.291 I70.498 I97.791 I69.859 I70.644 I82.441 I63.413 I70.362 405.11 I62 I87.012 I80.292 411.1 433 I70.532 I97.638 I87.091 I69.998 I07.8 I11.9 I69.390 445.01 I69.223 I37.2 I87.319 I69.932 I70.208 I82.492 I82.891 I63.233 I70.319 I70.65 I70.341 435 441.9 I40.0 I63.539 K64.4 I95.89 I69.028 I82.5Y9 I50.32 I70.731 I70.768 458.0 G43.601 I21.01 410.71 429.3 I69.398 I87.399 441.0 I70.421 I73 I70.729 E86.0 I69.231 I28.8 I13.0 I70.568 I42.2 I63.431 411.89 I70.709 438.21 438.53 I70 I50.84 I42.0 I70.212 I77.74 I08.0 P29.2 455.0 410.1 416.1 I24.8 433.10 I70.393 413.1 I70.561 I87.092 I83.218 427.60 453.82 I70.534 I97.130 I97.821 I97.711 I63.543 I02.0 405.01 I69.364 I07 I83.92 I69.928 I69.214 I70.418 346.63 I06.8 410.60 I31.2 I70.433 I75.013 I70.219 I70.431 I75.023 I82.403 I83.10 I25.730 415.13 I13.2 I69.814 I50.812 I79 429.89 I69 I69.833 I23 410.20 I77.6 I69.165 I60.52 459.81 I47 410.10 I83.201 I82.419 I69.033 I15.9 404.0 I69.213 441.7 I82.412 I69.261 I82.432 417 I24.9 I69.315 438.19 I72.8 I36.2 I97.648 I70.539 I56 I69.392 I63.512 I69.820 I77.70 I63.00 I70.439 I70.643 433.80 276.50 459.3 I70.522 I69.121 433.21 426.4 346.61 I61 I75.021 I88.8 I55 785.1 I01.9 I25.729 I63.20 454.9 I63.521 I70.769 I69.334 I72.4 I50.31 438.50 434 I70.349 I48.2 435.1 I80.219 I10 I69.115 I70.544 414.00 I69.010 I66.12 445.8 I30.9 I27.1 I80.293 432 I97.190 I69.864 I86 I34.1 410.8 438.9 I63.133 I25.89 I63.032 I34.8 I77.4 I82.422 I87.391 411.0 I87.312 440.4 I63.232 I87.009 R00.8 I69.012 I70.468 Q82.5 I21.3 I87.303 I25.6 I69.842 290.41 455.8 I69.042 I82.C23 I87.099 I69.314 I74.10 I77.812 I69.393 I42.5 I69.141 I70.491 I82.210 785.50 I69.351 I82.513 785 I69.252 785.52 I77.819 415.11 I80.13 I71.5 I82.422 I42.6 P29.30 I69.031 I70.222 I31.4 I82.603 I82.729 437 I70.621 I70.509 I70.763 I95 I38 433.3 I69.133 K55.0 426.6 I80.212 I70.723 I70.229 404.10 I83.029 437.3 426.13 I65.22 I75.012 I80.202 I48.3 I27.83 I69.815 I75.022 I27.20 I70.711 453 I65.9 I80.233 410.01 I70.291 440.2 I63.29 404.1 I82.A21 R04.89 I08.3 785.0 438.10 I70.469 I91 I69.163 447.2 I50.1 414.4 I83.002 410.5 I70.243 I63.039 I70.249 I70.269 I80.211 I86.8 I70.499 I69.363 404.02 I22.0 I69.211 458.2 I83.213 I83.028 I74.2 428.0 I70.634 I69.918 I95.1 I69.362 I31 I70.398 I81 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404 I24 455.9 I32 I70.798 I44.60 441.02 R04 I50.40 I87.302 I82.509 441 I77.3 I97.630 I69.993 I53 I83 I82.499 I69.034 I70.402 I60.01 458.1 438.82 I24.0 458 I69.144 R01.2 I70.231 I65.1 I70.429 I70.612 I50.33 I82.612 I63.422 I57 433.2 I69.221 I95.9 I78 I97.111 I04 I69.963 779.82 410.52 410.3 I70.298 438.20 I48 I50.82 I70.698 I70.533 I69.915 I69.052 425.9 I69.243 I80.229 427.32 438 410.41 I69.092 413.0 290.4 I27.22 I69.043 442.83 453.86 557 453.75 445.0 I23.2 438.1 458.21 I70.303 I70.541 I70.201 I69.154 411 429.1 I51.9 I60.7 I69.244 427.41 I72.6 I16.0 290.42 I70.793 I82.491 I69.022 443.8 I51.5 I26.09 I83.225 I37.9 I66.13 I70.329 I69.191 I70.638 444.2 I36.1 I69.91 R01.1 I08.1 I70.333 I70.462 I82.401 I82.A19 I63.519 K55.9 I82.4Y3 I82.523 I33 410.7 I45.4 I69.333 I83.219 I69.139 I70.399 426.54 I25.710 442.81 557.9 I80.231 I82.443 I80.01 P29.12 447.3 I70.245 410.70 433.91 I69.812 I50.23 448.9 434.9 I26.99 427.5 I77.7 453.6 I69.118 I35 441.3 I82.C22 I08.8 I41.07 I28.0 438.89 I97.42 I65.09 I37.0 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I36.9 I89.9 785.3 429 I69.344 I97.811 I63.113 443.21 I69.020 I70.328 I72.9 I62.01 I70.613 447.72 I82.542 785.51 I69.132 I83.015 I82.493 I67.4 426.52 425.7 I80.00 I70.338 I63.30 I78.9 I74.19 I87.392 442.9 I82.449 I69.862 403.90 402.10 I25.758 402.1 I27.21 I83.202 I86.0 I70.401 I69.093 I49.8 I95.3 433.1 I02.9 425.2 I70.519 412 I70.739 I70.702 404.03 429.5 I88.9 I01 I82.B21 410.22 I69.169 I70.368 429.82 I82.619 I82.592 I60 437.8 I80.10 414.0 433.9 I72.5 I70.591 404.12 I69.219 I73.9 I46 I63.50 434.1 I82.599 I74.9 I83.018 I82.429 I70.392 I66.11 I63.531 I70.435 I22.2 I65.02 I82.541 425.0 I69.298 I63.40 I69.263 I95.81 453.8 I82.409 R03.1 I25.759 I87.1 I69.353 434.01 557.1 I25.12 I70.598 I70.601 I79.1 R57.8 I63.131 I22 414.03 I46.2 I19 I63.439 403.91 I69.064 429.8 426.9 I63.09 I80.03 I45.89 I97 I80.31 429.79 I13 I69.032 I22.8 I26.90 434.10 I45.12 I70.639 I69.632 I59.10 I60.51 I63.411 I97.131 I69.891 I70.8 I44.0 I39</p>
		<p>346.32 335.10 G40.019 G47.54 G43.609 G44.029 G16 344 349.2 G47.20 G45.0 G21.4 347.00 G81.11 346.82 G95.19 G47.27 345.70 347.11 G25.89 341.21 322 344.30 346.93 G04.2 G40.909 G40.219 G43.619 G80.0 327.15 G43.011 333.1 349.82 327.51 G83.10 G12 G47.35 327.32 G03.8 327.41 337.00 G46.2 G96.12 G05.4 G43.101 G24.2 G47.29 G12.21 345.00 G93.1 346.72 G13.1 G95.9 331.7 G31.01 343.8 G40.209 346.40 334.9 G30.1 G44.309 G83.13 321.0 344.89 G47.23 G44.009 G11.9 324.9 G43.00 G81.90 346.20 G03.1 333.84 320.1 348.30 G30 G81.93 G95.0 G37.5 G47.12 G25.71 327.29 G40.201 346.41 G06.2 G37.9 767.0 G40.813 P91.63 G93.49 344.9 345.01 334 G47.52 322.9 G44.41 336.1 G44.82 335.11 348.39 G47.22 G37.2 G46.0 327.11 G04.89 G22 331 G41 G43.509 G83.30 320 G93.7 332.3 333.5 G47.419 344.41 P91.2 P91 328 349.1 G90.529 G25.79 344.5 G40.111 337.20 G83.89 G37.1 348.4 G23.2 G25.1 G44.81 G00.2 G40.804 G40.B09 336 G44.83 G47.00 G82.50 344.60 337 343 G47.63 327.44 G44.40 336.9 G13.8 P91.1 333.82 G47.59 G31.1 G82.20 334.2 333.71 G35 G21.0 G24.1 G25.3 G23 G46.5 322.0 327.8 779.2 333.85 G25.0 G81.01 344.04 G43.C1 G44.53 G40.814 G00.3 G43.111 342.02 333.89 G23.1 G90.59 G80.2 F51.05 G91.0 G40.823 343.4 344.01 335.20 G40.411 G44.221 G47.14 G12.25 G04 343.3 G43.A0 333.79 327.22 346.01 G18 G03 G83.9 G40.409 G44.001 331.82 323.42 323.72 G82.53 337.3 G93.40 G99.0 G43.719 E75.4 G40.009 G47.30 G47.10 G40.802 336.0 327.01 G40.B01 P91.60 323.63 340 G43.B1 345.91 P52.8 G12.8 G43.419 G07 G93.9 G40.001 327.40 G44.209 337.1 G25.4 G99.2 333 333.72 323.81 327.23 323.02 344.2 G12.24 333.4 327.59 G12.23 G43.601 331.2 333.3 G83.4 G44.219 G40.101 B45.1 330.0 G44 G83.23 G93.2 G43.001 G43.C0 327.49 G21.8 G46.7 G30.9 G40.419 G82.52 G40.A01 345.61 347 G44.321 G11.8 G00.9 330.1 G43.B0 G44.011 323.1 G31.81 G43.401 320.89 G83.20 346.80 G47.9 G43.911 G47.62 348.9 G13.2 346.90 G47.31 G90.09 335 342.82 327.20 342.11 G11.2 327.19 346.02 341 G40.119 G47.09 322.1 G04.02 G19 348.5 G43.829 323.82 333.99 342.12 345.3 G40.011 G20 G45.9 G40.89 P91.0 346.42 346.60 335.23 G03.9 G40.309 336.3 333.90 349 G04.01 346.00 327.14 342 G05.3 G44.059 321.2 G31.89 G43.701 G37 G43.511 G40.822 G43.919 G44.51 G47.36 345.41 G31.2 G13.0 G91.1 344.31 G00.0 320.2 G25.81 344.61 G44.329 G47.429 G40.824 G80.8 346.63 G46 G30.8 G43.831 G80.3 348.2 333.83 G45.4 G13 320.0 345.10 344.40 341.1 G37.3 G31 G14 333.94 G24.3 G36.9 G45.2 349.39 G24.8 G47 G04.31 G05 G11.4 341.20 332.1 344.1 G47.39 G83.5 G46.1 G25.70 G21.19 G00.1 343.9 G25.61 G40.311 G21 331.11 G32.89 G47.51 332.0 335.22 G44.091 345.80 331.81 G36.8 G00.8 G46.8 G47.34 P91.88 G43.D1 323.71 330.9 G04.90 331.89 G06.1 G46.4 348.1 346.30 G43.019 G82.54 337.29 335.8 G04.1 337.22 G43.839 344.02 327.43 G12.1 G43.901 G47.69 G10 G47.421 G47.50 G44.84 G31.83 346.62 G47.01 345 G47.19 G44.031 G25 320.7 323.51 G33 G06.0 G32.81 346.50 G83.11 G27 337.09 G24.09 322.2 344.00 346.61 G43.801 327.37 G31.85 327.42 G36 346.31 G46.3 G24.9 G40.211 G24.01 327.26 G44.049 341.9 G44.039 327.33 346.83 334.1 335.29 344.09 323.2 346.13 327.12 G47.37 327.02 G43.909 G25.5 G40.803 346.12 G12.20 327.31 G37.8 345.2 327.10 G44.311 G43.409 344.42 343.0 G06 323.01 333.93 346.81 G40.509 325 G44.211 G43 G81.00 G93.0 341.8 335.0 G09 G96.9 320.81 G44.229 G04.32 G24.4 346.11 G25.69 333.6 G37.4 G04.81 G44.201 345.81 332 G12.22 346.51 346.33 331.5 342.90 G44.099 G40.401 G95.89 346.10 F51.13 G43.501 G01 334.4 324 327.13 G44.051 345.71 327.53 320.3 345.60 G12.0 G04.91 G44.85 G43.821 G97.41 G11.0 346.21 P91.62 G39 345.51 321.1 G96.11 323.62 G80.1 G43.009 G31.82 344.81 327 G43.519 346.23 G43.119 336.8 345.40 345.50 G40.901 G40.811 G93.89 G93.6 E75.23 G21.3 G94 342.01 G45 G37.0 G12.29 G47.61 334.8 343.2 349.9 342.80 G93.41 G25.83 G43.709 G43.819 335.9 G43.811 346.53 347.01 G47.8 G97.82 G34 342.81 342.91 G44.319 347.10 G43.611 G03.2 G31.9 G44.1 327.21 G23.0 G47.32 341.22 323.41 320.82 G40.B11 P91.9 337.9 G00 335.24 G47.411 321.4 348.31 346.91 327.27 330.2 348 327.00 348.81 G03.0 346 G44.041 321.3 G31.09 346.03 G28 G21.11 G25.2 G02 349.0 327.52 G40.A09 G40.821 349.89 G17 346.22 327.35 330.8 331.83 G81.13 G97.1 G23.9 329 G90.01 G40.911 333.81 G21.0 P91.5 G43.809 335.19 G45.1 336.2 G24.02 335.21 346.92 G23.8 P91.4 341.0 G83.0 327.25 G47.25 346.52 G21.2 349.31 G25.9 G40.812 G24 337.21 331.4 G47.53 346.70 G91.2 345.11 330 327.09 403 G96.8 323.9 G44.019 G47.13 323.52 G44.301 324.0 G90.9 G42 346.73 320.9 G44.59 G25.82 G40.919 330.3 327.39 321.8 331.0 331.9 G30.0 G36.1 779.1 G81.03 334.3 G08 G47.21 331.3 G40 G11.3 G32 G04.39 342.10 G92 G36.0 323 G82.51 G45.3 G12.9 349.81 P91.819 321 G47.11 G40.A11 348.0 G93.81 G11 G40.801 G26 G80.9 342.00 G40.501 320 P91.3 G44.89 G90.519 G93.5 G81.91 G24.5 G45.8 331.19 323.61 G96.0 343.1</p>
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Infections-Bacterial		041.4 T79.A21 T79.A29 041.86 A43.0 034.1 020.1 030.0 041.5 A27.89 038.2 023.3 T50.A25D A25 021 A24 040.89 A48.0 036.1 041.7 040.82 041.10 039.3 T50.A24S A39.83 T79.A22A 036.3 A23.9 B96.81 A44 041.04 A48.51 026.1 A37.80 032.84 041.00 A41.02 H90.A21 A22.0 A40.0 B95.0 A27 A21.2 A49.3 T50.A22 T79.A29S A48 020.3 040.3 041.84 038 A30.3 020.5 T50.A22D I82.A23 H90.A32 A39.50 T50.A21A J02.0 A22.8 A36.2 T50.A23A A41.89 038.19 041.1 A41.81 A20 A30.9 020 A22.2 A41.2 A32.89 041.03 030.8 A23.0 036.81 A28.2 A36.85 A39.9 032.2 041.6 A49.8 I82.A29 036.42 B47.9 M79.A21 T50.A25A 020.8 M79.A22 038.40 041.83 A31 038.44 T79.A22S 040.81 027.2 027 032.83 A46 038.49 039 041.85 036.40 A44.0 T50.A22A 038.42 A42.89 B95.7 A21.8 A41.01 A36.9 A39.3 A20.9 A40 H90.A22 T50.A26A A49.01 A37 023.1 041.09 A49.9 A49.1 A22 A23.1 T79.A21A A48.52 A49.2 A42.7 A42.7 A28.1 M79.A29 034 A32 031.0 038.10 A38.9 A21.9 037 A21.3 A44.3 038.0 A48.8 A39.1 022.0 A49 020.9 A28.9 A39.89 026.0 036.0 036.82 A30 T50.A26 A44.1 041 T79.A21S 036 A26.7 A28.8 039.1 A22.1 022 B95.1 A41.1 A36.0 A49.4 038.3 020.0 A27.0 038.12 A20.0 A43.8 023.9 A23.8 A39.53 027.9 B96.4 T50.A23 A41.9 A36.3 033.1 030.9 040.2 A25.0 A41.51 A32.12 A36.86 A23.2 A39 022.8 029 B96.89 A22.9 030.1 034.0 036.43 B95.8 A38.0 T50.A24 B95.4 B96.5 T50.A26D 027.8 A40.8 T79.A29D A36.1 A39.82 A43 A44.8 040 039.2 T79.A22 021.9 A43.9 L08.1 A26.0 020.2 A37.10 036.41 022.1 041.9 A42.82 038.41 A41.50 A35 B96.7 021.1 T50.A21S A49.02 T50.A21D A32.7 T50.A23S A20.1 T79.A21D A37.11 A48.4 T50.A25 A36.81 A41.53 033.8 A30.8 032.82 A21.1 A36.83 032.81 A21.0 A39.2 A32.11 023.0 A40.9 041.19 M60.009 021.2 032.1 035 A40.3 B96.1 028 A36.82 022.3 A34 A37.01 036.2 A47 023 B95.2 A38 A30.1 033.9 A42.2 041.81 032.89 A30.4 A39.4 A39.0 I82.A22 020.4 A41.4 027.0 038.8 A39.52 021.3 036.89 T79.A22D A21.7 A32.9 031.2 A37.81 041.89 A37.91 T50.A23D A30.2 A23.3 T79.A29A A42.9 030.3 A32.82 A40.1 A32.81 A26.8 T50.A26S 038.43 B96.3 H90.A31 A31.8 039.4 041.01 032.9 039.9 024 040.42 040.41 030 A39.51 041.82 041.2 A36 030.2 A41.59 A48.1 A26 T50.A25S A38.1 025 021.8 A31.1 A37.00 040.0 026.9 031.9 027.1 036.9 A42.0 032 031.1 023.8 A24.0 A28.0 A43.1 B95.61 B95.62 A20.3 041.11 A31.0 I82.A21 A25.9 022.9 A42 A41.3 B96.6 B95.3 A30.0 041.12 038.9 A45 A28 A30.5 A48.2 031.8 A20.8 A31.9 A39.81 T50.A24A 040.1 A31.2 A39.84 A25.1 A42.81 033 T50.A24D A24.1 A27.9 A26.9 A27.81 B95.5 A23 K90.81 021.0 041.05 A37.90 032.3 039.0 A36.84 A42.1 033.0 A33 032.0 026 A32.0 A29 T50.A22S 023.2 032.85 A24.9 A21 A41 T50.A21 039.8 A24.2 038.11 A20.2 A24.3 A20.7 041.02 A41.52 022.2 A36.89 A38.8 031
	Infections-Fungal-and-Other	B46.4 122 B90.2 M86.642 B76.8 B58.81 M90.829 123.0 B87.2 B77 T50.B96D B69 136.4 B63 B37.1 B54 117.4 122.3 M62.3 B40.81 B67 B47.1 126.2 B60.11 B94.2 M62.89 122.4 B95 114.4 B35.0 133.8 138 123.1 115.00 B73.1 B74.8 B81.2 128.8 728.82 B57.1 728.3 B57.49 B48.8 B60.12 B35.2 139.0 116.2 B65.8 B37.81 B730.91 T50.B93S 117.7 B65.3 B39.5 B94.0 B88.2 M90.869 B67.39 115.94 730.00 127.3 B30.21 B75 728.85 B51.0 125.2 730.25 B37.3 B96.81 B40.89 134.9 133.9 M90.839 131.01 131 B47.1 B83.9 B57.32 B65.0 136.29 B36 B37 122.2 B87.89 B95.0 B50.0 B66.8 114.9 B66.2 730.81 B43 B44.89 M90.849 115.10 B38.89 B40.9 M62.838 B71.1 B83.2 130.1 730.94 B42.89 112 B60.0 B35.5 B74.4 B38.7 B52.9 M86.639 B98 117.8 B97.32 137.2 B42 B97.11 127.9 B50 730.27 B37.6 122.5 B58.9 B81.3 115.03 I32 B39.1 B37.41 122.6 B58.89 730.98 B56.1 115.99 B46.9 730.13 112.9 B55.9 T50.B96 730.95 B59 A07.8 T50.B91 T50.B92D B46.0 B67.4 M46.30 123.6 B76 B77.0 112.89 B37.84 M86.179 136.5 115.14 B73.00 B47.9 B36.0 B60.10 B45.2 730.77 730.36 111.0 B38.2 B80 120 730.38 B40.3 B48.3 130.9 B40.2 121.5 B37.0 730.82 B30.32 B83.1 112.1 122.8 M89.659 M62.81 110.4 T50.B94 B53 B43.0 730.03 117.5 111.3 B81.1 T50.B91D B46 M86.619 728.10 127.8 128.9 B88.8 130.2 M86.19 730.29 137.3 136.3 730.24 B97.0 113 B57 136.9 B87 B95.7 728.81 B97.89 B45.8 B45.9 110.6 121.2 B76.1 M46.20 B37.9 B97.10 B74.3 B57.0 A59.00 B66.1 B97.89 112.5 730.19 115.13 B37.83 111.1 728.0 B55.1 B35.1 B78.9 117.0 730.22 B85.2 H32 M86.60 M62.00 M86.20 730.17 112.84 730.18 B38.0 B71.9 728.12 B53.8 B79 B60.2 M89.619 T50.B93 B97.35 M86.149 B45.1 B37.5 A59.9 730.09 B38.1 B67.7 126.3 M90.879 728.6 B51.9 111.8 B35.6 123.4 M61.10 B78.0 121.1 B58 B44.0 B40.0 B72 B97.4 B35.4 730.76 730.15 730.39 T50.B95A B37.7 112.83 730.75 B96.22 117.2 M89.669 B36.8 728.71 B41.7 B71.0 B71.8 A59.8 B48.0 110.9 B56.9 B65.9 M35.7 B67.99 127.7 730.96 B44.9 T50.B95D M62.82 B65.1 B88.3 L94.6 730.88 123 B68.1 B46.2 M60.10 B68.9 B95.1 B86 B43.2 T50.B96S B87.81 112.81 114.0 728.2 B60.19 131.9 B57.42 120.9 131.8 B97.39 B83 M89.679 137.4 125 130.4 730.33 B96.4 117.1 B78.1 B99 B97.5 133.0 133.0 121.4 B88 T50.B92S 116 B57.2 B37.2 A59.03 123.5 B85.1 B78 B41.8 M86.9 B38 112.2 139.1 B97.29 B96.89 B51 123.9 B38.4 129 B40.1 B97.12 123.2 B40.7 728.5 B99.9 B88.9 M61.40 B71 B81 114.0 T50.31 J17 121 B36.2 B50.8 B95.8 B81.0 132.9 B57.39 M72.5 T50.B91A B55.2 B69.81 134.1 132.0 B39.2 T50.B93D 110 B42.1 134.8 B77.81 126.0 B67.5 B95.4 T50.B91S B41.9 B96.5 B48.4 B69.89 B67.61 132.2 B65.6 M24.20 B85 B35 115.04 T50.B92A 123.3 B58.00 B37.42 B47 115.05 B68.0 110.0 B36.3 B85.0 B87.9 115.01 730.26 126.8 110.5 T50.B95S 121.6 730.30 730.01 B56.0 130.8 B60 B87.82 B83.4 728.19 730 B51.8 728.11 B67.69 111 B90.9 B94.1 B96.7 M86.669 B52.8 B96.21 728.89 730.12 B38.81 B45 B73.02 B67.8 B58.2 124 730.28 B67.32 121.0 110.8 B87.3 134 D86.9 9 132.1 A59.09 M90.819 111.2 730.07 B66.4 115 125.7 130.3 B39.9 B85.3 B67.2 728.84 730.04 B69.1 A59.01 134.0 B38.9 B40 B94.9 115.12 B55.0 B42.7 127 B36.1 B97.33 B93 136.8 M60.009 128.1 B74.2 B96.23 121.8 B85.4 M90.80 A59.02 730.10 112.4 B39.3 117.9 B96.1 730.06 M72.2 B73 B82.9 B66.5 B69.0 139.8 B95.2 137.1 B42.0 B46.3 B48.1 115.09 B67.90 B94.8 137.0 M86.169 130.5 M86.139 131.09 115.02 T50.B93A M61.00 125.1 120.1 128.0 139 M89.69 728.87 M86.659 730.16 132 B78.7 B35.3 M86.129 116.1 120.0 B44.1 122.0 B39.0 B45.3 730.37 730.72 B57 040 730.85 B97.21 B82 B74.0 M86.119 128 M86.69 B39 B94 136.21 B58.83 728.88 B57.5 B39.4 T50.B94A T50.B92 B38.3 120.8 B99.8 M86.159 B96.82 730.78 B74 728.13 B48 730.80 B82.0 B36.9 B46.1 T50.B94D B68 B37.82 B96.3 B43.9 728 B58.3 122.9 728.79 T50.B96A 730.35 730.11 B62 B90 B97.81 115.91 M89.629 B81.8 115.19 B96.20 B42.81 B90.8 B97.6 B84 M72.0 132.3 126 B97.34 B41 B65.2 127.4 B45.7 730.02 M90.859 125.0 114.5 111.9 730.89 117.3 730.83 M86.18 B49 B70.0 730.90 M62.9 110.3 115.90 T50.B95 B66.0 110.1 B88.1 131.02 M72.6 B57.30 126.9 730.87 730.23 135 M62.50 114.5 111.4 730.47 134.2 M61.9 117 B44.81 B95.61 B95.62 B69.9 B52 M86.68 B65 114.3 T50.B94S B97.31 125.5 B76.9 B45.0 M35.2 B70 B74.9 M61.59 B77.9 M89.60 B70.1 730.34 116.0 125.6 127.2 B67.1 728.9 B81.4 B90.0 730.08 M89.639 B50.9 119 B60.8 B43.8 B52.0 B96.6 B97.30 B66 B89 B87.4 B95.3 120.2 M62.10 B97.19 728.86 B37.89 B57.41 B58.09 136.0 122.7 130 136 127.1 B90.1 730.71 G02 B92 114.2 B87.0 M60.20 730.84 730.86 730.99 112.85 B64 114.1 730.92 B61 730.20 M89.649 125.9 115.93 B43.82 B73.01 127.0 136.1 117.6 730.05 730.73 115.11 121.3 B57.31 M86.679 B97.7 B35.8 M86.629 730.14 B76.0 B87.1 B83.0 B73.09 B96.29 M90.89 127.5 B83.8 B60.13 121.9 123.8 B95.5 B44 B53.0 126.1 B58.1 112.3 B41.0 B97 730.12 728.83 B46.8 B47.0 B37.49 125.3 B91 B96.0 130.7 131.00 B58.01 B74.1 B56 B53.1 730.70 127.6 B83.3 B66.3 B67.0 B66.9 I39 112.0 120.3 B44.2 B55 B58.82 730.79 B42.9 730.93 B48.2 728.4 115.15 131.03 122.1 730.97 112.82 137 118 115.92 125.4 B67.31 B88.0 M89.68 B35.9 B96 M90.88 115.95
	Infections-General	041.4 017.10 B02.21 055 098.14 042.9 B09 011.80 569.5 B69 136.4 A19 078.0 057.8 A50.09 017.81 590.3 083.8 016.4 013.83 003.8 B67 341.21 372.05 016.32 380.12 015.62 017.20 466.1 380.2 001.1 001 A52.10 B94.2 H70.009 B35.0 A92.8 017.44 017.82 123.1 115.00 016.71 B74.8 T79.A12S 081 016.60 011.8 B02.24 T50.A15A A05 B60.12 T50.A25D A04.9 B33.23 T50.A11A 682.6 098.41 B35.2 116.2 131.03 018.92 040.89 A77.0 117.7 095.8 045.1 A07.4 A63 B08.1 018.01 070.3 B88.2 M90.869 482.42 A85.1 005.9 041.10 015.5 375.30 A39.83 016.36 013.53 B96.81 011.93 488.11 041.04 A48.51 B26.1 A73 A08.32 B43.1 A18.4 B65.0 A41.02 T80.A19D 018.85 B16.9 066 B87.89 060.1 I82 B29 324.9 P36.2 012.85 685 B50.0 A27 A66.5 070.70 A66.1 B02.9 T50.A93A P35.1 A48 100 B17.9 590.1 058.1 079.3 130.1 B06.00 B42.89 112 017.9 B60.0 T50.A22D B74.4 B52.9 046.2 077.9 381.1 086.0 483 056.01 A54.41 016.24 062.4 A39.9 K67 B97.11 449 085.0 007.8 013.62 A92.9 P36.39 T50.A94S 016.1 011.5 J05.10 466.0 A50.07 B00.82 015.61 B81.3 017.76 012.81 B08.010 015.04 771.3 A30.9 063.8 016.93 A52.05 B02.0 A22.2 059.22 041.03 008.69 011 21.380.1 A06.9 380.1 083.1 A28.2 A36.85 B46.0 013.14 070.52 B77.0 082.40 054.1 482.89 112.89 A02.0 T50.B12S 010.02 032.2 A16.54 B27.82 B73.00 B08.5 047 036.42 T80.A10D M79.A21 B42.5 A08.39 681.0 111.0 T50.A25A B40.3 B48.3 375.31 094.1 017.33 014 J31.0 038.4 G00.3 B83.1 045.23 011.4 034.05 01 T50.B94 A41.83 071 015.21 B43.0 016.53 048 094.8 472.1 016.04 010.94 073.7 A96.9 017.4 079.52 015.12 12.7 016.14 T80.A11S A00.1 097.9 A07 011.64 A66.3 038.49 039 100.81 137.3 136.3 382.2 B57 006.0 038.42 A51.45 B87 B95.7 771.1 H70.209 483.8 012.1 A36.9 010.01 063.9 J15.20 B97.89 420.91 B26.85 B45.8 081.2 074.22 A88 010.46 042.0 567.3 115.13 B55.1 016.54 016.35 B35.1 573.3 053.13 A37 015.75 079.2 J18.9 N11.8 008.45 056 A52.06 A54.83 A23.1 093.81 A53.0 424.90 A54.84 I40.0 H10.239 A48.52 A49.2 112.84 013.23 021.61 099.55 051.0 004.9 093.20 B14 B24 373.4 011.72 B79 098.39 M89.619 T50.B93 A80.9 091.1 A32 A17.82 031.0 M90.879 043.1 488.1 A51.9 J09.X3 A87.2 123.4 G00.9 A21.3 B40.0 B97.4 066.49 A02.24 038.0 B06.01 A48.8 017.06 730.76 421.1 098.5 094.83 020.9 001.9 115.9 015.66 A02.22 A50.03 B37.7 026.0 077.98 482.8 730.75 117.2 055.0 A93 A77.8 A04.5 A01.05 B02.32 003.21 A53.9 322.1 B48.0 B56.9 A44.1 098.50 015.70 B17.2 B67.99 H60.399 098.59 T50.A94 T50.B95D G03.9 A01.2 123 039.1 077.4 682.2 P35.2 T50.B15D B31 017.66 A80.39 A81.09 381.3 B87.81 B60.19 B32 038.12 074 321.2 131.9 012.8 A43.8 B57.42 131.8 015.92 482.2 A07.0 T50.A13D 125 011.90 072.2 060.9 014.05 027.9 101 B30.9 A06.1 320.2 B97.5 484.8 A41.9 130.0 013.90 078.19 T50.B12 084.8 040.2 102.2 A25.0 B57.2 123.5 I31.2 J15.5 B27.81 099.59 B08.72 M86.9 005.2 094.82 H59.42 112.2 T79.A11 139.1 J85.1 003.9 008.43 003.8 A82.9 480.3 A08.2 083.2 123.9 070.43 078.4 078.1 B38.4 B40.1 B00.89 034.0 A51.5 012.01 B71 006.4 513 J17 074.3 A56.4 A18.12 A77.49 B95.8 132.9 B55.2 011.15 017 008.42 T50.B93D L03.039 B77.81 126.0 A56.09 077.3 B95.4 484.5 323.71 682 074.0 008.49 B17.11 010.05 A66.8 A85.2 B48.4 B96.5 A51.31 054.42 011.41 A52.8 132.2 A50.45 A04.7 A77.9 B46.5 006.5 115.04 009 A39.82 B37.42 011.0 B08.09 054.73 A44.8 012.84 P36 B85.0 383.21 059.0 040 126.8 T50.B95S 771.0 074.23 323.51 685.0 A26.0 382.01 B01.2 B83.4 A42.82 B80.7 B67.69 015.7 038.41 B94.1 421.0 021.1 098.86 A68 T50.B15A A49.02 T50.A21D 013.22 A32.7 B58.2 124 099.49 B67.32 079.83 121.0 A54.5 A52.3 J12.0 B87.3 B70.1 B08.03 132.1 016.55 111.2 T50.A25 090.7 A36.81 A41.53 018.80 A81.01 B69.1 A21.1 098.82 I30.9 002 102.9 016.94 J04.30 A19.8 050.0 017.65 A18.18 A50.43 B93 023.0 A92.5 103 B74.2 032.1 121.8 B85.4 A18.59 A59.02 015.22 A40.3 392 T50.B16D T80.A19S B82.9 A52.15 T50.A93A A30.1 B42.0 053.11 376.00 B44.8 018.04 137.0 033.9 130.5 045.9 131.09 A05.1 A19.9 A77.1 A02.9 T50.A11 125.1 590.01 011.46 A82 128.0 A39.4 139 A99 016.0 041.0 070.0 008.04 B18.1 015.73 B78.7 B34.0 P36.10 B44.1 B39.0 077 095 383.22 A93.0 381.4 062.3 036.89 326 B82 046.72 422.91 099.0 070.30 A54.85 B08.79 016.31 372.03 057.0 013.51 A37.81 T50.B94A 017.73 464.30 T79.A29A A50.9 A54.03 A52.71 730.78 A30.2 J31.2 A02.20 010.8 372.30 A26.8 012.33 008.67 B96.3 B43.9 018.84 A18.52 B58.3 I31.4 A79.89 046.8 T50.B96A B10.89 039.4 B97.81 B05.3 091 686.1 115.19 B81.8 B42.81 T50.A95S I38 A69.20 013.96 A06.81 015.2 B05.81 126 070.20 010.84 A93.1 041.82 A56.3 A65 085.9 054.40 093.89 015.54 016.42 084.7 464.31 B05.0 111.9 030.2 A48.1 008.64 072.1 H60.40 B10.82 A06.89 055.1 052 J12.81 056.11 T50.B95 007.2 A38.1 060 A31.1 B34.3 372.04 026.9 M72.6 016.12 027.1 590.2 P39.2 126.9 110.2 011.35 095.1 482.9 013.13 B44.81 004.8 A20.3 013.65 013.8 062.8 I82.A21 382.00 B76.9 A18.10 013.54 A68.0 M89.60 A56.19 116.0 041.43 A52.09 320.82 B25.1 J12.1 A17 036.8 091.3 M89.639 001.0 074.1 A41.3 A03.8 B02.7 B43.8 B97.30 018.96 56.5 682.0 372.20 B87.4 072.9 018.81 J16.0 G03.0 A83.0 041.12 J15.6 321.3 B37.89 012.16 391.2 018.9 B57.41 B58.09 070.5 K65.2 045.03 A98.8 070 095.4 G02 A66.9 T50.B14D 053.29 B33.0 A48.2 031.8 P39.0 099.41 A06.6 A31.9 114.2 J03.90 065.1 730.99 H05.029 A55 A50.7 H67.9 047.8 017.3 054.41 050.2 127.0 016 B34 018.94 011.34 033 056.0 115.11 121.3 A42.81 A24.1 079.50 B76.0 T50.A93D 072.71 099.51 015.95 A15.9 012.10 059.12 B07.0 T50.A13S B96.29 134 B00.2 B60.13 P35.9 078.2 049.8 121.9 B44 598 103.0 A05.0 H04.309 021.0 041.8 B22 B02.31 730.74 014.81 012.83 372.21 011 B91 A77.2 B58.01 J15.9 T50.B13D 015.51 054.49 B33.3 026 A54.33 A29 053.21 A51.39 682.4 488.09 021 T50.A12S T50.A22S 088.0 032.85 A00.9 008.8 073.8 730.79 A80.4 B42.9 A41 A71.9 A80.1 093.23 567 039.8 A06.0 H04.429 P37.0 015.23 B78 112.82 041.02 115.92 A41.52 B88.0 B96 022.2 A36.89 A52.9 B35.9 I31.8 A38.8 013.92 I82.B23 H66.90 015.94 M35.8 G06.1 391 B46.4 017.86 A02.25 A17.83 122 B90.2 B19.11 T50.A96A T80.A11D A43.0 A74.81 016.51 056.00 A18.39 472.0 102 099.5 A67.0 H70.229 323.3 J09.X9 117.4 015.71 A80.0 B47.1 041.5 126.2 J21.8 484.7 I33.0 016.13 B95 016.95 054.71 043.2 422.93 045.10 128.8 B57.1 059.10 B50.9 041 038.2 016.61 021 567.1 B65.8 079.81 B37.81 730.91 018.86 B65.3 372.0 B02.23 B39.5 A48.0 B18.8 482.0 381.10 005.3 017.6 464.50 A50.6 P37.8 T50.A96 A52.11 B67

Infections-Respiratory	017.10 013.95 017.86 A17.83 J12.9 013.42 016.51 011.80 J15.1 017.83 017.42 A18.39 A19 010.91 J09.X9 017.81 015.71 017.30 013.83 J03.00 T50.A16D A15.8 016.32 017.20 015.62 017.31 B25.0 J20.6 482.32 J21.8 017.02 484.7 016.13 012.31 016.95 017.44 017.82 016.71 013.61 016.60 T50.A15A 011.33 011.84 018.93 016.61 011.10 485 015.50 018.92 018.86 J01.21 J12.3 017.70 482.0 018.01 464.50 011.31 J11.82 482.42 010.06 014.01 J01.20 016.36 J15.8 015.56 T80.A19 013.53 010.14 A19.0 011.93 013.44 A18.4 A17.9 017.22 T50.A15D J20.9 J03 017.80 T80.A19D 011.91 018.85 A18.83 013.06 016.03 012.85 A17.89 J18.1 012.21 015.01 482.82 011.42 462 017.32 J20.0 482.31 017.74 015.14 012.00 J01.10 487.1 012.06 483 012.86 017.93 J09.X1 011.30 016.24 J02.0 J15.212 016.73 010.11 016.66 J10.81 013.62 016.30 480.0 A18.6 013.10 016.34 017.25 017.13 A18.02 J05.10 466.0 013.01 J11.00 015.61 J06.0 010.85 017.76 012.81 015.04 480 011.70 A18.13 015.05 016.93 A19.2 013.80 012 A15 016.05 488 A18.85 015.53 011.23 012.04 J01.00 016.45 011.10 013.14 482.89 010.02 A18.54 013.93 J10.08 J01.41 011.96 J07 011.26 015.10 J11.08 018.05 466 J05.0 461.8 017.33 014 015.55 011.43 011.01 013.46 015.21 015.26 016.53 015.20 012.03 011.92 J10.00 016.04 013.60 J21 010.15 J01.01 010.94 010.04 461.2 J15.7 015.12 J02.9 464.51 016.14 017.41 018.82 013.52 011.64 011.83 J85.0 A18.09 482.1 J11.1 482.84 011.24 011.04 J15.3 483.8 010.01 010.83 J15.20 J20.1 A15.0 017.63 J22 016.90 013.26 A19.1 010.16 014.06 016.92 016.35 016.54 010.96 J00 015.75 016.91 J18.9 T50.A16 012.35 016.01 015.76 017.92 A18.31 010.93 012.13 018.95 016.21 T79.A19 013.23 016.41 012.14 482.49 014.85 011.72 017.01 A17.82 J10 488.1 011.71 487.0 J09.X3 T50.A16A 013.66 011.53 013.55 015.83 A17.81 J01.80 015.74 J12.89 B44.0 J18.8 464 482.83 017.06 A18.89 016.65 011.14 J10.01 015.66 J11.2 017.90 013.31 012.34 018.91 J08 010.80 J20.5 A16 182.A19 011.76 017.24 011.50 013.20 016.16 016.50 015.03 015.65 012.32 015.70 016.52 A15.5 461 016.44 A18.14 015.52 A22.1 013.82 A18.53 460 J01.11 486 017.66 480.8 464.10 J02.8 012.30 J10.89 J21.9 J85.3 012.23 016.76 017.84 016.02 465 015.92 482.2 014.03 J16.8 014.05 011.90 J18.2 018.83 A17.0 017.40 484.8 013.45 464.20 013.90 014.00 J11.83 013.11 011.54 482.41 017.56 J15.5 012.22 482.30 J18.0 015.90 013.12 011.20 T79.A19S 013.81 013.33 J85.1 480.3 J01.40 015.85 012.02 013.43 016.74 017.94 010.95 017.64 461.3 011.95 012.01 016.46 A15.6 513 J18 011.65 J17 013.21 A18.12 J01.31 A17.1 011.15 015.84 017 013.00 016.63 014.04 013.40 011.94 A18 J01.91 484.5 J06.9 J20.4 464.00 461.1 010.05 012.36 010.86 A18.50 J03.80 011.41 015.15 J01.30 016.33 483.1 T79.A19D 013.32 012.84 012.05 017.52 011.06 J01 010.10 12 015 013.15 J14 011.45 J15.211 J09.X2 016.20 015.02 013.04 J01.81 014.86 011.05 013.82 487.8 015.16 011.66 A18 015 J10.82 017.53 010.90 M79.A19 017.43 013.22 012.11 J03.91 J12.0 J21.1 484.6 A18.2 017.15 J01 011.00 013.03 017.16 J12.2 016.55 J15 016.70 018.80 488.0 013.41 013.25 014.02 016.94 011.32 013.64 J04.30 J09 465.9 A19.8 017.65 A18.18 J03.01 480.2 A18.51 012.20 016.72 J15.29 016.40 010.13 J16.00 A18.59 015.22 016.75 018.00 017.51 513.1 T80.A19S 012.85 016.05 015.00 A18.82 017.50 018.04 018.06 013.85 J16 011.55 A19.J J20.2 015.06 011.22 011.46 011.73 J06 016.22 010.03 013.30 017.60 015.73 017.05 012.25 017.46 016.10 T50.A15S 012.82 J04.2 016.31 013.51 A18.81 013.36 J12 017.73 017.91 464.30 018.03 010.10 A37.91 016.43 013.16 010 481 017.35 A18.17 015.86 011.56 J20.8 T50.A16S 011.52 017.72 010.00 011.36 015.82 012.33 011.03 483.0 A15.4 018.84 013.35 A18.52 011.51 012.24 018 J11.89 J03.81 J15.0 013.96 G40.A19 010.84 017.95 010.92 015.54 464.21 016.42 464.31 016.25 A48.1 011.63 464.01 464.4 012.12 T50.A15S J04.0 015.03 015.60 J20 011.11 484 466.11 011.25 013 J12.81 017.23 015.96 016.12 013.63 484.3 461.0 017.03 011.35 480.9 J04.10 013.13 017.12 013.65 015.63 015.80 015.93 A18.10 018.7 T79.A19A 013.54 J04.11 482 016.62 011.75 A17 J12.1 016.56 J10.83 017.36 011.13 J10.1 011.85 016.64 018.96 011.61 015.91 015.48 481 018.81 J16.0 013.05 J20.7 011.86 015.81 J15.6 017.71 012.16 A15.7 011.40 013.50 J02 018.90 016.26 013.91 J15.4 017.14 482.39 A18.32 482.9 A18.11 J03.90 016.11 015.24 465.8 011.60 010.82 487 017.96 013.94 012.26 013.34 016 017.55 018.94 011.34 011.21 014.82 018 012.05 015.95 J20.3 017.26 017.00 A15.9 012.10 017.54 J11.81 013.56 015.72 013.02 017.34 016.15 J10.2 012.15 011.74 480.1 J05.11 011.44 017.45 014.83 015.13 017.11 014.84 A18.01 018.81 466.19 J11 015.25 A18.84 016.06 016.23 017.21 014.81 A18.16 012.83 J85.2 014.80 017.75 011.16 484.1 011 017.61 J15.9 017.62 015.51 011.12 463 J05 J04.31 A18.03 J85 016.96 482.40 012.80 013.24 013.84 J04 464.11 011.62 J19 017.85 014.02 J21.0 015.23 011.81 T80.A19A J13 013.92 461.9 015.94 011.02 465.0	
Injuries	S06.9X4S T84.490D T63 S63.621D S82.232C S65.391S T85.614 S25.809D T85.398 S72.346 S83.011A S60.212A S66.526D T80.59X S52.232D S53.026A S82.115P S56.822 S86.391D T63.614D T50.992S S61.221S S19.9XXA 943.23 T23.179 S71.131 T80.410S S93.129 T40.0X2 T81.83XS S72.436R S63.433D T24.591D 832.01 S72.91XK T24.031D S36.533A S56.196S T22.232A T24.332D S92.355K S59.129 S31.112 T78.3XX S66.120A T81.516 S21.442D S82.343P 803.50 S63.232S T53.0X4A S92.123A S36.020D S72.019A T63.511S S82.864R T65.831S S63.657D S14.157 T04 T84.620 S22.040K S56.892D S72.441A T56.1X1D T83.85X T53.7X3 S68.123A T47.1X6S T26.71XA S14.4xx S89.002D T53.1X1 S62.307S T65.213S S82.241A T22.741A S62.023D T46.6X1 S32.131K S52.515C T65.0X3S S46.012A S52.265C S92.221B S65.111A S06.1X1A S60.461 S61.549D S36 814.03 S24.151A S50.811A T62.1X1S S42.446P S52.264G T24.491A S52.042A S92.599K S66.4X9A S92.416D T01.1X1A T81.507D S12.600B S82.492P S21.351S T45.1X4S S32.000 T75.4X4 T82.391 T43.623 S36.290 T54.3X1S S42.209K T56.3X3D S59.222 S99.829S S09.19XD S24.32D S63.652A 942.45 S32.471A T40.3X2 S60.444D S82.146S S82.822K S50.10X T83.022S S56.128S S05.91K S82.874Q S42.119 S25.402A T82.322 S62.614S S86.929S S90.464D S74.00xA T65.4X2 T61.784D S83.30X S32.456B T53.93X T24.501A S37.69XA S37.091D S63.022D S80.849S T46.991S S61.021 T49.0X5 S90.411D S30.826 T63.834 S64.494A S42.033D S32.058D S42.191D S52.332C S31.110S S82.871M T43.4X5S S95.911S 861.20 S20.309A S01.01X S13.171D S72.366M S82.154B T79.5XXA T83.69XS S09.90x S00.252S S83.096S S01.90XA S72.031K S63.439A S06.365 T50.292 T25.139 S09.312A T50.211D S37.031 S82.426A S82.022K S95.809 S12.300K S35.338S S92.244D T23.799 T28.412 S82.254 S62.312 T22.022S S02.118B S06.6X2D S60.940S S31.20XA T17.408D S09.312D S52.399F S62.251K T63.071D S82.464Q S52.243J S82.465Q S82.401N T49.8X6A 914.3 S55.212 S59.102K T86.23 S96.899 S22.050S S41.112D S50.11XA S52.272M S72.416C S82.876G S22.039D S42.144G S63.227A S66.511A S72.416S T85.511A T48.4X4 S82.034R T20.691D S82.62XP S42.112B S52.244 S92.031K T12.151K S42.216 S41.031A S15.202D T23.079D S39.91XS T19.4xxA S82.291A S92.491K S01.449S S52.361J T63.813S T63.713A S72.434J S82.016D S99.029B S22.002A S80.911D S83.231D S82.209H S90.933 T78.07XA T53.2X1S S82.461 T36.7X2 927.8 T82.897A S72.365F T20.72x S63.065 S72.11B 821.00 S63.432D S65.911D S96.102A 944.46 S30.857A S83.001 S22.032D S87 S93.324D S15.9XXS S41.031D T63.93XD S82.154 S60.031 T23.469A S21.429A S52.282 T71.223 S62.338G S82.443D S67.90XS S92.111P 887.7 S15.121D 917.7 S66.516S S70.12XS S82.143A S56.0 T39.8X3S S72.012D S90.01XD S61.1205D S82.242S S82.843M T46.6X6D S39.002A S62.331B S09.312 T45.2X1S S82.843D S86.111S S20.02XA S42.335A S59.299A S20.112S S81.019 S32.120S S81.23A S92.331G S50.912 S50.02XA S67.194 S02.630K S82.033P S66.002A S61.234S S61.217D 901.1 810.12 S89.392P S60.342 S52.265N S60.471 S00.451D S53.091S S72.041D S59.101G 923.03 T24.031A S01.81X S89.101K S51.842A T52.2X4 S92.323D T50.4X5S S82.234J T23.351D S76.311A S52.044R S82.872M S83.262S T55.1X2 T71.234A S82.156K T38.4X2D S31.145D S62.399P S63.217A T41.0X2 S92.411D S63.121D S52.225 S56.329D T23.091A 866.10 S45.011A S36.99XA T72.361A S52.343F 949.4 S75.811S S81.822D S82.124P S72.442D S46.891 S92.326D T25.219A S72.425F S42.251B S66.120S S88.021S S27.69XD S52.513J S60.569D T63.832A S65.508S 935.1 S82.113N S62.329D T83.39XA T63.823A T61.04XA T81.532 S42.035 S02.602A S52.609A S56.418D 806.31 S82.253Q S98.912S T21.31XS T37.5X6S S09.0XX S72.344D S25.192S S25.511A S59.919S S62.637B 812.19 T33.519A S00.221 S01.401 883.1 T24.501 T18.120S T14 T48.0X5D S40.862D S30.870S S92.242G S48.021A S52.035S S52.321B S52.334R S62.620P S42.409A S43.402S S62.513D S82.126A S92.051D T43.226A S62.637A T21.33XA S62.644P T48.1X6D S45.392 S52.223A S45.1X4D S92.356K S72.052K S52.365C T65.6X1A S72.341H T82.872D 844.8 S89.312K T37.8X4 S34.101A T84.121A S10.92XD S61.344D T20.63X S92.513 T32.321A S62.226P S12.040S S93.409S S03.02XA S45.901D T39.1X1A T81.519D S62.102S S63.391S S37.022A S62.601 T43.601 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T85.122S S62.92XG 915.4 S62.311A T63.634S S72.322B S60.559D S82.192P T41.205D S89.099P S07 T65.214 S52.511G S36.30XA S65.091D S66.313 S01.422D T36.6X2S T50.991 S75.999D S92.401P S26.91x S85.131 T87.0X9 S52.326N T17.910S T50.4X1 S65.999A T49.7X4S S55.811 S32.509G S62.164D S91.141A T23.479S S72.90XS S62.335S S93.333S S43.91XA S52.263F 913.1 S82.862S S56.122S S76.011 T83.25XA S31.122D S62.186B 943.31 S92.351B S10.14X 945.36 S70.369A S31.639 S89.199G T56.1X2D S75.199S T52.4X2A S31.551S S52.132B S62.308K S62.629P S61.541 S89.312P S72.451A S82.022F S93.602D S66.510 T36.4X3D T23.442A S32.442 S37.818S S66.911D S92.343S S30.842S S99.129G S63.093 S12.291K S32.601G S68.711D T45.69S S27.53XD S22.068K S92.233D T80.A9XA S90.02XD S00.04XD S62.224K S82.444K S04.032A S42.482P T49.0X1S S75.091S S56.019A S52.026N S82.846A S52.261K S68.114A S20.222A S92.513B T41.41XA S52.611H S14.107D S92.141S S52.336F S32.008B S12.112S S42.331G S63.251S S82.436Q S30.846 S52.512Q S82.453M S52.002R T23.442S S01.339 S06.9X4 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S92.422G T71.193S S82.491G S50.861D T44.993A S82.012R S30.92X T23.312D 834.02 S72.462G S63.633S S65.502A S61.348 S72.115R T46.5X2D T26.12XD S62.610D S37.429D S82.876J T21.71XA S93.429S S76.929S T49.2X5S S62.342P S62.222B T63.793D S32.421A T24.731A S21.329A S09.0xxS S98.011A S62.515S S72.346H S63.106S T28.911A S63.636 S72.063D S04.042A S62.514B T84.112D S59.202P T56.5X1D T34.512S T36.4X4S T45.615D T24.202A S42.332K S20.479A S72.116N S82.199R T65.222D S53.106A T45.4X3A S92.062D T69.9XX T38.2X1S S72.415B S86.801S S46.121A S91.359D S89.80X S92.346G S82.426G S82.891Q S92.054P S42.443P S42.296K S53.193S T63.114S S37.591D S92.919B S31.23XS S20.469S S92.522G S24.149 S82.424J S42.125S S99.222G T48.204D S60.473S S09.21XD S62.638A S92.812K T40.904D S82.043M T20.32X S12.391D T22.17XD T22.791D S83.420S S61.243S S62.176S T23.449 S43.121S S62.025P S83.252D S00.01X T22.052D T79.A12D S30.93XD S25.892S S82.422A S20.462D S45.019A S42.463K T63.061A S27.812S T51.3X4 S69.90XS S93.135S S32.444S T23.179A S99.142S S25.502 S56.012D S81.839D S82.092J S20.2X1D S50.322A S00.471S S32.811K T85.860 S61.353A T82.221S T34.3XXD S84.20XD S72.133M T54.2X2 S09.399A S62.251S T76.822S S82.141B S78.911 T83.23XA S93.303 S34.103D S52.599P S21.232 896.3 S06.6X3S T45.7X6 T38.4X4 S82.235D T23.321A T36.8X2S S42.115G S14.135D S72.324R S82.846D S96.999D S63.635 T83.83XD S70.593S S06.4X1D 848.40 S65.811A S66.401S S82.312G S52.311D T16.2XXA S82.102H S52.246C S56.802S S06.384S T65.291A S36.269A S02.621A S83.211A S72.326A T17.598A S36.299 T23.672S S42.156 S52.132E S63.423A S82.431K S66.501A S62.252S S20.342A S42.492K T85.613 S32.409K S01.342A S60.542 S63.312A T67.5XX S51.822A S66.902S T33.90X 805.02 S92.035D T33.02X S83.122D S65.291S S30.0xxA	

Integumentary		<p>L10.81 L89.813 709.2 L02.639 R20.8 L02.619 L97.218 L92.8 L21 690.12 L56.2 Q84.0 778.1 521.15 L64.8 L03.123 L06 R23.9 782.8 L94.9 L03.213 L16 L97.503 L89.814 L98 L97.923 L66.3 L97.812 L02.422 L89.514 L02.33 680.9 690.18 L97.529 J70.1 680.0 L97.824 L89.149 757.5 L40.4 L97.413 L51 L63.0 L92.2 L97.504 L93 L24.89 704.00 P81.0 529.2 L02.432 709.01 K08.51 P83.8 L08 L89.124 525.0 L89.129 K05.00 L10.2 L72.2 K08.403 L89.614 K13.29 L03.212 L71.1 522.7 703.8 707.02 L49.7 L02.235 690.8 695.3 705.0 737.33 L89.209 L94.1 L04.2 729 K03.9 L02.239 L89.133 L41.5 523 L29.1 707 L98.422 L89.620 778.3 782.1 L89.610 L41.8 778.0 L40.3 L35 521.09 710.9 L43.2 L03.114 L12.2 L64.0 L81.0 L49.5 L97.205 L97.306 525.64 L26 521.32 L89.103 L92 K08.530 L97.929 528.6 L89.629 L66.1 Q84.3 L89.603 L90.2 L12.0 K08.0 K05.30 695.57 L08.81 L70.3 L97.314 K08.9 L04.8 L50.8 L24.0 L89.503 L20 558.1 M35.9 692.71 L32 L89.009 L58.0 525.42 L97.118 L74.2 L89.40 L97.309 L30 L70 L40.8 L98.498 L69 525.52 L81.5 525.44 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	Metabolic	<p>269 E83.30 270.5 P71.4 276.7 264.1 712.38 M1A.9xx0 274.82 E71.42 278.02 274.19 278.01 276.69 263.8 712.86 E72.8 268.1 275.40 274.03 712.28 M10.30 E66.2 783.1 E74.9 E71.41 270.8 712.19 E83.59 E87.70 M11.80 E50.7 E88.1 275.42 E67.0 260 M10.9 E46 274 E72.20 M11.88 276.3 712.84 E83.50 P19.0 264.3 E50.8 278.2 275.1 E50.1 M11.20 E83.81 R63.4 775.9 277.81 268 712.36 277.88 E83.40 E53.9 271.9 P71.3 E87.1 M11.879 270.7 E52 D84.1 273.9 266.2 264.4 265.1 274.8 712.1 M11.249 712.8 M11.849 277.82 E72.9 M11.269 712.16 E50.4 712.88 M10.40 M11.28 269.9 E88.9 264.9 268.0 E55.9 278.0 712.85 266.9 277.9 E75.21 712.3 712.89 712.27 712.97 277.8 P72.8 M11.859 278.3 264.0 278.03 G93.9 E53.0 E16.1 271.3 251.0 775.89 E70.0 P71.1 E51.11 P70.1 275.5 P70.4 277.7 272.3 712.15 E50.6 277.87 712.39 274.81 712.96 712.10 274.02 E87.8 712.90 E15 273.8 R63.0 271.2 E66.9 277.86 266.0 E53.8 E64.3 263.1 278 E87.0 272.5 E66.3 712.32 E67.1 262 712.92 M11.9 M11.29 712.31 272.1 P19.1 P71.8 M11.279 712.95 277.85 E65 E88.40 775.81 783.22 E61.4 783.2 263.2 269.0 261 E83.89 P71 M11.829 P74.0 E74.12 274.89 E70.21 E72.03 712.11 E50.2 M11.869 712.80 P19.9 E50.5 264.6 712.13 275.49 E16.2 E54 E67.8 712.83 276.8 278.4 775.7 712.37 E78.3 270.2 270.4 E53.1 E83.52 M83.9 269.2 269.1 783.21 712.33 M1A.00x E87.4 E87.5 P70.3 268.2 271.8 E87.3 M11.259 E76.01 E87.2 266.1 P71.2 E88.01 E55.0 251.2 266 273.4 274.00 272.2 275.01 275.8 712.98 E56.8 E56.1 E74.21 E44.1 272.7 712.91 263.9 E88.81 E78.89 E78.9 712.34 269.3 274.01 263.0 P70.9 712.22 277.2 E74.39 263 E67.3 276.6 E88.09 E50.3 E72.10 R63.5 E43 P19 265 275.9 264.5 E66.01 E83.00 E80.0 E88.89 712.18 E83.118 275.4 E63.8 264 274.10 277.5 275.3 712.94 712.12 E44.0 E40 M11.819 276.2 274.0 E51.8 270.6 E79.8 274.1 267 E83.9 712.23 276.9 272.4 P71.0 G93.89 712.2 712.87 E83.51 P70.2 271.1 276.4 E45 712.93 277.89 P84 P71.9 M11.89 E87.6 E41 712.17 265.0 E78.2 272.9 277.6 274.9 276.0 E56.9 E70.40 E83.110 M11.229 268.9 712.25 272 270 330.2 271 712.35 M11.839 264.2 275.09 712.30 276.1 R63.6 264.8 277.1 270.9 P70 712.21 278.8 272.6 712.9 275.03 M10.00 270.3 270.1 E88.3 E50.0 N20.0 775.8 P70.0 E63.9 E71.50 278.00 712.29 E74.4 274.11 E83.10 712.24 275.2 E78.1 P70.8 712.99 330.3 712.82 712.81 M11.219 M1A.9xx E50.9 251.1 E78.5 E78.6 272.8 P19.2 E71.318 264.7 E71.0 783.0 712.26 712.20 269.8 M1A.00x1 P72.9 265.2 M11.239 712.14 275.41 278.1</p>
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Musculoskeletal		<p>553.9 M84.574D Q67.5 M84.442S M70.30 M25.761 M46.87 550.00 M60.231 M71.829 M85.622 M84.675A M84.753D M08.429 733.20 M84.472 M60.239 M84.346K 727.6 M12.332 735.1 M84.550K M62.241 M71.062 M66.219 M05.051 M24.275 552 M67.479 755.67 M89.322 M27.59 M25.842 M80.821S M84.753A M84.573P M54.02 718.80 M53.86 M85.58 Q65.00 733.43 717.41 M24.174 718.9 M85.012 M84.58XG M15.9 M10.452 M41.22 M20.21 M84.522K M16.10 M23.041 M66.211 M19 M13.822 M24.231 717.82 M90.871 M87.035 M48.57XD M96.679 M21.40 M32.12 M93.841 718.82 M46.96 M65.341 M11.10 M25.222 M67.279 M80.019S 719.99 M66.172 M84.462K M84.442K M96.639 M80.011S M08.231 K43.7 M08.849 M23.007 M12.212 M48.02 M84.619G M65.171 M67.229 M66.272 M60.819 719.90 M11.049 M84.553A M85.812 M89.312 719.70 M06.811 M12.449 M45.0 M79.4 M26.03 M24.075 M86.151 P13 M24.676 M99.77 M84.651 M10.329 M89.752 M23.91 M05.271 755.30 M80.052 M05.842 M08.829 M96.662 M00.232 M80.069A M85.311 M63 M94.279 M08.839 718.47 M77.30 M80.012G M05.372 M15.4 M62.511 719.04 M89.542 M84.561S M84.572 M94.9 736.05 551.01 M08.469 M94.0 M71.129 M80.011P M99.9 M07.649 M67.832 M05.519 M25.642 M84.533D M54.15 M05.069 M62.259 M84.662K M24.031 M20.001 M90.551 M60.031 M05.60 M61.146 M24.651 M41.112 M93.811 719.12 M89.619 M08.911 M14.879 M08.3 M05.69 M00.162 M05.722 756.55 M05.431 M18.32 M70.951 M80.859G 730.39 M92.12 M48.43X M65.852 M26.00 M23.052 M24.572 M40.14 M80.079D M86.542 M05.049 M65.261 M65.011 M84.663P M60.172 M05.811 M11.822 M71.562 M85.321 M99.21 M67.971 733.1 M84.364P M02.10 M60.074 M83.1 M35.9 M97.42X M12.529 M05.879 M87.032 M46.38 754.5 M90.672 M50.23 719.50 M85.859 737.21 M12.9 M84.452S M84.443 M11.869 719.45 M93.879 M36.3 719.25 M89.49 M76.899 M08.929 M71.869 M89.042 M70.21 M87.334 M10.451 M26.23 M85.00 M06.831 727 M80.831 M90.852 M76.42 M89.28 M65.332 M86.661 M23.631 M50.823 M75.00 M05.479 M84.379 M10.321 M86.021 M61.129 M79.0 M84.569K M61.229 Q79.4 M08 M62.441 M66.811 M06.859 M54 M45.1 M84.571G M84.672D M23.005 M47.13 M84.612S M84.542 M67.272 K08.23 M12.379 M24.839 M10.019 M89.439 M48.51XS M89.30 M25.149 M22.3X2 M89.061 719.20 M84.756D 552.3 M60.831 717.0 M89.08 M32.11 M90.861 M42.09 M54.13 M12.519 M92.291 M93.851 719.83 M23.212 M71.80 M87.838 M06.059 M84.462A M99.43 M66.842 M23.322 722.30 M84.663K M01.X51 M07.60 M24.376 M80.069P M20.031 M72.2 767.5 M61.161 M02.361 M00.811 M26.213 M87.861 M84.673 M85.071 M84.475A M84.519P M99.18 M71.552 M24.575 M43.04 M12.579 717.8 M89.78 M12.219 M84.639 M84.563P M89.165 M60.261 M80.00X 730.37 M34.1 K40.10 P11.3 M26.82 M84.322G M84.564 M46.52 M51.05 718.89 M88.88 M05.121 M05.10 M84.674D M84.342D M89.571 M80.872A M84.841 M23.352 M71.051 M93.969 M99.01 M63.869 M48.061 M02.122 M21.379 Q65.30 719.92 M21.221 M25.361 M87.29 M84.359P M90.511 M72.0 M11.032 M85.639 M60.262 M80.00XP M84.350A 524.07 M94.261 718.41 M86.432 M54.81 M84.459 M10.422 M84.446K M84.572S M23.009 M06.4 M72.6 M87.263 729.39 M14.659 M87.274 M41.41 M84.750A M84.639A M84.672S 719.49 M91.10 M99.00 722.72 M14.621 M61.59 M67.942 M80.869G M89.032 M24.562 359.5 M60.019 M76.61 M24.371 M87.850 M92.219 M84.432G M13.841 M80.822 M84.474D M85.331 719.16 M25.051 M84.353S M94.229 718.73 M19.032 M84.38XK 717.83 M80.031 M84.632K M94.232 M90.532 737.41 M84.575 M10.349 M86.621 M21.859 M60.20 M61.512 M93.022 M84.649 M10.159 M71.811 M05.762 718.76 M23 M84.669D M48.8X5 719.91 M87.037 M52 M10.022 M84.511P M62.011 M26.31 M47.23 718.4 M31.0 M25.641 M11.219 M65.872 M24.112 M65.141 M21.331 M84.757 M20.092 M80.851D M27.0 M87.151 M99.08 M05.742 M70.971 M97 M84.534S M08.412 M43.8X8 736.02 M84.632A M87.011 M24.021 M61.461 M21.629 718.84 M40.56 M84.369G M87.378 M06.849 M89.157 732.8 M66.89 553.03 M92.299 M42.00 M71.572 M35.62 M02.152 755.65 726.70 M89.8X9 M12.822 M80.042K M84.433G M88.832 M67.411 M23.307 M24.7 M05.759 M67.864 M61.412 M54.08 M10.169 M84.434K M18.50 M24.276 M62.89 M84.833 Q65.4 M40.00 M02.022 M85.329 M60.259 733.10 754.81 M80.80XG M90.542 K08.20 M11.019 718.97 M71.121 756.53 M21.029 M62.131 M26.221 M25.129 M34.82 M86.261 M80.042S M86.462 M47.016 736.75 M46.81 G71.19 727.49 M61.071 M71.21 M02.18 M11.152 M80.829K M12.039 M13.31 M88.841 M85.48 M85.129 M84.361 M60.839 M84.350G M84.422G M19.079 M54.9 718.77 M23.003 M80.852S M60.073 M87.031 M71.479 M61.022 M05.321 719.19 M06.022 M84.352D M34.83 M62.419 M11.051 M84.369K M60.821 M90.551 29 M76.891 M66.352 M67.451 M86.061 M24.171 M86.079 M05.429 M97.42XD K44.0 M60.112 M90.552 M06.051 M05.552 M47.28 M08.48 M12.249 M84.439P M00.221 M85.332 M11.021 M85.029 M76.12 M26.52 M86.442 M84.334S M84.576P M13.112 M10.112 M86.252 M94.1 727.3 M85.342 M85.879 524.06 M85.821 M10.359 M84.475S M12.532 717.7 M27.62 M26.73 M43.01 M12.861 M60.869 M84.459A M17.5 M85.061 M48.55XD M88.839 M76.892 M19.022 M80.861A M84.321S M65.311 M80.852P M96.843 524.1 M80.019G M93.839 737.34 M84.632P M90.811 M18.11 M43.20 M24.673 717.81 M14.629 M61.032 M05.461 M85.052 M24.642 M67.89 M89.163 721 M35 M87.20 M99.41 M05.169 M84.575K M08.40 732 M05.349 M42.9 M80.80 M84.434A M86.559 M12.852 M70.11 M51.25 M94.221 M96.5 M25.28 M66.351 M84.345S M84.752S 526.69 M07.611 M87.261 M70.969 719.17 738.7 M84.312P M33.93 M66.371 M84.662A M48.54XS M89.124 Q65.1 M86.039 M65.821 M25.075 718.0 M84.532M M67.841 M75.52 M80.00XD M17.31 M11.142 M66.311 M24.22 M65.062 M84.652S M80.019A M89.162 M60.046 M32.9 M84.631D M87.132 M23.8X2 M84.552P 722.6 M43.4 M87.271 M84.542D Q67.7 M05.631 726.7 M62.58 M84.751 719.77 M84.671P M96.65 M99.31 M26.06 M62.529 M62.28 M12.121 M60.032 736.22 M71.862 M79.69 M87.00 M05.49 M48.34 M25.039 M24.232 M92.9 M20.42 M80.859P M90.579 M62.459 M20.039 M99.33 733.82 754.44 736.29 M06.321 M84.753P M60.279 M80.861P M84.433D M26.24 M33.02 M80.029G M11.221 M84.443A M65.121 M06.011 M25.531 M21.239 553.2 727.0 M66.852 M86.469 M70.869 M01.X39 M50.221 M84.662S M99.47 M80.052D M84.839 754.42 M10.072 M87.135 M31.31 M87.076 M91.229 M85.842 738.9 M12.361 M79.3 M48 M05.222 M48.56XD 719.56 M84.353A M77.00 M80.851S M80.051D M24.271 735.4 M84.362G M86.569 M80.862K M63.842 526 M80.069D 717.40 M80.88XK 736.0 M87.077 M92.30 M02.211 M25.532 737.29 754.59 733.94 726.8 M67.371 M85.572 M41.30 M08.229 M05.351 M05.512 M42 M25.229 M02.39 754.60 M42.13 M25.871 719.64 717.5 M06.272 Q66.3 M66.132 M61.239 M66.839 M08.042 M21.061 M93.952 M89.462 M96.661 M25.142 M86.8X3 M85.421 M10.131 M91.42 M89.321 M25.419 M71.451 M87.339 M70.911 524.12 M61.00 754.6 M06 M84.451G M86.329 M89.221 M80.052G M89.359 M05.712 M84.758 M86.659 M40.37 718.18 M24.451 M60.061 M47.25 M01.X32 M05.562 M84.476K 726.72 M97.02XD M14.669 M80.052P M87.236 M85.422 M86.172 M89.339 M80.822A M21.539 718.08 M41.43 M84.434 M05.672 754.7 M84.431P M85.839 M05.052 M67.829 M84.663D M75.32 M90.859 M87.363 M12.369 M84.476S M12.062 M80.019 M06.331 755.35 M12.079 M60.162 M84.532 M84.633D M99.16 M06.09 M24.312 M95.4 M90.662 K45.8 M46.05 M08.012 M11.272 M61.19 M46.24 M84.673D M48.8X9 M79.9 M84.755S M12.39 M64.58XA 736.73 M21.511 M00.271 M21.162 M66.329 M59.172 M4.84 443P 719.01 M05.741 M66.331 M84.659G M67.429 M20.22 M80.831P M84.431A M60.045 M25.339 M60.242 M20.62 724.01 M19.279 M48.56XG M65.147 M48.41XG K08.26 M71.821 M06.012 M66.332 M12.09 M66.369 M86.279 M47.813 M11.271 550.11 M12.462 M54.14 M05.122 M79.645 M71.039 M89.231 M87.372 M62.449 M11.111 M05.862 M92.01 Q72.10 M47.24 M99.42 M43.22 M20.10 M06.341 M33.29 736.72 M56 M71.819 M86.452 M65.28 M00.842 M50.80 M79 755.33 550.93 M80.039K M00.152 M25.271 M66.122 718.93 M50.12 M84.68XP M89.59 737.39 M25.772 M19.141 553.00 M65.151 M05.022 M80.811A M70.89 718.83 M10.011 M10.261 M90.50 M11.061 M89.158 M19.039 M86.132 M16.7 M84.350D M41.07 524.63 M46.1 M15.0 M12.131 M89.272 M93.832 M48.31 D48.1 M11.18 M05.771 M35.6 M12.141 M24.652 M87.029 M61.171 M33.11 524.61 M25.06</p>
Neoplastic		<p>C21.2 C05.8 D04.20 C81.30 202.64 172.5 C93.Z1 D46.C 277.84 C44.301 229 C60.0 C75.3 C44.691 D28.2 C66.9 D37.030 160.0 C91.00 D07.69 D3A.023 173.01 233.30 C34.01 C85.80 D44.4 C45.0 234.0 217 D41.8 209.3 273.3 C44.292 D30.8 227.9 194.9 D06.0 202.52 171.9 202.53 173.41 D29.22 206.2 151.5 C44.112 D38.5 D27.1 C45.7 600.1 D02.4 D07.2 C45.1 210.5 201.72 174 C16.8 155.2 C85.29 155.1 C57.12 192 D44.12 C50.122 C82.02 140 C81.77 149.8 C91.01 C25.8 201.50 237.3 C04.40 C08.9 C84.42 140.6 C83.19 152 186.0 198.8 D23.12 181 146.1 C44.622.81 1 C66.1 202.55 C78.6 100.50 C91.40 236.7 195.0 C96.2 196.0 196.6 173.92 C49 216.8 205.11 D23.21 198.7 206.82 C93.32 189.2 193 D05.01 173.9 140.1 200 200.21 C44.92 233.9 D30.4 C06.0 236.6 C84.07 C44.199 202.2 238.74 228.03 C10.2 D3A.020 C82.44 229.0 C83.72 125 205 C62.00 C33 202.31 D46 C78.7 144.9 188.6 C85.21 C50.422 218.1 C73 C06.0 C69.62 D31.00 C36.13 C76.41 172.2 201.74 187 172.9 173.82 161 D25.1 C44.82 C50.129 C48.8 200.16 175.0 D35 C25.9 C81.04 C84.44 204.10 C44.310 205.32 C49.0 182.C29 C50.629 200.55 C49.8 D41.00 D05.82 204.81 D48.4 203.1 C81.90 C38.3 C68.8 623.7 209.34 208.91 239.5 C63.86 185 164.0 164.1 C82.46 151.8 201.0 C34.82 235.8 C84.13 198.0 203 202.06 C51.2 200.48 157.1 624.3 D42.1 C34.2 D21.4 204.30 205.91 C44.721 C69.40 164 C82.28 200.5 D01.49 M20.11 C49.A4 C43.60 D02.21 C44.219 C84.08 D30.00 C72.32 D15.7 C74.01 206.92 C83.13 C7A.020 C81.35 D23.61 202.42 160.1 D31.50 143.1 D31.32 C62.10 200.54 202.43 C81.99 C81.21 D36.10 D35.01 C84.3 A3 D10.4 C82.23 209.65 C72.21 C90.20 D05.00 C22.1 213.1 Q85.00 D24 173.52 202.11 C34.31 173.6 D13.7 D03.70 190.3 201.08 D15.0 C76.50 D12.6 D41.21 D3A.098 D26.0 184.1 208.2 C84.54 C84.10 225.4 C83.79 D39.9 C82.34 145.4 C69.01 C79 201.75 C84.A2 C41 143.9 C84.A9 214.4 D27.02 208.8 227.4 206.1 C15.9 C91.Z1 200.37 C17.3 C83.05 207.2 600.9 C50.222 D01 623.0 C81.20 209.13 D06.7 C09 201.73 C90 C88.8 200.30 C84.90 C40.22 C92.30 201.58 202.57 155 C50.619 D47.29 200.72 C82.94 170.2 C34.30 215.8 C40.50 C83.51 C92.41 201.94 204.8 173.32 173.91 E31.22 C50.311 D13.5 200.65 207.21 Z15.01 201.6 C16.6 C50.911 206.81 D31.10 D37.6 D07.60 C60.2 C82.24 C82.89 C43.39 C69.11 C82.21 D31.9 C76.51 D05.12 C83.34 C44.319 159.0 232.4 C84.61 C44.41 201.52 D03.4 C92.61 153 237.70 D21.9 D21.5 D38.2 D30.11 D18.03 209.11 233.39 D22.30 201.54 173.59 C48 209.30 C67.9 C72 C7A.00 C82.88 C16.0 C25 C18.2 C18.4 D23.72 189 C88.0 D05.02 C24.8 C68.1 C76.40 C63.12 147.0 C47.20 C82.33 C84.A5 D28.9 C48 92 201.1 205.80 C49.A2 C51.8 C78.01 600.20 D16.5 216.0 228.0 C44.91 149.9 C93.90 153.0 C46.50 200.10 199.1 D31.01 202.50 C82.81 223.81 622.1 233.6 C50.822 202.83 C44.01 C82.38 C83.91 C92.92 N60.89 C62.90 C44.712 C26.9 228.00 144.8 220 D21.5 759.5 C85.25 624.01 D03.62 D30.20 209.50 216.9 239.7 C84.Z2 C50.922 190.0 C44.399 C85.96 C85 201.07 D28.7 207.0 157.9 D3A.00 152.2 201.96 205.01 D43 C85.27 C82.30 201.28 D09.10 C91.41 C64.9 C22.4 238.76 224.5 C50.511 186 202.52 203.10 C7A.092 201.60 209.52 D41.20 C13.1 224.3 C84.04 C81.78 C90.00 D31.12 D01.3 C78.02 209.31 157.8 C50.611 D12.1 236.99 D09.22 D17.0 202.85 C22.0 C77.9 D37.01 D06.1 D37.5 231.2 224 209.61 C84.97 C50.812 C00.0 C50.019 C84.72 173.4 222.0 C7A.022 D10.39 205 C81.32 C83.01 C83.77 227.6 C79.32 C37.2 D23.0 200.27 C85.95 621.30 C90.10 C10 200.31 C79.11 C18.8 N60.49 C89 C91.Z2 C72.9 209.02 200.67 140.5 C13.2 204 D31.40 235.5 D07.39 238 C29 C92.A2 D08 C54.0 D17.22 182.C23 153.7 C81.05 C41.9 C00 183.3 D04.61 202.38 C06 174.4 D17.71 N40.1 D09.20 225.2 C44.500 D16.6 C84.A7 C82.95 C81.39 233.1 141 188.4 C69.42 C82.93 202.01 C83.02 C82.01 C65.1 239.4 192.8 160.2 C46 142.2 C49.3 218.2 200.2 C62.01 201.47 C84.05 C62.92 C60.1 192.9 C90.02 C82.25 202.76 600.00 C50.621 212.7 201.44 153.9 C82.61 203.11 202.97 208.01 D37 C55 C82.49 D21.10 208.12 D48.9 C22.3 C44.609 201.10 C54.1 160.9 C13 D31 C82.39 C84.01 197.7 600.0 175 C84.66 D01.2 D29.20 D35.9 D36.17 D39.2 C88.9 198 C56.9 D14.2 156 E31.21 200.68 C84.64 600.2 D37.9 239.9 C81.25 C85.16 C92.02 C44.529 D31.41 D12.3 227.1 212.8 221.0 C44.90 C50.111 C81.48 C84.92 C53.8 209.20 174.1 C00.8 202.16 237.7 205.82 C56 Q85.03 C84.45 173.70 151.4 D23.71 C83.18 C92.Z2 C81.78 205.30 239.2 C96.29 C10.8 200.11 C99 602.3 16.4 C16.3 C50.829 C71.8 C92.31 206 173.5 230.6 190.1 202.14 C82.16 201.00 C69.52 D12.9 173.89 D15.9 205.8 202.28 D29.21 D19 C82.57 C84.62 C43.0 C81.70 C94.01 C81.08 D02 214.8 C60.8 C83.06 C13.9 231.8 C72.59 C90.32 C50 187.8 D14.1 202.88 C51.9 202.81 C83.36 C44.509 C44.619 D04.2 D26.9 D37.8 214.3 C25.0 C46.2 182.8 C75.5 D07.30 200.38 C70.9 D15.2 188 C84.A1 C44.391 C84.02 202.26 173.81 C88.4 C91 D29.31 C94.6 C57 202.4 C00.34 Q85.1 218 236.9 173.11 C18.7 C31.3 201.25 C14.8 D22.22 D35.5 C71.6 C90.21 C43.62 C49.6 236.5 188.0 C31 C22.9 C50.212 C57.7 C93.02 171.0 201.76 C00.5 C25.1 213.4 200.57 C82.64 C84.98 D35.3 D49.512 C67.1 D04.10 C83.14 C75.9 200.23 200.26 161.0 C78.1 200.7 C82.85 D31.22 C83.75 D21.11 200.83 200.43 C57.4 D10.7 146.5 D49 C44.510 C57.11 238.0 C50.021 196.3 D46.A D16.31 C78.39 569.0 D39 161.2 C25.3 C30.0 C01 D31.31 D36.14 201.46 C94.81 140.4 150.3 C91.A2 D16.02 D12.3 C47.10 C26.1 160.8 D23.10 173.8 D37.1 C44.701 C11 D25 C63.8 C94.00 D17.24 200.94 C02.9 C91.61 C28 205.02 D21.0 171.6 C17.9 210.9 174.0 D21 C67.4 C50.821 C49.5 173.7 C92.11 209.73 C84.67 C74 C7A.095 219.8 161.8 C06.9 202.75 200.80 224.9 C84.73 C88.2 D17.79 201.21 208.90 152.1 D03 147.8 186.9 C50.622 198.6 229.9 C49.A5 D22.62 203.80 C40.32 C63.9 C81.33 C96 209.5 C87 202.86 C43.30 207.01 D35.1 164.8 238.73 201.62 C96.21 D04.71 171.4 201.41 141.0 C91.60 182.C21 206.80 189.8 208.21 C82.03 C52 D18.09 C25.7 162.0 C38 202.72 C82.41 C82.62 C17.39 C72.41 202.00 C03.9 229.8 173.40 224.4 C213.3 216.3 209.14 C83.83 C16.4 C75.4 202.05 C44.191 213 200.13 D41.11 C69.50 192.1 200.75 D13.1 D48.3 C00.2 C80.0 C81.0 C83.89 195.8 C93.Z0 N40.0 C30 C92.A0 C09.1 C34.10 200.1 174.2 173.71 158.0 D07.61 C84.91 156.1 C84.12 C91.42 D00.07 221 D35.6 225.9 624.6 233.31 D19.1 C91.A0 C05.0 192.3 211.4 C82.45 160.3 622.10 211.5 C7A.011 D10.0 204.0 C81.42 201.26 D23.30 C02 201.91 C40.90 C78.02 C43.21 C44.22 C91.62 239.3 237.71 239.6 230.</p>

Ophthalmological		<p>H34.8332 H50.812 H10.439 H35.111 H53.043 364.5 H50.32 H44.812 H01.112 H05.243 H26.493 H10.221 377.62 362.89 H49.43 H18.811 364.71 375.13 365.59 365.89 370.3 H40.51X H44.21 370.24 375.14 H25.23 H17.00 H47.631 H05.342 H21.323 H50.811 H59.022 364.8 H21.229 H20.022 H02.134 H15.022 H46.02 H47.211 H31.111 H59.322 H35.3133 H11.032 H11.432 H16.072 H40.10x2 371.73 370.03 H11.10 362.31 H02.734 H44.753 369.3 H16.142 H40.63X H33.051 H18.739 369.05 360.8 H31.092 H52.532 H18.892 H17.03 H04.223 H01.133 371.20 H27.112 H44.621 H20.813 H53.033 367.20 369.08 372.9 H02.871 H40.1310 H40.51X10 H15.091 H40.302 H01.023 H31.303 H26.119 H40.1114 H54.2X1 368.31 H15.813 H35.463 H05.812 H26.103 H04.011 372.4 364.53 H10.511 H39.H40.1192 375.22 H10.512 H31.022 H35.052 H40.149 362.9 H40.241 363.70 H34.812 H53.003 H26.069 H18.833 H18.223 H16.132 H47.312 H47.333 H01.019 H21.342 H02.30 H20.821 H40.53X3 H02.104 H02.839 H05.031 H59.343 H16.061 H16.071 H34.02 377.10 371.45 371.60 H18.623 369.75 H02.209 H33.102 369.60 H50.50 371.51 H40.032 H40.2214 H33.22 H05.53 H05.813 H44.649 H54.1224 H02.439 369.66 H40.049 H40.51X1 H40.10x H02.054 H34.00 H50.15 H18.55 H15.821 H44.511 H49.813 H40.53X0 372.56 H02.136 H21.1X9 H53.023 H04.123 H02.89 H18.422 H31.123 H02.036 H20.021 374.54 368 H26.412 H40.60X3 H46.9 368.12 H57.13 H25.811 360.40 H40.62X4 371.58 369.01 H10.413 H16.309 H26.042 H44.431 H49.02 H53.031 362.6 H11.152 H35.439 362.36 H44.131 H35.3114 H26.123 H40.42X3 H53.132 H53.133 366.19 H40.1111 H08 H44.2C2 H53.433 H05.023 H50.69 H04.541 360.34 H04.212 H05.263 H11.133 H31.411 H18.232 H30.111 371.54 H04.023 H40.61X H35.172 H02.203 362.24 H33.032 H40.32X4 H44.712 377.52 H21.319 H20.22 H02.409 H10.12 H15.812 366.10 H18.9 H52.201 H50.022 H11.423 H34.813 H54.60 H57.051 H18.062 H40.63X H44.2A3 H44.539 361.10 H27.133 368.16 H40.233 H30.133 H43.813 H00.023 H02.109 H18.712 H57.8 371 H47.149 H15.129 H40.62X1 H10.239 377.32 H00.011 H44.723 H10.223 H40.139 H18.312 H35.322 H49.01 371.0 H02.735 374.87 H30.012 H02.123 H44.2C3 H13 H44.2E2 366.1 369.62 H27.119 H31.21 H47.323 H53.422 364.7 H16.051 371.56 H35.079 H40.1312 H53.039 H15.052 H40.1290 H30.009 H40.20x2 H01.002 H40.041 365.21 H34.819 375.54 H02.043 H44.449 H54 H18.713 362.85 364.59 H44.629 H46.12 H47.032 H40.159 364.63 H02.006 H40.822 H21.219 H44.022 H35.3290 368.41 H05.339 377.11 H05.269 H11.063 H54.1152 360.81 H05.52 366.04 H52.13 H53.429 362.77 369.61 369.10 H01.013 H02.879 367.9 365.04 H35.413 H11.242 H30.91 H11.019 H02.239 H30.029 H35.70 H40.43X1 H59.312 371.11 368.2 H04.149 H18.022 367.42 H40.41X2 368.8 H15.819 H05.262 H00.16 H01.014 H47.142 365.63 368.10 H01.113 H55.81 374.85 H05.423 H21.521 H40.052 H54.0X4 362.70 H02.61 H10.231 H51.22 H35.013 H34.8131 369.65 H52.12 370.40 H21.352 H35.3232 H15.123 H02.832 369.24 H57.11 H59.42 369.02 H50.611 H44.441 H31.009 H34.8392 H54.414 H15.841 376.5 374.13 H16.121 379.14 H35.359 H44.811 H54.1141 H47.611 376.21 H04.432 H05.219 H40.123 H21.262 H34.832 H44.702 H00.13 H40.221 H43.392 H40.1412 H01.129 H44.652 H02.863 H40.50X H00.304 H30.101 H16.212 H59.88 H21.532 H01.125 H31.129 H40.33X3 H22 H33.029 H02.721 362.10 H20.041 362.3 360.44 H40.52X4 H02.013 H21.40 H07 H30.129 372.8 375.15 H21.232 H01.016 H31.029 365.05 H40.1491 H53.59 H35.3121 365.6 H02.32 367.2 H11.212 H44.622 H05.021 H50.312 H16.032 H02.516 362.14 H40.1123 H43.312 372.6 H33.193 H44.732 H04.551 H43.03 377.72 H44.512 H33.322 379.25 H05.231 H47 H50.30 H21.301 H21.343 H59.21 H40.42X2 H16.323 366.20 H40.62X2 H10.411 H02.042 H04.013 H15.102 H35.411 H16.019 367.5 371.3 H40.1193 H59.319 H18.812 H35.019 H47.013 H02.432 H40.1291 H53.142 H21.333 H54.512 H10.021 369.04 362.16 369.72 H02.875 H30.021 H43.01 365.72 H59.813 368.55 362.74 H31.311 H30.103 H47.219 363.56 H02.833 H40.1194 H00.035 H04.211 H47.393 371.24 379.32 H02.025 H02.204 H15.832 376.41 H18.052 H52.209 H18.332 H40.51X4 H43 H40.52X1 H11.422 H40.1423 H40.60X H52.203 369.0 374.89 H02.849 374.12 H40.50X0 H54.8 H40.043 H44.611 365.60 A18.59 362 368.34 H50.011 H59.021 369.71 367.0 362.15 H11.32 H18.319 H11.131 H53.483 H02.59 H35.3291 H40.30X2 H44.529 H35.319 H40.40X2 H11.052 374.5 H16.391 H21.263 366.42 366.18 H16.129 1362.1 H18.419 362.29 368.47 H21 365.23 376.40 H18.819 H21.321 H40.63X1 H30.21 H50.0 H33.052 379.21 H02.514 H40.1121 H47.42 H53.411 H15.019 H05 H54.40 372.55 H40.1120 H35.113 H05.011 H59.222 370.44 H33.192 H59.333 362.61 362.17 H02.522 H02.119 H10.812 H59.323 H54.0X45 H18.039 H43.02 H035.722 366.09 H21.313 H04.523 H21.551 H05.033 H54.62 H54.42A H58 H04.332 H10.502 H34.829 365.31 H42 367.1 H30.013 375.57 H21.303 H47.20 H02.864 H20.032 H26.062 377.3 H52.223 H31.002 H40.2232 H44.623 H44.821 H27.03 H04.012 H16.013 H34.833 372.62 H02.055 H02.114 H30.121 H27 377.33 369.9 H16.223 H16.213 H18.829 363.72 H35.723 H25.041 H44.2E3 H44.012 H34.10 H16.221 H40.069 H02 363.55 H04.202 H16.131 369.06 H31.9 H35.3222 H34.822 H35.3293 H47.512 H44.413 H20.21 H16.331 368.62 H35.371 H40.41X3 H21.312 H33.331 H16.012 364.89 H05.412 H00.024 H1.001 H40.1210 H30.893 H26.499 H31.429 H47.12 377.24 H35.3120 H40.1130 H18.719 371.9 364.52 H40.1322 372.34 H11.411 H16.073 H10.232 H10.212 376.43 H35.81 H35.712 H01.025 H11.069 362.65 379.13 H01.123 H35.373 H16.122 H40.2220 H43.811 H31.409 362.1 H34.213 H02.815 H01.029 H44.533 H52.521 H21.242 H44.422 H02.714 366 H34.8191 H34.8391 H35.53 H21.89 H01.001 377.41 H49.33 H31.321 H44.023 H16.052 369.17 370.21 H16.249 H55.09 H26.051 H18.061 H21.223 H25.11 H30.032 H59.362 H53.10 H40.321 H40.1234 H20.12 H11.111 H11.40.119 H40.1113 H04.031 H21.213 375.52 H26.491 H21.1X1 H40.2292 H26.011 H26.033 H43.20 H15.041 368.9 362.50 H35.349 H15.89 552.229 H51.8 364.64 H02.829 H00.039 H18.322 H40.42X1 H40.812 H50.42 H02.816 H02.034 H05.029 H21.561 372.42 H40.40X3 H40.823 H50.53 H34.8312 H35.151 H40.10X3 370.20 H59.361 H16.429 H31.423 362.4 H02.105 H40.023 H35.3193 H11.033 367.8 H14 H20.052 H11.142 H40.1324 H18.031 H02.851 H46.10 H50.54 H02.712 365.43 H15.092 H40.42X0 H53.2 H18.011 H11.119 H40.62X0 H44.309 H05.252 H10.422 H35.3131 H40.811 H02.004 H53.55 H10.521 H21.309 H15.012 H40.832 H44.2E1 H50.141 H26.039 H02.115 H31.121 377.0 H16.201 H35.3112 H20.9 H57.09 H52 368.53 H40.1133 H52.202 H40.132 H40.52X3 H05.10 H54.413 374.51 H05.012 H40.1223 H11.829 365.32 377.03 H40.1432 368.32 371.05 H11.431 H01.124 368.30 H34.233 366.4 379 H10.819 H53.129 H02.731 H02.205 H04.429 H49.32 371.02 H53.15 H40.1422 H04 H02.234 H40.022 H33.011 H35.732 H44.391 366.23 H04.039 H50.17 H16.139 368.52 H44.793 H11.059 H18.449 H18.231 H05.823 H18.032 H35.352 H26.049 H04.129 H10.30 H02.811 H11.113 H02.212 H11.439 366.2 H35.3292 H35.441 H40.10X0 H35.023 376.51 H31.103 H43.391 H02.016 H35.3110 H05.253 H05.821 H40.219 H05.409 H53.021 H21.329 H40.443 365.11 H17 H49.11 368.3 372.54 361.3 H54.52A H25.093 H02.145 H44.522 H04.132 H11.022 H04.552 H16.041 H44.722 H54.415A H38 H40.1213 H01.121 363.9 H02.403 H40.40x0 H35.461 363.35 H18.793 376.8 H35.3223 H43.393 H48 H18.52 H34.8390 H40.51X3 H04.339 H47.11 H01.022 H05.811 H40.141 H04.301 H31.422 H15.823 H21.503 375.69 H40.009 H01.146 H57.052 H30.139 H44.601 H26.411 H27.132 H18.899 366.41 H54.61 H20.819 H54.42A4 370.34 H33.129 H21.1X3 H02.019 H26.112 H44.323 374.41 H05.221 363.33 366.43 H18.421 H52.11 376.47 H53.131 H44.602 H30.031 364.60 H10.10 H11.229 H00.021 H16.063 H02.133 369.11 H16.011 H52.32 H18.20 H31.403 H52.533 H04.612 H31.23 H43.311 H35.459 372.5 H16.233 H35.713 H11.239 H16.412 H40.2293 H33.121 364.51 H35.012 H53.439 H40.213 368.40 H18.229 H25.011 H01.021 H17.13 H30.143 H02.812 H44.2D1 H35.341 H04.133 H18.799 H35.3192 H59.329 H26.213 H18.54 376.89 H01.011 H31.102 H21.233 H16.422 H53.19 H04.522 H31.29 H47.233 H53.421 368.60 H49.31 H31.412</p>
Otic		<p>H66.006 H60.23 H93.249 H69.41 H91.02 388.71 H61.391 H80.20 H93.219 H93.212 H93.099 381.89 H95.811 H72.10 H73.91 H74.09 H66.21 H70.229 H90.A12 H95.123 384.00 H60.312 H61.302 H95.193 H65.199 H61.011 389.7 H70.009 380.39 H71.31 H69.91 H60.543 H94.01 H66.3X3 H80.91 H75.00 H65.191 H73.822 H68.019 385.8 H65.04 388.0 H68.112 H68.131 H92.20 H60.61 H95.54 H90.2 H74.392 H60.532 H70.211 H65.20 389.17 H69.90 H95.89 H90.3 388.70 H71.33 H74.41 H65.413 H83.12 H90.6 H67.3 H60.8X2 H72.93 H61.323 H80.23 H60.323 H80.92 H72.829 H90.A21 H72.01 H93.1 H70.631 H61.103 H74.321 H72.11 H80.01 H70.092 380.5 H95.119 H72.813 381.9 H81.313 388.02 H81.43 H66.10 H70.811 H61.23 386.40 H83.90 H94.03 388.72 H94.80 H90.12 H74.40 386.32 H83.8X3 H73.811 H75.02 H95.121 H60.539 H73.093 385.13 H66.3X2 H90.A32 H61.003 H60.02 H73.012 H91 380.21 H93.03 H95.03 H95.53 H83 386.31 H73.001 H95.11 H60.502 H88 H66.005 H65.01 H66.42 H81.12 H60.8X3 H60.42 388.2 389.02 H61.392 380.4 H61.031 H60.43 H61.8X9 H70.099 381.8 H66.009 380.03 H83.3X9 H93.293 H68.012 H62.8X2 H74.02 H72.12 H70.202 380.0 H74.8X3 H60.60 H61.113 H61.819 H93.243 386.48 H65.31 H73.003 380.00 H82.3 H95.88 389.03 H65.06 H79 H60.03 H81.41 H61.393 388.60 H92.13 388.00 H83.3X1 H60.10 389.0 H62.43 H83.19 H95.133 380.50 H61.019 H81.01 H93.091 H73 384.1 H66.23 H71.10 H74.391 H80.03 H72.02 H60.599 H66.91 380.51 380.52 381.62 H60.592 H71.32 H70.011 385.0 H73.099 H68.12 H71.93 H68.023 H93.232 H93.8X2 H77 388.11 H72.823 H60.00 H70.093 H65.93 H81.93 H67.2 H93.3X9 389.16 386.5 H60.559 389.08 H73.019 H61.013 H60.512 385.01 H95.113 H70.209 H81.49 H65.21 H74.323 H73.813 H70.012 389.14 H69 H62.42 H61.001 H90.A22 386.43 385.23 H61.102 H95.21 H68.129 H83.01 H61.129 H65.196 H72.90 H65.32 H83.2X2 384.8 H73.22 H95.139 H65.90 H74 384 H72.00 H91.20 H83.8X2 H71.23 H89 H93.3X3 H62.8X9 H73.829 H66.11 H71.00 389.11 H65.03 H74.399 H69.03 385.11 384.23 H60.511 H90.72 380.02 H60.391 H81.8X2 386.30 H91.09 H95 H66.003 H75.83 384.25 H83.02 H65.115 H73.10 H65.197 H60.541 H61.811 385.89 H60.331 H81.92 H70.219 385.24 380.9 H61.399 H68.022 384.21 H74.92 380.81 H60.40 H66.93 H92.23 H65.492 H69.02 H70.893 380.8 384.01 H73.821 389.05 H73.93 H91.01 H65.05 H74.393 387.1 H72.13 H81.391 H73.21 H81.391 H73.01 H70.11 H60.399 H61.123 H69.80 H74.312 H61.93 H74.322 H83.11 H91.91 H75 383.32 H91.93 H74.311 H73.11 381.5 H93.241 H80.83 H90.5 H92.10 385.2 H61.039 380.89 H95.42 H68.133 H80.11 386.34 384.20 H81.11 384.9 H73.819 H93.A9 H80.90 H65.116 H65.193 H73.92 H65.113 H60.542 H70.813 385.21 H90.71 H81.23 386.58 385.12 380.31 381.6 H70.92 H66.22 H65.114 H80.93 H92.03 H65.419 H61.111 H93.223 H93.A2 H94.82 H60.521 H66.012 381.81 380 H93.12 H95.129 H93 H90.A11 H74.02 H81.22 385.35 H71.90 H93.239 H69.01 H95.02 386.56 387.8 H89.06 H66.014 H70 H73.011 H60.333 384.82 H60.20 385.00 H60.392 385.09 H61.032 H74.329 H83.09 388.31 H74.22 H74.03 H93.019 H71.92 388.3 H70.12 H61.311 H93.221 H93.013 389.01 H61.023 H66.019 381.63 H60.529 H71.91 H95.813 H60.549 H75.82 H81.399 H61.119 H91.8X3 H65.22 H93.211 H90.212 H70.213 H60.92 H71.12 H61.92 H73.21 H61.303 H80.21 H83.91 H91.22 H73.091 H66.20 H71.11 H72.91 H90.0 H61.121 H70.222 H95.819 H61.301 H70.891 H73.891 H73.009 H65.07 H66.007 H61.029 H68.113 H71.02 H82.9 H61.813 H70.001 H81.393 H93.8X9 H61.009 H61.109 H94.02 H61.319 386.41 H93.012 H60 H60.8X1 H80.12 H81.312 385.33 H70.812 H74.12 H70.91 H95.132 H93.222 381.52 369.8 H80.10 H66.001 H65.119 H65.111 H93.299 H80.80 H65.195 H68.122 388.01 H95.22 H66.40 H74.13 H85.191 H81.8X9 H60.591 H61.892 H72.2X1 H74.313 H69.129 H65.30 H61.193 H81.13 380.32 387.2 H68.102 H60.523 H66 H74.43 H60.501 H83.13 H93.90 387 H91.3 H94.81 H95.52 H66.92 H80.02 H70.13 H73.893 H73.892 H65.00 H90.42 H60.62 H93.92 H60.41 H65.411 H91.11 H91.92 H71.30 389.9 H60.313 H62.8X3 H70.091 H83.2X3 389.00 H60.63 H70.20 389.12 385.82 H65.192 H93.092 H72 H68.109 H65.92 H73.90 H80.22 H69.00 H60.322 H66.004 H90 H68.132 H60.503 H71.01 H68.111 H91.13 H74.8X1 H64 388.6 H95.192 H72.821 H81.8X3 388.7 H61.012 H83.3X2 H74.01 H95.131 H66.3X1 H93.11 H83.8X1 386.50 H75.81 386.55 H61.112 H65.33 H60.332 H72.2X3 H81.02 H72.03 388.9 H60.11 380.01 H61.20 382.2 H62.8X1 H95.41 387.9 H73.812 388.8 H60.522 389.2 388.69 H91.8X2 H95.32 H95.812 H92.12 H93.291 H70.10 H70.201 H71.22 387.0 H71 H85 H72.2X9 H61.321 H65.194 H66.002 H61.91 H92.09 H61.313 H83.2X1 H66.43 H86 H83.8X9 H91.21 H70.002 389.13 H60.93 H67.1 H69.81 H81.42 H90.11 H71.21 H78 H80.13 H84 388.30 H61.812 H61.021 381.7 H74.8X9 H60.311 H74.90 H90.A31 H60.12 H60.8X9 H69.83 H65.493 H60.551 384.09 H61.893 385.03 H93.3X1 H60.513 H68.123 H72.822 H68.002 H60.393 H91.8X1 H93.011 H61.891 H66.013 H70.899 H60.329 H61.309 H80.82 H62.40 H60.13 H66.016 H75.01 H91.23 H81.09 380.3 386.33 H72 H80 H66.001 381.61 385.3 H93.093 H61.899 H81.91 H93.19 H81.319 H74.21 388 H92.01 H68.021 H83.92 H72.819 H92.02 H71.13 H61.192 H60.321 H68.009 H61 H74.319 H93.8X1 H68.119 H81.8X1 H68.001 H70.90 H83.03 385 H61.033 H65.491 386.54 H93.3X2 H70.003 H75.80 389.20 H93.A1 H89 H68.013 H81.90 H60.01 H75.03 H81.1 H66.3X9 H70.203 H81 381.60 384.22 H95.199 H81.311 H92 389.04 H65.117 H68.101 381.50 H70.93 H73.823 H80.00 H60.519 H83.2X9 H61.122 H74.8X2 H60.509 386.52 385.9 H61.002 H82 385.02 388.32 H95.01 385.10 386.51 H61.191 H60.593 H73.13 H82.1 H95.122 H61.312 389.21 H62 H91.10 H73.23 384.81 H68.011 H95.00 H93.8X3 H70.892 H74.11 H80.81 H60.339 H65.02 386.30 H90.8 H65.412 H93.229 H93.231 H66.13 H73.002 H61.199 H67.9 H60.533 380.53 H65 H81.20 H92.11 H81.10 H65.12 H87 H87.21 389.15 H95.51 H93.93 H94.83 H68.003 H83.3X3 H60.21 385.32 H60.319 H61.90 H72.812 384.24 389.1 H74.23 H93.A3 H70.819 388.12 386.4 H60.22 385.19 H65.499 H69.82 H71.03 H74.93 H68.029 H70.013 H91.12 H70.019 H74.91 H70.223 H83.93 H81.392 386.53 H60.553 H61.101 H93.25 H60.91 H67 385.1 H68.103 H71.20 H65.23 388.10 H69.93 H74.19 H66.017 H73.20 H68 H90.41 H66.41 H91.03 388.1 H60.552 H95.31 H82.2 386.35 H61.322 H60.90 H81.03 H68.139 385.30 H65.91 389.18 H93.292 H95.112 H94 381 H93.233 386.42 H94.00 389.10 H72.92 H70.221 H72.2X2 H73.899 H93.242 H66.015 385.22 H92.22 384.0 H73.092 H93.91 H76 H69.92 H61.022 384.2 H91.90 381.51 H73.12 385.31 388.61 386.8 H93.2</p>

PNS		<p>G56.91 G73.3 G81.92 G62.82 355 359.21 P11.5 G81.11 352.5 G57.53 352.4 G82.22 G83.14 G57.00 354.3 G80.0 354.4 355.3 354.2 353.3 G83.10 G50.0 767.6 R26.9 G56.43 G79 G71.19 G60.9 G83.13 350.2 G81.02 G71.13 G81.90 G52.9 G57.32 G56.40 767.7 G81.93 G72.1 G62.89 G65.1 R26.0 356.2 G51.8 G57.92 P14.8 G57.21 G54.4 G72.2 357 G83.30 359.22 358.2 781.94 351.8 G71.11 G54.7 G72.9 G57.22 G83.89 359.81 G56.42 G60.2 G72.41 G82.50 G80 G56.02 359.71 G82.20 359.79 G83.32 G57.10 353.0 781.1 357.7 G57.80 G81.01 359.4 G57.43 354.8 G57.40 G56.00 G59 R26.1 G80.2 G81 G57.61 G56.80 355.2 353.4 G52.2 354.5 G81.14 358.9 G55 G72.89 G83.9 350.9 G57.83 G68 G58 358.8 G82.53 G57.82 G66 781.0 G69 355.0 351.0 R27.8 G56.83 R25.8 352.6 353.1 G70.89 G56.92 G83.84 G80.4 R29.5 352.1 G50.0 353.6 G61 G56.32 R41.4 R26.2 781.3 G83.4 R29.3 G51.0 G83.23 359.89 G82.52 G54.6 G56 G56.03 G83.20 G56.90 353.5 G60.1 G73 P14.3 G50.8 G60.0 350 358.01 G51.4 G57.02 G50 G61.82 G62 357.9 R43.0 359.3 G57.71 353 352.0 R25.0 G60.8 356.8 355.1 357.89 G54.8 G80.8 G57.90 G71.9 G57.12 G80.3 357.1 781.5 G65 R29.1 R25.1 G61.81 356.4 357.0 359.29 781.2 G54.1 G70 P14.9 G53 G56.33 G65.0 356.3 G57.73 G56.23 G83.5 353.8 G57.93 781.99 R25.2 G57.13 352.9 G83.24 G54.5 G57.12 359.9 G61.89 355.71 G82.54 355.8 G56.11 G71.8 P14.0 G51.1 351.9 359.24 355.6 G56.93 355.4 G57.50 357.2 G70.01 G76 G73.1 G57.20 359.6 G83.11 351.1 781.8 G56.21 G82 G50.9 G83 R25 G57.63 G65.2 G57.62 G54.0 R25.3 G57.31 G83.82 357.3 355.79 G56.31 G81.00 352.2 G57.91 P11.4 G70.81 G78 R27.9 G62.9 G71 G56.20 358.1 G72.0 G74 P14 767.5 P14.1 G72.3 G83.31 357.81 359 E13.42 G57.70 R27 G57.33 G70.1 G80.1 359.0 356.9 G54.8 G81.10 P11.3 357.5 G71.12 356.1 781 G51.9 G52.0 350.1 G58.8 G77 355.5 G51 358.00 G81.94 358 G81.04 G56.22 G83.21 359.23 781.6 G83.34 G67 781.93 G57.41 R29.891 G57.11 G54.3 R29.810 R29.890 359.1 G57.42 352.3 355.9 G52.8 G57.01 353.2 767.4 G57.30 G62.1 P14.2 G54.9 G54.2 G58.7 G53.2 R26.89 G56.12 781.91 G52.7 G70.80 781.7 G70.9 G57.23 356.0 G83.33 R27.0 G52 G61.0 G50.1 G62.2 354.0 359.5 G51.2 R29.0 G60 354.1 356 G62.81 357.6 G83.22 G71.2 354 G61.1 G56.30 G82.21 G73.7 G81.13 G56.41 G56.01 G81.12 G51.3 G83.0 G83.83 R25.9 781.4 G57.51 R29.818 781.92 357.4 G71.3 G57.52 G62.0 R68.3 G57 G63 G83.81 G56.13 G52.1 G57.03 G56.81 G72.81 G81.03 352 G64 353.9 R26 G61.9 G71.0 G71.14 G72 G83.12 G82.51 G72.49 G60.3 354.9 R26.81 350.8 351 G57.60 G57.81 G80.9 G58.9 G75 357.82 G81.91 G56.82 G58.0 G70.2 G56.10</p>
		<p>F12.90 F91.8 F12.229 302.3 307.81 F41.3 F32.9 F10.29 F52.1 300.13 313.22 R44.3 F11.21 F13.221 F63.89 F60.81 R40.2440 R48.0 F16.24 F10.230 F15.260 F51.02 F35 F40.298 292.84 F42.2 R40.2254 301.4 308.4 F20.2 F14.259 F40.231 F31.4 F40.241 F17.293 296.35 F18.27 F81.89 301.8 312.10 F19.988 F14.94 F42.8 F64.9 292.12 F98.5 295.1 F80.0 F01 F13.90 F17.299 295.45 F15.250 F10.288 312.2 F13.150 F18.259 F31.0 301.9 F84.3 296.61 F13.939 302.73 293.9 F18.19 F13.232 301.12 F41 F10.150 F31.76 F45.21 R40.2240 296.81 F18.988 F19.99 F13.10 F48.1 F11.250 312.35 R40.212 F10.94 308.1 290.1 R47.1 290.10 F13.288 298.8 R40.2132 295.70 F13.99 F11.11 F30.10 F34.9 300.22 F11.14 R40.2231 315.9 307.4 F15.280 R40.2110 293.83 315.4 F19.181 300.01 F99 F80.82 R47.01 F15 F47 296.24 F96 R41.4 F12.120 F40.290 307.49 F55.4 R41.0 301.13 295.00 F14.10 307.44 F30.4 F51.4 R37 F17.218 315.31 313.2 F10.920 R40.2033 R45.3 F44.7 F25.8 294.0 307.3 R45.2 F20.3 F19.920 F20 295.43 F15.951 F10.26 316. 291.1 296.90 F16.150 295.63 292.81 296.44 312.3 302.89 R46.2 295.61 310.9 R43.0 294.9 315.1 312.30 F83 F15.259 F42.3 299 R49.22 F11.90 F15.20 F10.951 F91 F12.222 R45.1 R40.2213 F20.5 F15.11 F19.20 295.34 F16.920 F31.73 295.51 291.9 295.03 F50.2 F18.921 F20.0 291.82 F94.1 300.00 R40.2212 294.11 F07.0 F18.929 294.10 R46.1 F13.14 R40.214 306.5 F30 295.3 F16.920 F31.73 295.51 291.9 295.03 F50.2 F18.921 F20.0 291.89 F74 312.01 F30.12 F19.29 296.56 F32.1 F18.24 295.8 F90.0 R48.1 F13.96 R45.82 296.40 R40.2211 R40.2444 295.92 296.36 293 F45.1 F40.2228 F14.980 F15.23 315.5 F10.188 F16.188 F65.9 F13.19 300.20 F41.0 309.2 F10.280 F52.6 F64.2 F18.959 F19.10 F26 F16.20 F19.21 F19.14 F65.81 F19.97 F80.2 F13.932 F10.24 F14.21 F51.13 307.40 F18.11 F02 307.0 296.4 F43.23 290.41 296 R40.2114 R40.2331 298.2 R40.2334 F52.32 F31.60 F45.42 F19.980 R46.6 300.9 F06.31 F90.8 F50.02 F17.208 F13.151 F13.21 F19.932 F43.29 F45.22 F19.230 R40.2244 F30.11 R40.1 F16.283 F93.0 F43 313.89 F11.10 F14.121 F18.980 F31.75 152.122 F63 298.4 F98.3 313. F64.1 296.99 F80.1 F09 F19.951 F63.0 F18.29 F19.250 F43.9 F10.11 R40.2134 F43.25 F60.5 296.80 297.9 R44.9 F98.1 R40.2413 F31.11 F19.90 F10.20 306.59 312.3 R40.2121 291.8 295.73 F11.94 F14.922 F33.1 F25.1 F14.180 R49.8 F40.232 296.33 310.0 R40.225 302.0 F15.920 301.2 297.2 F63.4 F84.8 296.15 F17.211 F32 F17.201 F19.96 301.40 R40.2361 F19.122 F65.1 F67 R40.2342 R40.2220 296.10 308.0 301.11 F18.229 F10.231 300.29 F15.982 306.4 F18.120 310.1 302.2 292 F80.4 295.35 301 F42 F46 F17.223 F15.129 F31.77 R40.2241 F40.8 R40.2332 F59 F18.221 301.20 290.13 301.59 F12.920 306.1 F18.129 R45 F43.22 R44.2 F15.180 295.71 F18.150 F10 F18.251 R41.842 F98.29 R40.2142 R43.8 R40.2330 F13.282 R40.2314 F16.129 F19.121 R40.2341 313.23 302.1 312.23 F11.988 R45.0 F58 302.8 307.23 294.20 310.8 F10.96 295.2 306.0 F10.982 R40.231 295.22 298.1 F62 295.9 F14.288 F31.5 F40.233 F64.8 F20.81 F51.11 F06.0 F13.931 F07.81 F13.988 F77 F14.988 R40.221 F15.19 F68.8 F11.281 R40.2344 302.9 F16.122 296.03 312.1 295.11 F43.21 F84 F32.5 F13.94 F63.9 301.6 F14.19 306.2 F18.951 F16.288 F14.55 F15.221 F11 F45.0 302.76 F19 F10.988 F51.01 307.47 296.66 F12.259 R40.2424 R49.1 F90 297.0 F10.239 F51.05 300.09 315.8 291.2 307.6 F63.2 F14.181 295.01 302.81 R48 F16.99 R40.2421 F12.220 R40.2440 F44.01 301.30 F90.9 295.83 300.6 299.4 F84.5 306.3 F33.40 295.55 F93.9 F50.0 F11.981 R46.3 295.01 F81.81 F28 F68.10 F12.950 R40.2141 290.8 295.0 F14.221 F16.251 R40.2113 314.8 295.33 F64 295.15 F48 F11.950 293.82 290.42 297 R40.2111 F84.0 R45.4 292.8 F52.31 R43.1 302.84 F14.982 R40.2251 F06.34 302.79 F19.939 F16.14 F33.0 F15.282 R40.2360 F19.259 F13.259 296.01 F94.9 R40.2232 F31.74 F15.24 302.4 F48.121 310.9 F42.4 R41.9 302.7 R47.02 F90.2 293.89 F11.922 F12.980 R46.7 301.21 296.05 F12.221 F40.240 F44.6 F16.151 F93.8 F17.203 F15.281 F68 F40.210 F13.929 F19.921 F11.20 307.48 F13.920 F11.129 296.3 R40.2441 R40.211 F16.180 309.24 F18.90 F11.121 F19.930 F01.51 F19.959 F19.17 F87 F19.11 F40.00 315.2 F76 R43 F17.291 312. F05 295.91 F15.14 F11.182 F98.0 F55.3 306.51 R48.8 F13.120 295.41 309.23 296.06 F11.188 F19.282 F12.288 F44.89 F14.120 300.81 296.42 R40.222 F45.20 R40.2242 F13.982 R40.2131 F15.21 F51.3 R41.2 314.2 F13.97 300.15 F11.29 301.83 F19.232 F50.81 R45.84 R40.2124 F40.01 F91.1 F10.959 F12.959 R40.222 300.82 F10.221 F42.8 295.5 290.3 F13.27 290.2 292.89 F51.8 F15.959 296.65 F13.959 306.52 F33 F19.16 F11.222 F02.80 F52 F14.29 F31.78 294.8 315. F31.70 315.39 F15.921 R33 R43.1 F16.90 R40.2112 R40.2323 295.54 302.2 308. 296.50 F07 315.00 296.46 F14.122 312.11 295.81 F18.159 296.00 F19.07 F07.89 F15.922 F33.41 302.75 315.35 307.80 312.12 292.82 295.6 F06.2 F49 F86 F19.281 F11.251 F19.221 R40.2353 309. F15.188 312.4 F52.0 F19.19 F13.24 295.13 R42 308.9 F65.4 R45.6 309.9 307. F45.8 F11.122 R41.1 F30.3 F16.159 F32.89 F34.81 F14.981 F13.11 F10.929 F33.2 299.0 296.53 312.34 F16.10 F33.9 F65.51 R40.213 F17.209 F12.209 F12.20 F19.180 F10.180 296.6 296.04 F15.959 F31.12 F70 F55.1 F15.90 F32.81 F16.959 300.16 F45 F65.2 F14.250 F34 F12.990 F95.9 R44 F17.221 F19.929 300.21 R40.2252 295.7 R40.2324 F95 312.33 F15.10 295.04 314.00 F13.230 F14.159 308.2 F40 F16.120 F94.8 F60.1 295.84 F18.188 F40.243 F68.11 F18.920 F13.950 310. F12.150 F51.03 F13.129 F12.122 300.2 312.20 F16.988 295.93 F60.4 R41.843 R46 296.31 F48.9 F07.9 R40.2321 298.9 F11.959 F31.63 215.150 F16.221 F15.288 296.12 F16.983 F94 F11.120 F10.981 295.42 295.85 290.20 296.23 F48.8 R40.2420 F14.280 F30.2 R46.0 F19.150 F13.981 295.12 312.89 F15.222 F65.89 309.0 F19.922 R41.3 R40.2250 F15.181 F34.8 F57 F98.21 313.00 12 95.50 F25.9 F16.950 R40.2433 292.1 312.21 F14 307.46 F91.2 R40.2350 R49 F43.12 F91.0 F36 F17.229 F17.228 R40.2221 F43.0 F31.10 F14.11 R40.2352 F30.9 F14.129 309.0 R40.2253 F14.90 R48.9 294.21 F12.11 R49.21 F14.229 293.81 296.32 F91.3 290 296.21 F11.259 F14.222 R40.20 F14.150 F14.921 296.51 307.42 F12.180 F15.121 R49.1 F18 292.9 300.19 F61 G44.209 F11.99 R45.7 309.89 F31.81 F19.280 295.72 F40.02 F22 F51.04 F30.13 F10.281 292.11 296.5 294 F12.19 F11.23 F13.231 F40.220 F14.950 F14.24 295.64 296.8 F40.230 300.10 F18.94 F16.951 F13.121 F19.159 F15.981 F12.10 313.82 296.34 F56 R47.81 F14.23 F13.159 F12.988 299.8 F15.99 309.29 F10.181 F55.8 F19.288 295.74 300 F50.9 R40.2320 F44 F31.64 296.41 F44.9 F19.982 F80.81 R40.2230 F13.281 R40.2354 F52.21 F34.0 R40.2144 F10.99 302.82 F29 295.10 F11.229 292.85 R40.2423 F12.921 300.5 F48.2 313.21 F10.182 310.81 F13.250 295.65 313.83 312.32 R48.3 R40.233 F31.75 F63.1 307.43 F50.01 F16.183 295.14 R40.2364 F88 302.83 F15.151 315.01 312.8 R41.84 F12.121 296.22 292.0 306.53 R41.82 R41.841 F53 R40.2123 313.9 312.22 296.60 R40.2312 300.0 302.52 R40.2120 307.20 R40.2243 296.9 F15.182 R44.8 F13 296.45 F15.120 R45.89 F65.3 F89 F60.9 F14.929 F60.6 F94.2 R40.2143 F43.8 F18.99 F12.129 F51.9 F37 295.5 F01.50 296.7 R40.243 301.22 F12.280</p>
Reproductive		<p>764.96 O41.91x O70.0 628.0 646.03 O31.30x 634.91 608.22 679.10 662.11 O35.0xx0 P24.21 O13.9 656.01 O34.00 P57.0 649.7 662.00 669.82 656.23 663.60 618.0 670.2 O34.529 671.80 O03.32 646.51 771.8 E28.2 668.03 674.80 651.2 653.50 651.1 629.9 N82.5 676.32 661.21 646.93 763.9 O36.0110 659.90 673.34 649.03 660.33 669.0 674.02 656.13 O92.5 675.11 668 659.10 674.50 N89.4 P07.24 669.50 660.20 617.1 060.22 O00.1 O99.350 N88.0 A48.51 660.31 O22.91 611.72 O01.9 651.50 661.2 648.51 642.53 634.50 O98.03 604.0 679.14 O35.4xx0 665.24 661.71 P35.1 655.70 099.215 676 P91.63 773.4 767.0 616.51 671.10 O91.219 653.3 664.44 O72.0 669.94 670.8 761.7 673.11 P51.8 660.03 658.40 O00.0 651.7 765.27 671.90 O99.815 663.2 663.01 771.3 302.73 647.8 665.61 N70.93 611.0 O34.41 O34.01 N64.2 631.01 652.73 642.23 762 666.3 640.83 763 764.92 P05.06 N85.4 652 618.0 O36.61x0 O63.04 671.04 674.32 642.54 673.22 O75.89 N64.89 625.5 O88.0 O33.5xx0 765.10 652.40 O42.00 764.12 O91.22 679.01 608.24 653.90 647.44 O41.91x0 647.84 643.81 630.0 762.4 659.30 656.4 651.20 669.6 O72.2 654.62 650.0 N64.3 649.60 O71.9 642.13 648.81 659.91 771.1 P01.0 654.93 603.9 654.14 670.80 674.52 768.1 O26.21 O33.5xx0 665.54 661.41 E23.0 602.1 O33.9 652.50 O92.111 P03.0 O87.4 N88.8 642.92 N60.19 614.4 653.43 648.94 O99.330 O22.31 644.2 659.50 O71.3 646.3 670.0 651.21 O33.6x 669.8 651.11 652.13 O91.12 762.61 614 660.43 O22.40 O32.6xx 760.61 653.4 E29.1 765.08 765.05 679 P09.1 656.93 647.01 F120 760.76 669.24 648.0 N48.6 N43.1 643.8 659.53 O69.2xx 647.10 651.23 N94.819 629.41 764.10 649.41 641.13 655.31 765.18 774.31 642.63 671.51 659.93 616.11 672.00 607 653.20 661.00 644.0 O41.1090 O35.4xx O41.9xx 625.67 607.85 639.12 O99.419 O69.1xx 671.23 671.1 N81.2 664.8 O11.9 O83.8 O99.341 665.60 604 656.31 661.23 655.33 669.00 656.7 653.70 614.7 646.61 661.4 620.1 645.03 O92.3 648.02 765.16 625.71 663.6 655.9 664.0 N71.0 651.31 768 O99.845 620.8 626.1 P35.2 656.41 652.90 646.54 P08.1 648.93 O22.0 662.1 655.1 N82.8 649.62 654.90 607.82 N80.9 O98.619 625.0 674.84 O31.31x0 R10.2 618 O41.8X90 647.20 653.80 679.02 648.52 O10.111 768.0 606.9 668.11 656.30 629.89 669.10 N89.6 670.10 642.93 N80.3 642.1 628 O86.0 660.93 630 646.01 N80.5 655.40 647.63 652.23 N92.4 P07.21 N94.818 656.71 765.02 O89.1 P03.6 O63.1 764.2 P56.8 N85.6 646.10 O23.91 654.03 670.32 654.33 P24.81 610.1 768.9 N81.12 648.73 652.10 O87.3 P50.3 654.52 662.30 761.3 O36.60x0 P03.89 669.1 P05.05 N94.810 658.01 O14.02 660.12x0 N48.89 N95.2 O69.9xx 643.23 663.83 O88.23 673.0 771.0 626.5 665.6 659.70 662.23 667.14 647.50 648.14 P59.8 647.60 673.30 661.0 658.10 646.82 N83.4 674.90 669.51 620.4 765.07 670.20 646.1 639.5 P04.8 659.13 653.33 664.01 660.90 661.62 041.8x1 N49.9 N71.9 653.71 N51 O26.879 O22.10 P22.0 624.5 665.0 P52.21 654.01 O99.03 647.61 665.9 634.31 669.91 O35.8xx0 O08.0 P24.30 659.33 N86.1 646.6 O24.31 675.04 658.21 674.10 N92.1 676.33 O88.019 669.04 676.1 668.23 668.80 665.81 762.8 654.54 763.4 O90.4 653.91 O25.2 670.84 647.64 766.21 674.3 659.60 P05.17 648.83 676.60 665.30 651.03 647.32 651.0 659.01 668.83 N46.9 767.5 610.0 668.2 675.23 661.40 642.33 768.3 644.03 N76.0 622.9 O92.6 O36.90x O88.31 654.00 656.00 601.8 668.04 P91.62 O99.340 761.4 765.03 659.3 652.6 648.43 674.9 669.43 643.93 O36.111 647.31 F52.32 647.3 O92.011 642.03 664.00 P11.3 608.8 668.22 641.80 O90.81 659.23 641.30 667 663.23 658.80 608.8 626.9 O66.1 665.64 O88.119 N64.1 P07.18 676.81 N92.2 N48.9 O03.7 O69.2xx0 O99.13 O08.6 657.0 673.00 664.81 N73.3 643.01 633.10 641.9 634.62 647.9 622 099.280 N73.9 649.30 674.20 626.7 671.40 669.83 N41.9 651.6 647.04 764.04 E28.39 764.14 671.20 764.94 642.72 649.73 765.28 774.6 767.4 663.51 647.14 653.60 E29.9 671.3 642.52 649.2 O34.10 673.24 660.13 648.84 O86.12 649.6 O33.3 O36.8190 769 673.21 671.33 663.10 O41.8X10 O98.219 642.62 N64.59 N94.6 764.93 P03.4 772.5 604.99 641.23 663.90 O98.519 768.2 O26.893 669.90 668.12 648.41 674.00 646.4 651.63 627.4 O60.12x 669.5 634.22 665.40 674 646.83 O03.80 765.15 654.9 664.54 O36.80 645.2 P39.0 616.1 O03.31 667.1 765 N64.4 649.11 N93.0 676.50 651.5 648.40 649.53 634.82 O99.345 O32.1xx0 665.83 O91.011 O30.029 653.61 O4</p>

Respiratory			J27 J63.0 J12.9 J37.0 P26.0 J39 R05 J69 J15.1 J67.0 516.0 P24.21 J95.859 770.3 502 J09.X9 J34.3 J52 770.81 J03.00 786.9 J95.01 277.09 J20.6 J21.8 J33.8 P28.0 J95.850 J84.848 770.0 J67.7 P28.2 R06.7 J34.89 P27.8 478.30 J01.21 J12.3 518.3 G47.35 495.7 J11.82 J95.71 J64 J82 P28.11 J01.20 J15.8 J45.21 495.4 J39.9 J95.89 P23 P26.9 J95.811 J70.1 J73 J95.862 J66.1 J79 J93.83 J20.9 512 J41.8 J84.112 J03 518 518.1 J94.9 471.8 J18.1 J34.81 786.7 478.33 J34.2 J93 J32.9 R06 J68.8 J45.30 519.9 327.29 J20.0 J63.5 J84.03 P91.63 770.15 R06.81 495 P19.0 J01.10 770.7 J95.863 J09.X1 J02.0 J34.9 J84.02 J15.212 J81.0 J94.0 478.3 J23 J10.81 J84.116 495.1 507.0 J05.10 P26.1 J11.00 J06.0 J96.91 J33 R06.6 J45.991 516.32 770.12 491 J32.0 768.4 J87 768.70 J01.00 R06.01 J94.1 512.1 786.51 786.6 J38.02 J95.830 J38.01 478.79 770.84 J68.3 J10.08 J84.115 J25 J01.41 M34.81 P27.0 J07 512.8 R06.00 J11.08 J46 R09.3 J49 J70.5 J95.4 J05.0 J95.02 J31.0 J95.821 P24.80 J91.8 768.71 J30.5 J38 J70.2 J63.4 J86 478.4 J10.00 J84.9 J96.20 J21 J30.2 J31 J01.01 J29 R07.9 J75 J15.7 327.22 J61 J93.11 J02.9 478.75 P28.5 491.2 J45.22 J96.11 J67.8 J85.0 J35.03 J96.21 J11.1 J35.01 505 491.1 P28.10 J15.3 J38.00 J67 492.8 R06.2 770.88 770.86 J15.20 J38.5 R07 J30.1 J95.62 J20.1 J22 512.0 G47.30 768.1 P23.0 J35.3 J95.88 P91.60 J95.860 J81 J43.8 J00 J68.0 J83 478.34 J18.9 J94.2 J70.8 J35.9 J33.0 R07.1 770 501.0 J43.2 478.74 J45.20 470 J45.40 786.06 327.23 P28.89 R06.9 J39.0 J98.9 J47.0 J98.3 P22.1 J39.8 R06.83 J65 P24.10 R07.0 J37 R07.89 517 503 786.52 J10 491.20 J95.72 J28 J09.X3 J70 P23.3 J01.80 J97 J12.89 J18.8 516 J67.3 495.9 J40 P24.01 E84.9 J10.01 500.0 J11.2 519 501 J93.0 J98.01 P22 495.8 J08 G47.31 518.8 327.20 J20.5 786.01 786.50 P24.00 J41 770.2 J84.843 J93.81 515.0 J95.03 J30.0 786.00 J92 491.21 515 J92.9 768 R06.89 J56 J01.11 770.5 P19.1 J70.3 516.3 J32 J41.1 J85.3 J02.8 J21.9 J10.89 J68.2 518.2 R06.3 P25.1 R06.5 J91 P25.2 G47.36 J45.901 J16.8 J84.83 P28.4 R07.82 J18.2 J34 J74 J30.89 478.7 768.0 J11.83 J95.84 J59 478.5 J15.5 J84.17 J35.02 J18.0 768.72 786 519.02 J95.04 J63.6 P28.9 P19.9 J95 J85.1 491.8 J66.2 517.8 J95.822 J01.40 J48 519.09 518.4 G47.39 J51 786.59 277.03 J84.111 J86.0 P23.9 J34.0 J18 J17 J43 786.2 J96 J96.22 J71 J01.31 J63.3 495.6 494.0 P24.81 J95.2 J42 J76 J95.09 J84.09 768.9 J35.8 J01.91 G47.34 J06.9 J62.0 J96.10 J20.4 J50 491.9 R06.82 J32.2 J03.80 516.36 770.11 P23.4 J01.30 J84 J84.89 J47.1 J98.4 J01.90 R06.03 491.22 786.8 R07.81 492.0 J14 J66 P28.81 J15.211 J09.X2 J93.9 J67.5 J70.4 J45.32 84.09 770.6 J89 J01.81 P28.19 518.5 J32.8 J33.1 J10.82 786.05 478.6 J32.4 J81.1 J98.8 327.26 J96.02 516.8 518.0 519.4 770.9 J38.3 R06.09 J03.91 G47.37 327.2 J34.1 J12.0 J21.1 J01 P22.0 J12.2 J39.3 P25.3 786.02 J95.851 J31.1 P25.0 J15 J43.0 P23.1 495.2 478.31 P24.30 770.18 P24.31 J57 J63 J95.00 J69.0 J38.4 J09 277.0 J04.30 J95.5 J45.902 504 P24.11 J45 J03.01 P23.6 R06.1 519.0 786.1 J37.1 J15.29 J98.6 J44.9 J84.10 P27.9 J44.0 J96.00 517.3 E84.0 J45.998 516.9 J86.9 471 J63.2 491.0 J68.1 786.07 J98.19 P25 J66.8 768.3 518.84 J95.3 J30 J72 J44.1 519.00 J16 J84.2 770.85 J66.0 J20.2 519.11 277.00 J47.9 P27.1 770.4 J06 770.87 P91.62 P22.9 786.03 J84.117 J84.113 516.30 770.16 P23.2 495.0 J67.6 J93.82 J98.51 516.37 770.89 768.6 510 J04.2 J44 J12 327.24 'J43.9' J77 J84.82 J20.8 510.9 770.13 P28 J31.2 478.32 478.70 496 J38.6 J41.0 J24 J68 J11.89 J45.909 J03.81 J98.09 518.89 P91.61 770.10 J67.2 J15.0 J39.2 494.1 516.2 G47.33 277.02 J38.2 J60 E84.11 R09.89 J47 277.01 J95.831 J35 P23.5 J94.8 P24 J04.0 J69.8 517.2 R07.2 495.5 786.09 J20 J12.81 J45.31 J58 J45.51 J43.1 E84.19 P84 494 J55 J33.9 516.31 J30.9 P22.8 J98.59 J04.10 J38.1 J53 P25.8 P23.8 J62 516.33 J84.842 J54 J92.0 J32.1 769 J04.11 786.04 J68.9 J70.0 327.21 J90 P24.20 G47.32 770.83 P24.9 J12.1 J84.81 J67.1 J10.83 J32.3 J10.1 492 514 768.2 327.27 J95.61 J38.7 J16.0 J20.7 478.0 471.1 R06.02 J15.6 J95.1 J02 J95.812 J15.4 J68.4 J96.01 514.0 J03.90 J35.1 516.35 J45.990 786.3 J35.2 J62.8 J91.0 500 J93.12 770.82 J84.01 516.1 J45.41 J88 327.25 J84.114 P27 J20.3 471.9 J96.90 J11.81 518.82 495.3 J39.1 J98.11 J10.2 J80 519.8 J45.52 J96.12 518.83 J05.11 R06.4 770.17 J69.1 J67.4 J84.841 J99 J98.2 P26.8 J11 J63.1 J78 768.5 J85.2 J45.50 P26 P28.3 J15.9 J70.9 786.4 J36 J05 J95.861 J04.31 J67.9 J85 J04 478.71 471.0 518.81 E84.8 J98 J19 J21.0 J94 J43.9 770.14 516.34 J30.81 510.0 J45.42 J13 J26 768.73 R22.2 J96.92

SI-Table II: Diagnostic codes for dyspnea for investigating ZCoR-IPF effectiveness in identifying IPF without such indications*

ICD code	description
R06.9	Unspecified abnormalities of breathing
784.99	Head & neck symptoms NEC
786.0	Respiratory abnorm NOS
786.9	Resp sys/chest symp NEC
R06.02	Shortness of breath
R06.01	Orthopnea
786.02	Orthopnea
R06.89	Other abnormalities of breathing
786.8	Hiccough
786.05	Shortness of breath
R06.7	Sneezing
786.09	Respiratory abnorm NEC
R06.00	Dyspnea unspecified
786.06	Tachypnea
786.07	Wheezing
R06.82	Tachypnea not elsewhere classified
R06	Dyspnea unspecified
786.04	Cheyne-stokes respiratn
R06.6	Hiccough
R06.1	Stridor
R06.83	Snoring
R06.2	Wheezing
R06.09	Other forms of dyspnea
786.03	Apnea
R06.5	Mouth breathing
R06.81	Apnea not elsewhere classified
786.01	Hyperventilation
R06.03	Acute respiratory distress
R06.4	Hyperventilation
R06.3	Periodic breathing
786.1	Stridor

* The No-dyspnea cohort comprises patients who lack codes from this list. Thus these patients are at higher risk of mis-diagnosis

SI-Table III: Diagnostic codes for COPD, heart disease and asthma for investigating ZCoR-IPF effectiveness under other pre-existing diagnoses. The COPD/Heart disease/Asthma cohort comprises patients with one or more codes from this list.

ICD code	description
394.0	Mitral stenosis
J45.998	Other asthma
422.9	Acute myocarditis NOS
415	Acute cor pulmonale
I25.111	Atherosclerotic heart disease of native coronary artery with angina pectoris with documented spasm
426	Atriovent block complete
I27.21	Secondary pulmonary arterial hypertension
J42	Unspecified chronic bronchitis
395.9	Rheum aortic dis NEC/NOS
I20.1	Angina pectoris with documented spasm
425.0	Endomyocardial fibrosis
I31.9	Disease of pericardium unspecified
398.91	Rheumatic heart failure
423.3	Cardiac tamponade
J45.21	Mild intermittent asthma with (acute) exacerbation
427.6	Premature beats NOS
394.2	Mitral stenosis w insuff
J47	Bronchiectasis with acute lower respiratory infection
I51.5	Myocardial degeneration
I50.810	Right heart failure unspecified
395.2	Rheum aortic sten/insuff
428.1	Left heart failure
410.72	Subendo infarct subseq
491.2	Obst chr bronc w/o exac
493.9	Asthma NOS
I20	Unstable angina
I13.10	Hypertensive heart and chronic kidney disease without heart failure with stage 1 through stage 4 chronic kidney disease or unspecified chronic kidney disease
I49.2	Junctional premature depolarization
I50.42	Chronic combined systolic (congestive) and diastolic (congestive) heart failure
425.4	Prim cardiomyopathy NEC
J41.0	Simple chronic bronchitis
426.1	Atriovent block NOS
429	Myocarditis NOS
491	Simple chr bronchitis
I25.701	Atherosclerosis of coronary artery bypass graft(s) unspecified with angina pectoris with documented spasm
I25.84	Coronary atherosclerosis due to calcified coronary lesion
I50.84	End stage heart failure
I51.0	Cardiac septal defect acquired
414.01	Crrny athrscl natve vssl
I37.1	Nonrheumatic pulmonary valve insufficiency
115.03	Histoplasm caps pericard
I21.01	ST elevation (STEMI) myocardial infarction involving left main coronary artery
I06	Rheumatic aortic stenosis
I45.9	Conduction disorder unspecified
410.02	AMI anterolateral subseq
426.89	Conduction disorder NEC
422.92	Septic myocarditis
494.1	Bronchiectasis w ac exac
I23.1	Atrial septal defect as current complication following acute myocardial infarction
I31.8	Other specified diseases of pericardium
J45.41	Moderate persistent asthma with (acute) exacerbation
I25.769	Atherosclerosis of bypass graft of coronary artery of transplanted heart with unspecified angina pectoris
I34.1	Nonrheumatic mitral (valve) prolapse
I31	Chronic adhesive pericarditis
402.01	Mal hypert hrt dis w hf
410.52	AMI lateral NEC subseq
493.0	Extrinsic asthma NOS
I09.2	Chronic rheumatic pericarditis
J45.901	Unspecified asthma with (acute) exacerbation
B39.5	Histoplasmosis duboisii
425.8	Cardiomyopath in oth dis
I05.9	Rheumatic mitral valve disease unspecified
411	Post MI syndrome

Continued on next page

SI-Table III – continued from previous page

ICD code	description
J43.8	Other emphysema
I27	Primary pulmonary hypertension
428.31	Ac diastolic hrt failure
428.43	Ac/chr syst/dia hrt fail
429.5	Chordae tendinae rupture
I46	Cardiac arrest due to underlying cardiac condition
I48.92	Unspecified atrial flutter
410.01	AMI anterolateral init
411.1	Intermed coronary synd
I37.8	Other nonrheumatic pulmonary valve disorders
J43.1	Panlobular emphysema
402.91	Hyp ht dis NOS w ht fail
I13.2	Hypertensive heart and chronic kidney disease with heart failure and with stage 5 chronic kidney disease or end stage renal disease
I11	Hypertensive heart disease with heart failure
J41.1	Mucopurulent chronic bronchitis
I25.710	Atherosclerosis of autologous vein coronary artery bypass graft(s) with unstable angina pectoris
428.4	Syst/diastr hrt fail NOS
I31.0	Chronic adhesive pericarditis
394	Mitral stenosis
I44.4	Left anterior fascicular block
496	Chr airway obstruct NEC
I24.9	Acute ischemic heart disease unspecified
I25.110	Atherosclerotic heart disease of native coronary artery with unstable angina pectoris
I20.8	Other forms of angina pectoris
I47.1	Supraventricular tachycardia
I11.0	Hypertensive heart disease with heart failure
420.99	Acute pericarditis NEC
417.8	Pulmon circulat dis NEC
426.12	Atrioven block-mobitz ii
I28.1	Aneurysm of pulmonary artery
I50.83	High output heart failure
410.3	AMI inferopost unspc
I42.1	Obstructive hypertrophic cardiomyopathy
I49	Ventricular fibrillation
426.52	Rt bbb/lft ant fasc blk
I22.8	Subsequent ST elevation (STEMI) myocardial infarction of other sites
410.51	AMI lateral NEC initial
I25.739	Atherosclerosis of nonautologous biological coronary artery bypass graft(s) with unspecified angina pectoris
428.23	Ac on chr syst hrt fail
429.1	Myocardial degeneration
423.8	Pericardial disease NEC
I08	Rheumatic disorders of both mitral and aortic valves
I48.91	Unspecified atrial fibrillation
I37	Nonrheumatic pulmonary valve stenosis
I26.09	Other pulmonary embolism with acute cor pulmonale
I50.20	Unspecified systolic (congestive) heart failure
410.91	AMI NOS initial
402.0	Mal hyp ht dis w/o hf
426.53	Bilat bb block NEC
492.8	Emphysema NEC
J47.1	Bronchiectasis with (acute) exacerbation
I25.700	Atherosclerosis of coronary artery bypass graft(s) unspecified with unstable angina pectoris
I07.2	Rheumatic tricuspid stenosis and insufficiency
I08.8	Other rheumatic multiple valve diseases
396.2	Mitral insuf/aort stenosis
414.11	Aneurysm coronary vessel
I45.81	Long QT syndrome
495.4	Malt workers' lung
I39	Endocarditis and heart valve disorders in diseases classified elsewhere
I24.1	Dressler's syndrome
427.9	Cardiac dysrhythmia NOS
491.0	Simple chr bronchitis
414.2	Chr tot occlus cor artry
I36	Nonrheumatic tricuspid (valve) stenosis

Continued on next page

SI-Table III – continued from previous page

ICD code	description
I44.39	Other atrioventricular block
I21.A1	Myocardial infarction type 2
I49.02	Ventricular flutter
404.0	Mal hy ht/kd I-IV w/o hf
I27.82	Chronic pulmonary embolism
493.82	Cough variant asthma
404.12	Ben hy ht/kd st V w/o hf
I06.2	Rheumatic aortic stenosis with insufficiency
J45.32	Mild persistent asthma with status asthmaticus
427.41	Ventricular fibrillation
I34	Nonrheumatic mitral (valve) insufficiency
I07.1	Rheumatic tricuspid insufficiency
410.11	AMI anterior wall init
414	Cor ath unsp vsl ntv/gft
421	Ac/subac bact endocard
410.81	AMI NEC initial
I05.8	Other rheumatic mitral valve diseases
J45.902	Unspecified asthma with status asthmaticus
I28.0	Arteriovenous fistula of pulmonary vessels
427.0	Parox atrial tachycardia
397.1	Rheum pulmon valve dis
I09	Rheumatic myocarditis
I09.1	Rheumatic diseases of endocardium valve unspecified
428.9	Heart failure NOS
495.1	Bagassosis
398.0	Rheumatic myocarditis
T80.0xxA	Air embolism following infusion transfusion and therapeutic injection initial encounter
I49.01	Ventricular fibrillation
I26.92	Saddle embolus of pulmonary artery without acute cor pulmonale
I44.2	Atrioventricular block complete
I25.718	Atherosclerosis of autologous vein coronary artery bypass graft(s) with other forms of angina pectoris
414.06	Cor ath natv art tp hrt
I31.3	Pericardial effusion (noninflammatory)
J67.5	Mushroom-worker's lung
J67.9	Hypersensitivity pneumonitis due to unspecified organic dust
410.2	AMI inferolateral unspc
427.2	Parox tachycardia NOS
I25.708	Atherosclerosis of coronary artery bypass graft(s) unspecified with other forms of angina pectoris
413.1	Prinzmetal angina
410.7	Subendo infarct unspc
I21.09	ST elevation (STEMI) myocardial infarction involving other coronary artery of anterior wall
493.91	Asthma w status asthmat
J67.4	Maltworker's lung
I50.43	Acute on chronic combined systolic (congestive) and diastolic (congestive) heart failure
426.11	Atriovent block-1st degr
I13	Hypertensive heart and chronic kidney disease with heart failure and stage 1 through stage 4 chronic kidney disease or unspecified chronic kidney disease
410.71	Subendo infarct initial
410.1	AMI anterior wall unspc
I50.812	Chronic right heart failure
115.94	Histoplasmosis endocard
J45.909	Unspecified asthma uncomplicated
I25.751	Atherosclerosis of native coronary artery of transplanted heart with angina pectoris with documented spasm
424.2	Nonrheum tricuspid val dis
I25.798	Atherosclerosis of other coronary artery bypass graft(s) with other forms of angina pectoris
I37.9	Nonrheumatic pulmonary valve disorder unspecified
J43.0	Unilateral pulmonary emphysema [MacLeod's syndrome]
I28.8	Other diseases of pulmonary vessels
411.0	Post MI syndrome
422.91	Idiopathic myocarditis
424.3	Pulmonary valve disorder
I08.3	Combined rheumatic disorders of mitral aortic and tricuspid valves
I42.7	Cardiomyopathy due to drug and external agent
I50.9	Heart failure unspecified
495.8	Allerg alveol/pneum NEC

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ICD code	description
414.12	Dissection cor artery
424.9	Endocarditis NOS
404.03	Mal hyp ht/kd stg V w hf
I21.21	ST elevation (STEMI) myocardial infarction involving left circumflex coronary artery
I48.4	Atypical atrial flutter
I45.3	Trifascicular block
I05.1	Rheumatic mitral insufficiency
395	Rheumat aortic stenosis
I31.2	Hemopericardium not elsewhere classified
I42.8	Other cardiomyopathies
I45.19	Other right bundle-branch block
I25.10	Atherosclerotic heart disease of native coronary artery without angina pectoris
I44.7	Left bundle-branch block unspecified
I50.1	Left ventricular failure unspecified
397.0	Tricuspid valve disease
I50.23	Acute on chronic systolic (congestive) heart failure
493.11	Int asthma w status asth
I21.11	ST elevation (STEMI) myocardial infarction involving right coronary artery
J45.51	Severe persistent asthma with (acute) exacerbation
I45.10	Unspecified right bundle-branch block
420.0	Ac pericardit in oth dis
J67.6	Maple-bark-stripper's lung
I25.83	Coronary atherosclerosis due to lipid rich plaque
I46.9	Cardiac arrest cause unspecified
I06.8	Other rheumatic aortic valve diseases
I27.29	Other secondary pulmonary hypertension
J41	Simple chronic bronchitis
I07.9	Rheumatic tricuspid valve disease unspecified
J41.8	Mixed simple and mucopurulent chronic bronchitis
425	Endomyocardial fibrosis
I51	Cardiac septal defect acquired
I25.729	Atherosclerosis of autologous artery coronary artery bypass graft(s) with unspecified angina pectoris
410.82	AMI NEC subsequent
I42.6	Alcoholic cardiomyopathy
I50.41	Acute combined systolic (congestive) and diastolic (congestive) heart failure
402	Mal hyp ht dis w/o hf
426.54	Trifascicular block
J45.40	Moderate persistent asthma uncomplicated
495.3	Suberosis
I44.60	Unspecified fascicular block
494	Bronchiectas w/o ac exac
414.9	Chr ischemic hrt dis NOS
414.0	Cor ath unsp vsl ntv/gft
I23.3	Rupture of cardiac wall without hemopericardium as current complication following acute myocardial infarction
I44	Atrioventricular block first degree
493.92	Asthma NOS w (ac) exac
426.81	Lown-ganong-levine synd
I51.7	Cardiomegaly
417.9	Pulmon circulat dis NOS
I09.89	Other specified rheumatic heart diseases
I21.29	ST elevation (STEMI) myocardial infarction involving other sites
I44.5	Left posterior fascicular block
I47.2	Ventricular tachycardia
I24	Acute coronary thrombosis not resulting in myocardial infarction
I22	Subsequent ST elevation (STEMI) myocardial infarction of anterior wall
I25.760	Atherosclerosis of bypass graft of coronary artery of transplanted heart with unstable angina
414.05	Cor ath bypass graft NOS
404.02	Mal hy ht/kd st V w/o hf
I51.2	Rupture of papillary muscle not elsewhere classified
I50.31	Acute diastolic (congestive) heart failure
I42.5	Other restrictive cardiomyopathy
J67.7	Air conditioner and humidifier lung
425.18	Oth hypertrophic cardiomy
394.1	Rheumatic mitral insuff

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SI-Table III – continued from previous page

ICD code	description
I22.2	Subsequent non-ST elevation (NSTEMI) myocardial infarction
I25.811	Atherosclerosis of native coronary artery of transplanted heart without angina pectoris
I30.9	Acute pericarditis unspecified
I27.1	Kyphoscoliotic heart disease
I27.81	Cor pulmonale (chronic)
427.31	Atrial fibrillation
414.4	Cor ath d/t calc cor lsn
J40	Bronchitis not specified as acute or chronic
I25.9	Chronic ischemic heart disease unspecified
429.71	Acq cardiac septl defect
410.41	AMI inferior wall init
416.0	Prim pulm hypertension
428.3	Diastolic hrt failure NOS
429.2	Ascvd
410.22	AMI inferolateral subseq
416.2	Chr pulmonary embolism
I08.1	Rheumatic disorders of both mitral and tricuspid valves
I33	Acute and subacute infective endocarditis
410.61	True post infarct init
J45.52	Severe persistent asthma with status asthmaticus
I50.813	Acute on chronic right heart failure
402.9	Hyp hrt dis NOS w/o hf
396.3	Mitral/aortic val insuff
428.42	Chr syst/diastl hrt fail
I36.9	Nonrheumatic tricuspid valve disorder unspecified
I05.0	Rheumatic mitral stenosis
I40.1	Isolated myocarditis
I07	Rheumatic tricuspid stenosis
422.0	Ac myocardit in oth dis
I45	Right fascicular block
429.81	Papillary muscle dis NEC
I21.3	ST elevation (STEMI) myocardial infarction of unspecified site
428.32	Chr diastolic hrt fail
398	Rheumatic myocarditis
410.31	AMI inferopost initial
491.22	Obs chr bronc w ac bronc
410.62	True post infarct subseq
I40.0	Infective myocarditis
I45.2	Bifascicular block
428.22	Chr systolic hrt failure
I25.3	Aneurysm of heart
I28	Arteriovenous fistula of pulmonary vessels
414.04	Cor ath artry bypas grft
410	AMI anterolateral unspec
417.0	Arterioven fistu pul ves
I26	Septic pulmonary embolism with acute cor pulmonale
429.6	Papillary muscle rupture
I21.A9	Other myocardial infarction type
I22.9	Subsequent ST elevation (STEMI) myocardial infarction of unspecified site
I25.790	Atherosclerosis of other coronary artery bypass graft(s) with unstable angina pectoris
J67.0	Farmer's lung
424.1	Aortic valve disorder
I50.21	Acute systolic (congestive) heart failure
427.5	Cardiac arrest
495	Farmers' lung
424.0	Mitral valve disorder
I08.2	Rheumatic disorders of both aortic and tricuspid valves
I25.82	Chronic total occlusion of coronary artery
416.1	Kyphoscoliotic heart dis
I21.02	ST elevation (STEMI) myocardial infarction involving left anterior descending coronary artery
410.42	AMI inferior wall subseq
493.01	Ext asthma w status asth
J45.30	Mild persistent asthma uncomplicated
I50.814	Right heart failure due to left heart failure

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SI-Table III – continued from previous page

ICD code	description
414.19	Aneurysm of heart NEC
414.3	Cor ath d/t lpd rch plaq
I43	Cardiomyopathy in diseases classified elsewhere
422.99	Acute myocarditis NEC
493.21	Ch ob asthma w stat asth
I48	Paroxysmal atrial fibrillation
I97.0	Postcardiotomy syndrome
495.2	Bird-fanciers' lung
426.3	Left bb block NEC
427	Parox atrial tachycardia
I36.1	Nonrheumatic tricuspid (valve) insufficiency
I42.3	Endomyocardial (eosinophilic) disease
I25.711	Atherosclerosis of autologous vein coronary artery bypass graft(s) with angina pectoris with documented spasm
I51.4	Myocarditis unspecified
414.07	Cor ath bps graft tp hrt
I33.9	Acute and subacute endocarditis unspecified
428.33	Ac on chr diast hrt fail
I26.01	Septic pulmonary embolism with acute cor pulmonale
414.8	Chr ischemic hrt dis NEC
423.2	Constrictiv pericarditis
491.9	Chronic bronchitis NOS
I41	Myocarditis in diseases classified elsewhere
414.02	Crn ath atlg vn bps grft
404.92	Hy ht/kd NOS st V w/o hf
426.2	Left bb hemiblock
493.12	Int asthma w (ac) exac
425.11	Hypertrophic obstructive cardiomyopathy
I35.1	Nonrheumatic aortic (valve) insufficiency
I09.9	Rheumatic heart disease unspecified
413	Angina decubitus
I33.0	Acute and subacute infective endocarditis
115.04	Histoplasma caps endocard
425.2	Obsc african cardiomyopathy
I24.8	Other forms of acute ischemic heart disease
410.21	AMI inferolateral init
I37.0	Nonrheumatic pulmonary valve stenosis
429.82	Hyperkinetic heart dis
429.79	Other sequelae of MI NEC
I05	Rheumatic mitral stenosis
491.1	Mucopurulent chronic bronchitis
I25.738	Atherosclerosis of nonautologous biological coronary artery bypass graft(s) with other forms of angina pectoris
411.81	Acute coronary occlusion w/o MI
J47.9	Bronchiectasis uncomplicated
I30.8	Other forms of acute pericarditis
I23.5	Rupture of papillary muscle as current complication following acute myocardial infarction
I25.759	Atherosclerosis of native coronary artery of transplanted heart with unspecified angina pectoris
495.5	Mushroom workers' lung
I34.9	Nonrheumatic mitral valve disorder unspecified
397.9	Rheumatic endocarditis NOS
414.1	Aneurysm of heart
I25.721	Atherosclerosis of autologous coronary artery bypass graft(s) with angina pectoris with documented spasm
I52	Other heart disorders in diseases classified elsewhere
396.8	Mitral/aortic multivalvular involvement
410.32	AMI inferoposterior subseptal
I25.731	Atherosclerosis of nonautologous biological coronary artery bypass graft(s) with angina pectoris with documented spasm
429.3	Cardiomegaly
J44.9	Chronic obstructive pulmonary disease unspecified
I25.761	Atherosclerosis of bypass graft of coronary artery of transplanted heart with angina pectoris with documented spasm
I27.23	Pulmonary hypertension due to lung diseases and hypoxia
I48.2	Chronic atrial fibrillation unspecified
396.9	Mitral/aortic valve disease NOS
I47.0	Re-entry ventricular arrhythmia
I44.1	Atrioventricular block second degree
I21.19	ST elevation (STEMI) myocardial infarction involving other coronary artery of inferior wall

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ICD code	description
I06.1	Rheumatic aortic insufficiency
402.11	Benign hyp ht dis w hf
I25.791	Atherosclerosis of other coronary artery bypass graft(s) with angina pectoris with documented spasm
402.1	Benign hyp ht dis w/o hf
I46.2	Cardiac arrest due to underlying cardiac condition
410.8	AMI NEC unspecified
420.91	Ac idiopath pericarditis
I36.2	Nonrheumatic tricuspid (valve) stenosis with insufficiency
427.81	Sinoatrial node dysfunct
I48.0	Paroxysmal atrial fibrillation
I35.2	Nonrheumatic aortic (valve) stenosis with insufficiency
395.0	Rheumat aortic stenosis
425.7	Metabolic cardiomyopathy
398.99	Rheumatic heart dis NEC
394.9	Mitral valve dis NEC/NOS
I45.4	Nonspecific intraventricular block
426.82	Long QT syndrome
I37.2	Nonrheumatic pulmonary valve stenosis with insufficiency
425.5	Alcoholic cardiomyopathy
I25.42	Coronary artery dissection
I32	Pericarditis in diseases classified elsewhere
I34.8	Other nonrheumatic mitral valve disorders
I23.0	Hemopericardium as current complication following acute myocardial infarction
415.0	Acute cor pulmonale
I30	Acute nonspecific idiopathic pericarditis
J43.2	Centrilobular emphysema
427.1	Parox ventric tachycard
I21.9	Acute myocardial infarction unspecified
I25.41	Coronary artery aneurysm
I44.0	Atrioventricular block first degree
I25.750	Atherosclerosis of native coronary artery of transplanted heart with unstable angina
423.9	Pericardial disease NOS
410.5	AMI lateral NEC unspec
I08.9	Rheumatic multiple valve disease unspecified
410.92	AMI NOS subsequent
I50	Left ventricular failure unspecified
115.14	Histoplasm dub endocard
421.0	Ac/subac bact endocard
I05.2	Rheumatic mitral stenosis with insufficiency
I50.32	Chronic diastolic (congestive) heart failure
410.4	AMI inferior wall unspec
I09.0	Rheumatic myocarditis
495.0	Farmers' lung
I20.0	Unstable angina
I25.2	Old myocardial infarction
J45	Mild intermittent asthma uncomplicated
426.0	Atriovent block complete
426.5	Bundle branch block NOS
J67.2	Bird fancier's lung
I09.81	Rheumatic heart failure
J45.31	Mild persistent asthma with (acute) exacerbation
115.13	Histoplasm dub pericard
404.11	Ben hyp ht/kd I-IV w hf
411.89	Ac ischemic hrt dis NEC
I51.1	Rupture of chordae tendineae not elsewhere classified
495.7	"ventilation" pneumonit
J45.22	Mild intermittent asthma with status asthmaticus
I24.0	Acute coronary thrombosis not resulting in myocardial infarction
J43	Unilateral pulmonary emphysema [MacLeod's syndrome]
I49.1	Atrial premature depolarization
I26.90	Septic pulmonary embolism without acute cor pulmonale
J47.0	Bronchiectasis with acute lower respiratory infection
J45.990	Exercise induced bronchospasm
429.4	Hrt dis postcardiac surg

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SI-Table III – continued from previous page

ICD code	description
410.0	AMI anterolateral unspec
424	Mitral valve disorder
I27.0	Primary pulmonary hypertension
427.42	Ventricular flutter
404.93	Hyp ht/kd NOS st V w hf
491.8	Chronic bronchitis NEC
415.19	Pulm embol/infarct NEC
I25.719	Atherosclerosis of autologous vein coronary artery bypass graft(s) with unspecified angina pectoris
426.13	Av block-2nd degree NEC
I50.89	Other heart failure
410.9	AMI NOS unspecified
I51.9	Heart disease unspecified
427.69	Premature beats NEC
I49.49	Other premature depolarization
I23.2	Ventricular septal defect as current complication following acute myocardial infarction
I25.799	Atherosclerosis of other coronary artery bypass graft(s) with unspecified angina pectoris
427.61	Atrial premature beats
495.9	Allerg alveol/pneum NOS
412	Old myocardial infarct
426.51	Rt bbb/lft post fasc blk
404.13	Ben hyp ht/kd stg V w hf
I49.8	Other specified cardiac arrhythmias
395.1	Rheumatic aortic insuff
426.9	Conduction disorder NOS
493	Extrinsic asthma NOS
I30.1	Infective pericarditis
404.91	Hyp ht/kd NOS I-IV w hf
I45.6	Pre-excitation syndrome
I25.89	Other forms of chronic ischemic heart disease
I49.5	Sick sinus syndrome
I08.0	Rheumatic disorders of both mitral and aortic valves
J44	Chronic obstructive pulmonary disease with (acute) lower respiratory infection
I47	Re-entry ventricular arrhythmia
J44.1	Chronic obstructive pulmonary disease with (acute) exacerbation
I23.4	Rupture of chordae tendineae as current complication following acute myocardial infarction
429.9	Heart disease NOS
429.83	Takotsubo syndrome
I13.11	Hypertensive heart and chronic kidney disease without heart failure with stage 5 chronic kidney disease or end stage renal disease
I44.69	Other fascicular block
I51.81	Takotsubo syndrome
I13.0	Hypertensive heart and chronic kidney disease with heart failure and stage 1 through stage 4 chronic kidney disease or unspecified chronic kidney disease
B39.4	Histoplasmosis capsulati unspecified
I50.30	Unspecified diastolic (congestive) heart failure
493.2	Chronic obst asthma NOS
I31.4	Cardiac tamponade
414.03	Crn ath nonatlg blg grft
417.1	Pulmon artery aneurysm
I50.82	Biventricular heart failure
492	Emphysematous bleb
I35.9	Nonrheumatic aortic valve disorder unspecified
I20.9	Angina pectoris unspecified
422	Ac myocardit in oth dis
I45.89	Other specified conduction disorders
I50.33	Acute on chronic diastolic (congestive) heart failure
I25.768	Atherosclerosis of bypass graft of coronary artery of transplanted heart with other forms of angina pectoris
I42.4	Endocardial fibroelastosis
425.3	Endocard fibroelastosis
I23.8	Other current complications following acute myocardial infarction
I25.730	Atherosclerosis of nonautologous biological coronary artery bypass graft(s) with unstable angina pectoris
J45.42	Moderate persistent asthma with status asthmaticus
I49.40	Unspecified premature depolarization
421.1	Ac endocardit in oth dis
J45.991	Cough variant asthma

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ICD code	description
398.9	Rheumatic heart dis NOS
429.89	Ill-defined hrt dis NEC
J45.20	Mild intermittent asthma uncomplicated
J44.0	Chronic obstructive pulmonary disease with (acute) lower respiratory infection
I38	Endocarditis valve unspecified
I07.0	Rheumatic tricuspid stenosis
I22.1	Subsequent ST elevation (STEMI) myocardial infarction of inferior wall
423.1	Adhesive pericarditis
426.6	Other heart block
427.32	Atrial flutter
495.6	Mapl bark-stripprs' lung
428.41	Ac syst/diastol hrt fail
427.89	Cardiac dysrhythmias NEC
I35	Nonrheumatic aortic (valve) stenosis
I51.3	Intracardiac thrombosis not elsewhere classified
410.6	True post infarct unspec
I46.8	Cardiac arrest due to other underlying condition
J46	
415.13	Saddle embol pulmon art
'J43.9'	
B39.9	Histoplasmosis unspecified
424.99	Endocarditis NEC
492.0	Emphysematous bleb
I11.9	Hypertensive heart disease without heart failure
I27.24	Chronic thromboembolic pulmonary hypertension
I27.83	Eisenmenger's syndrome
I42.9	Cardiomyopathy unspecified
491.21	Obs chr bronc w(ac) exac
421.9	Ac/subac endocardit NOS
J45.50	Severe persistent asthma uncomplicated
423.0	Hemopericardium
I06.0	Rheumatic aortic stenosis
I45.0	Right fascicular block
397	Tricuspid valve disease
420	Ac pericardit in oth dis
I25.810	Atherosclerosis of coronary artery bypass graft(s) without angina pectoris
I44.30	Unspecified atrioventricular block
I22.0	Subsequent ST elevation (STEMI) myocardial infarction of anterior wall
426.4	Rt bundle branch block
J67.8	Hypersensitivity pneumonitis due to other organic dusts
I27.9	Pulmonary heart disease unspecified
416	Prim pulm hypertension
413.9	Angina pectoris NEC/NOS
428.0	CHF NOS
I40.8	Other acute myocarditis
428.2	Systolic hrt failure NOS
428	CHF NOS
J67.1	Bagassosis
I50.22	Chronic systolic (congestive) heart failure
I48.3	Typical atrial flutter
I36.8	Other nonrheumatic tricuspid valve disorders
423	Hemopericardium
415.12	Septic pulmonary embolism
I23.7	Postinfarction angina
I25.118	Atherosclerotic heart disease of native coronary artery with other forms of angina pectoris
J43.9	Emphysema unspecified
I06.9	Rheumatic aortic valve disease unspecified
404.9	Hy ht/kd NOS I-IV w/o hf
I47.9	Paroxysmal tachycardia unspecified
I45.5	Other specified heart block
429.0	Myocarditis NOS
I25.720	Atherosclerosis of autologous artery coronary artery bypass graft(s) with unstable angina pectoris
I25.812	Atherosclerosis of bypass graft of coronary artery of transplanted heart without angina pectoris
I25	Atherosclerotic heart disease of native coronary artery without angina pectoris

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ICD code	description
I50.40	Unspecified combined systolic (congestive) and diastolic (congestive) heart failure
I49.3	Ventricular premature depolarization
413.0	Angina decubitus
425.9	Second cardiomyopath NOS
I28.9	Disease of pulmonary vessels unspecified
I48.1	Longstanding persistent atrial fibrillation
396	Mitral/aortic stenosis
I42	Dilated cardiomyopathy
I21.4	Non-ST elevation (NSTEMI) myocardial infarction
I34.2	Nonrheumatic mitral (valve) stenosis
I36.0	Nonrheumatic tricuspid (valve) stenosis
I25.119	Atherosclerotic heart disease of native coronary artery with unspecified angina pectoris
I50.811	Acute right heart failure
404.01	Mal hyp ht/kd I-IV w hf
493.22	Ch obst asth w (ac) exac
420.9	Acute pericarditis NOS
424.91	Endocarditis in oth dis
I26.02	Saddle embolus of pulmonary artery with acute cor pulmonale
422.93	Toxic myocarditis
490	Bronchitis NOS
I27.89	Other specified pulmonary heart diseases
I25.6	Silent myocardial ischemia
426.7	Anomalous av excitation
I21	ST elevation (STEMI) myocardial infarction involving left main coronary artery
I26.99	Other pulmonary embolism without acute cor pulmonale
I42.0	Dilated cardiomyopathy
I42.2	Other hypertrophic cardiomyopathy
I07.8	Other rheumatic tricuspid valve diseases
I49.9	Cardiac arrhythmia unspecified
I34.0	Nonrheumatic mitral (valve) insufficiency
404.1	Ben hy ht/kd I-IV w/o hf
415.11	Iatrogen pulm emb/infarc
I23	Hemopericardium as current complication following acute myocardial infarction
416.9	Chr pulmon heart dis NOS
410.12	AMI anterior wall subseq
I27.20	Pulmonary hypertension unspecified
I23.6	Thrombosis of atrium auricular appendage and ventricle as current complications following acute myocardial infarction
I40.9	Acute myocarditis unspecified
I35.0	Nonrheumatic aortic (valve) stenosis
I31.1	Chronic constrictive pericarditis
396.1	Mitral stenosis/aort insuf
I25.758	Atherosclerosis of native coronary artery of transplanted heart with other forms of angina pectoris
I30.0	Acute nonspecific idiopathic pericarditis
I25.709	Atherosclerosis of coronary artery bypass graft(s) unspecified with unspecified angina pectoris
I27.22	Pulmonary hypertension due to left heart disease
493.02	Ext asthma w(acute) exac
493.1	Intrinsic asthma NOS
115.93	Histoplasmosis pericard
I25.5	Ischemic cardiomyopathy
393	Chr rheumatic pericard
I40	Infective myocarditis
494.0	Bronchiectas w/o ac exac
396.0	Mitral/aortic stenosis
493.81	Exercse ind bronchospasm
416.8	Chr pulmon heart dis NEC
I35.8	Other nonrheumatic aortic valve disorders
I51.89	Other ill-defined heart diseases
I25.728	Atherosclerosis of autologous artery coronary artery bypass graft(s) with other forms of angina pectoris
J67.3	Suberosis
428.21	Ac systolic hrt failure

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Figures

a. Geospatial distribution of positive cases

b. Distribution of onset age in the database

c. Risk of onset with age

d. CONSORT

Figure 1

Statistical characteristics of the Truven database. Panel a shows where our patients originate from. The geospatial distribution is correlated with population density, as expected. Panel b illustrates the distribution of patient diagnostic ages in the database. Note that the mean age of onset compares

favorably with the value reported in the literature (≈ 68 vs 66 years). Panel d shows the probability of diagnosis with age, taking into account the variation of the number of patients of a given age in the database (higher the age beyond 65, smaller the number of patients). Panel d shows patient selection via a CONSORT (Consolidated Standards of Reporting Trials) diagram.

a. Receiver Operating Characteristic curves

b. Precision Recall curves

c. Feature importances for broad categories of co-morbidities

Figure 2

Predictive performance of ZCoR-IPF for IPF diagnosis 1 year in future. Panels a and b show the out-of-sample ROC and precision-recall curves for diagnosis 1 year from the point of screening. We achieve AUCs > 88% for both sexes, with sensitivity > 55% at 95% specificity. The PPV achieved is $\approx$ 50% for females and 45% for males at 99.7% specificity for patients who have atleast one respiratory diagnosis with past two years of ZCoR-IPF screening. Panels c and d show the top 20 comorbidity categories sorted in the order of inferred importance in estimating risk. Importantly, the comorbidities modulate risk differentially by sex, although the patterns are broadly similar, e.g.; respiratory disorders are the most important co-morbid factor, and other factors such as known IPF high co-morbidities (See Tab;e V), cardiovascular issues, infections, hypertensive abnormalities appear in both males and females, with altered ranking.

Figure 3

Survival function, hazard rate improvements, and predictive performance for early screening. Panel a shows the estimated lower bounds on the survival function at two specificity levels (90 and 95%), and panel b the estimated upper bounds on hazard rates. The lower (upper) bounds are estimated due to the

often missing information on actual deaths. Nevertheless, the last diagnostic record in a patient's history is a lower bound on the survival time, allowing us to calculate the plots shown above. Panel c shows the variation of the mean survival time as a function of the specificity at which ZCoR-IPF is operated. The baselines shown are calculated from our patient database, and is somewhat lower to what is reported in the literature (2-3 years median post-diagnosis). This is expected since our estimate is a lower bound. We have a clear advantage for even high specificities. Panel d illustrates the variation of estimated raw risk as a function of age for screening four years from actual recorded diagnosis of IPF, showing that risk increases almost linearly with age for the patients eventually diagnosed with IPF. Finally, panel e shows the degradation of out-of-sample AUC as we attempt to screen earlier, stepping back from the time of current diagnosis (in absence of ZCoR-IPF screening). Note that starting from $\approx 88\%$ AUC at 1 year to diagnosis the performance degrades somewhat to $\approx 85\%$ for screening at 4 years to diagnosis.

ICD Class

a. Male Pulmonary Fib.

b. Female Pulmonary Fib.

Figure 4

Co-morbidity Spectrum (males). Disorders that increase the odds of the patient being a “true positive” vs a “true negative”. Such disorders (ranked according to the log-odds ratio) are more likely to be found in patients who are in the positive cohort. Comparing panel a with panel b, we note that these odds change from males to females, but as expected the patterns are broadly similar, with over-representation of respiratory disorders.