Original Research

Hospitalized Non-Tuberculous Mycobacterial Pulmonary Disease Patients and Their Outcomes in the United States: A Retrospective Study Using National Inpatient Sample Data

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Running Head: **Hospitalized NTM Pulmonary Disease Patients**

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Abbreviations: NTM-PD: Non-tuberculous mycobacteria pulmonary disease***;*** LOS: Length of stay***;*** NIS: National Inpatient Sample***;*** CCI: Charlson Comorbidity Index***;*** IRR: Incidence Rate Ratio***;*** aOR: Adjusted Odds Ratio

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Abstract

Background: Non-tuberculous mycobacteria pulmonary disease (NTM-PD) is an emerging public health concern with increasing incidence and prevalence. Despite its chronic and progressive nature, there is a notable gap in research on the factors influencing hospital outcomes in this patient population.

Materials and Methods: We conducted a retrospective cohort study using data from the National Inpatient Sample (NIS) to analyze hospitalizations of adult patients diagnosed with NTM-PD. We examined patient demographics, comorbidities, and hospital characteristics to identify predictors of hospital length of stay (LOS) and discharge disposition. Multivariate negative binomial regression and logistic regression models were employed to assess the impact of these variables.

Results: The study included 1,167 hospitalized NTM-PD patients, with a mean age of 66.9 years. The overall mean LOS was 7.4 days, with an average hospital cost of $15,606. Discharge to a nursing home was associated with a 78% longer LOS (IRR=1.78, $p<0.0001$). Key predictors of extended LOS included male gender, private insurance status, higher comorbidity burden, and increased number of procedures. Patients discharged to nursing homes were more likely to be older males with complex medical profiles. Interestingly, conditions such as malignancy and COPD, while linked to longer LOS, were associated with a decreased likelihood of discharge to a nursing home.

Conclusion: Our study highlights significant predictors of LOS and discharge outcomes in NTM-PD patients, emphasizing the need for personalized and proactive management. These findings underscore the importance of targeted interventions in the outpatient setting to reduce hospital admissions and improve patient outcomes.

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INTRODUCTION

Non-tuberculous mycobacteria (NTM) represent a growing public health challenge, with rising rates of infection increasingly recognized across various populations [1]. This trend may be driven by improved diagnostic capabilities, greater exposure to the pathogen, or heightened awareness among healthcare providers [2]. In the United States, from 2008 to 2015, the incidence and prevalence of NTM pulmonary disease (NTM-PD) increased annually by 5.2% and 7.5%, respectively [1]. This growing patient population experiences significant morbidity, elevated healthcare utilization and expenditures compared to those without the disease [3]. Patients with NTM-PD often endure debilitating symptoms such as chronic cough, shortness of breath, and fatigue, which severely impact their quality of life [4]. Recent studies have also indicated a heightened risk of all-cause mortality among these patients relative to age-matched controls [5].

Although NTM-PD is typically considered a chronic, progressive condition managed in outpatient settings, these patients are significantly more likely to require hospitalization and have a greater annual hospitalization rate than age- and sex-matched controls [3, 6]. Given that NTM infections predominantly affect the elderly and immunocompromised [7], it is reasonable to expect that the inpatient burden of NTM-PD will continue to rise as the prevalence of the disease increases.

Despite the substantial evidence highlighting the growing impact of NTM-PD on the healthcare system, there is a notable gap in research focused on this disease within the hospital setting. Our

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study seeks to address this gap by characterizing the hospitalized NTM-PD patient population and identifying the factors that influence key hospital outcomes, particularly length of stay and discharge disposition.

MATERIALS AND METHODS

Study Design and Data Source

We conducted a retrospective cohort study utilizing discharge data from the National Inpatient Sample (NIS), a component of the Healthcare Cost and Utilization Project (HCUP) under the Agency for Healthcare Research and Quality [8]. The NIS is the largest publicly available all-payer inpatient care administrative database in the United States, providing data on over seven million hospital stays annually from 48 states, covering 97% of the U.S. population. The database includes weighted discharges to represent the entire U.S. hospital discharge population, sampling from all hospitals within HCUP. Each record in the NIS includes up to 40 *International Classification of Diseases, 10th Revision, Clinical Modification* (ICD-10-CM) diagnosis codes and 15 procedure codes associated with each hospital stay. The dataset also contains de-identified patient-level information alongside hospital characteristics. The NIS database is de-identified and publicly accessible; as a result, we did not request Institutional Review Board approval or patient consent.

Patients and Variables

Our cohort comprised adult patients aged 18 and older who were hospitalized with NTM-PD. Cases were identified using the ICD-10 code A31.0. The NIS records the principal diagnosis as the first code, followed by secondary diagnoses in numerical order. We included all patients for

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whom NTM-PD was recorded as the principal diagnosis. Patients transferred between hospitals and those with cystic fibrosis (ICD-10 codes E84.0, E84.1, E84.11, E84.19, E84.8, and E84.9) were excluded from the analysis (See Figure 1 for cohort selection).

We extracted both patient and hospital characteristics from the NIS to assess various risk factors for two primary outcomes: hospital length of stay (LOS) and discharge to a nursing home. Variables of interest included age, gender, race, income status, insurance status, hospital bed size, hospital location, year of admission, number of diagnoses, and number of procedures. The Charlson Comorbidity Index (CCI) was used to risk-stratify the hospitalized patients. The ICD-10-CM codes used to identify chronic medical conditions included in the CCI calculation, as well as other medical conditions of interest, are detailed in Supplementary Table 1.

We conducted exploratory analyses to identify factors associated with increased LOS among the patient cohort. A significant factor influencing LOS was discharge to a nursing home, prompting us to further analyze the variables associated with this outcome.

Statistical Analysis

Patient characteristics were compared using the Student's t-test for normally distributed continuous data, the Mann-Whitney U test for non-normally distributed continuous data, and the Pearson Chi-square test for categorical variables. We performed both univariate and multivariate analyses. Negative binomial regression was utilized for analyzing LOS, while logistic regression was employed to assess the likelihood of discharge to a nursing home. Both models were adjusted for parameters significant in univariate analysis or those with biological plausibility.

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The predictors included in the models were age, gender, race, household income, payer status, hospital bed size, hospital location, calendar year, number of diagnoses, number of procedures, CCI, and chronic medical conditions of interest. We calculated adjusted incidence rate ratios (aIRR) for the negative binomial regression and adjusted odds ratios (aOR) for the logistic regression models. A backward conditional stepwise approach was used to develop various iterations of both models, with a p-value of 0.10 as the threshold for inclusion. A two-sided p-value of <0.05 was considered statistically significant. All analyses were conducted using IBM SPSS Statistics for Windows, version 25 (IBM Corp., Armonk, NY, USA).

RESULTS

NTM-PD Patients – Total Cohort

Baseline Characteristics

The study analyzed data from 1,167 patients diagnosed with NTM-PD (Table 1). The mean age of the cohort was 66.9 years, with males comprising 44.6% of the population. Most patients were White (66.6%), followed by Black (10.6%), Hispanic (8.6%), and individuals of other racial backgrounds (12.3%). Medicare was the primary payer for 63.7% of these patients, followed by Medicaid (14.0%), Private/HMO insurance (18.2%), and other/self-pay (3.9%). On average, patients had 14.5 diagnoses each. The Charlson Comorbidity Index (CCI) indicated a significant burden of comorbidities, with 52.6% of patients having a CCI score of 4 or higher. Chronic pulmonary conditions were prevalent, affecting 70.2% of patients, with COPD (39.0%) and bronchiectasis (24.6%) being the most common. Other frequent chronic conditions included

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hypertension (51.4%), cardiovascular and cerebrovascular disease (24.2%), hypothyroidism (15.3%), and diabetes (14.4%).

Most NTM-PD patients (75.1%) received treatment in urban teaching hospitals (Table 2). Of the cohort, 57.4% were treated in large hospitals, 27.2% in medium-sized hospitals, and 15.4% in small hospitals. Regionally, the highest proportion of patients was from the South (44.6%), followed by the West (19.7%), Northeast (19.2%), and Midwest (16.5%).

Outcomes

The mean LOS for the total cohort was 7.4 days (Figure 2), with an average of 1.4 procedures performed and mean hospital cost of $15,606 (Table 3). The in-hospital mortality rate was 3.1%. Regarding discharge disposition, 58.2% of patients were discharged home, 22.4% were discharged home with home health care, 15.3% were discharged to skilled nursing facilities, and 0.9% left against medical advice (Figure 3).

Multivariate negative binomial regression identified several predictors that impact LOS among NTM-PD patients (Table 4). Female patients had slightly shorter LOS than their male counterparts (IRR=0.91, p=0.04). Conversely, patients with Private/HMO insurance experienced longer LOS compared to those with Medicare (IRR=1.18, p=0.007). Patients treated in hospitals located in the Mountain and Pacific region had a 38% (IRR=1.38, p=0.02) and 33% (IRR=1.33, p=0.02) higher LOS, compared to the baseline region of New England. Additionally, we noted a 3% rise in the hospital LOS for each additional diagnosis (IRR=1.03, p<0.0001). Similarly, each additional procedure performed was linked to a 12% increase in the LOS (IRR=1.12, p<0.0001).

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Discharge disposition further influenced hospital length of stay. Patients discharged to a nursing home had a 78% higher rate of longer stays (IRR=1.78, p<0.0001), and those discharged home with home health services had a 40% higher rate (IRR=1.40, p<0.0001) compared to those discharged directly home. Certain chronic conditions were also predictors of longer hospital stays. Patients with a history of alcohol or drug abuse had a 23% higher rate (IRR=1.23, p=0.01), those with malignancies had a 17% higher rate (IRR=1.17, p=0.05), and those with COPD had an 11% higher rate (IRR=1.11, p=0.02).

NTM-PD Patients Discharged to Nursing Homes

Baseline Characteristics

Among the 1,167 patients, 179 (15.3%) were discharged to nursing homes. These patients were older, with a mean age of 74.6 years (Table 1). The gender distribution was similar to the total cohort, with males comprising 43.6% of this group. A higher percentage of White patients were discharged to nursing homes (79.8%) compared to the total cohort (66.6%), while the proportions of Black (3.5%), Hispanic (5.2%), and other racial groups (11.6%) were lower. Medicare was the primary payer for a larger proportion of these patients (83.8%), and they had a higher mean number of diagnoses (17.4) compared to the total cohort. Although the prevalence of chronic pulmonary conditions was slightly lower (68.2%), these patients exhibited higher rates of comorbid conditions, such as hypertension (63.7%), cardiovascular and cerebrovascular disease (31.8%), and hypothyroidism (18.4%).

Most patients discharged to nursing homes were treated in urban teaching hospitals (64.9%), with 20.7% treated in non-teaching urban hospitals and 4.1% in rural hospitals (Table 2). Among these patients, 50.8% were treated in large hospitals, 31.3% in medium hospitals, and 17.9% in small hospitals. Regionally, 44.7% of nursing home discharges were from the South, 21.8% from the Northeast, 14.0% from the West, and 19.6% from the Midwest.

Outcomes

Patients discharged to nursing homes had a longer mean hospital stay (11.4 days vs. 7.4 days) and incurred higher average hospital cost ($20,781 vs. $15,606) (Table 3) compared to the total cohort.

Multivariate logistic regression analysis identified key predictors for discharge to a nursing home (Table 5). Older age was a strong predictor, with each additional year increasing the odds of nursing home discharge by 5% (aOR=1.05, $p<0.0001$). Females had 36% lower odds of being discharged to a nursing home compared to males (aOR=0.64, $p=0.03$). Black patients had 71% lower odds of nursing home discharge compared to White patients (aOR=0.29, $p=0.008$). Hospital characteristics also influenced discharge disposition, with patients treated in urban teaching hospitals having 60% lower odds of being discharged to a nursing home compared to those treated in rural hospitals (aOR=0.40, $p=0.01$). Each additional diagnosis increased the odds of nursing home discharge by 10% (aOR=1.10, $p<0.0001$). Among chronic conditions, patients with malignancies had 61% lower odds (aOR=0.39, $p=0.03$), and those with COPD had 42% lower odds (aOR=0.58, $p=0.01$) of being discharged to a nursing home.

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DISCUSSION

Our study revealed an overall mean hospital LOS of 7.4 days and an average hospitalization cost of $71,334 in NTM-PD patients. Several patient variables were significantly associated with longer LOS, including male gender, private insurance status, a higher comorbidity burden as measured by CCI, and the need for a greater number of procedures while hospitalized. Among these variables, discharge disposition emerged as one of the strongest predictors of LOS, with discharge to a nursing home associated with a 78% higher LOS. Patients discharged to nursing homes had a mean LOS of 11.4 days and an average hospital cost of $20,781 per stay. Interestingly, while older age was not linked to a longer LOS in the overall cohort, it was a significant predictor of discharge to a nursing home. Additionally, Black and female patients were significantly less likely to be discharged to a nursing home. Among comorbidities, malignancy and COPD were most strongly associated with longer hospital stays. These were protective factors when it came to discharge to nursing homes.

NTM-PD is more prevalent in older adults, females, and patients identifying as white [1], as reflected in our hospitalized cohort. The literature is unclear about the relationship between household income and NTM-PD, though some studies suggest that factors like increased exposure to air pollution, occupational hazards, poor nutritional status, and a lower body mass index may contribute to the incidence of NTM-PD [9, 10]. However, we found no significant difference in household income within our hospitalized cohort or among those discharged to nursing homes.

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The most common non-pulmonary comorbidities in our cohort were hypertension, cardiovascular and cerebrovascular diseases, hypothyroidism, and diabetes. While similar findings have not been extensively reported in the NTM-PD population, given the older age of our cohort, it is not surprising to see high rates of these commonly prevalent conditions [11]. The average number of diagnoses per patient was 14.5 in the overall cohort and 17.4 in the subgroup discharged to nursing homes, which is notably higher than the average for Medicare beneficiary [11].

The association between NTM-PD and other airways diseases is well documented [12]. Bronchiectasis, a structural lung disease, is a recognized risk factor for NTM-PD [13, 14], and the coinfection of COPD patients with NTM is increasingly acknowledged as a cause of uncontrolled symptoms [15] and perhaps linked to exacerbations [6]. There is a mechanistic overlap between alpha-1-antitrypsin deficiency and NTM infection [16]. In our cohort, 39% of hospitalized NTM-PD patients had coexisting COPD and about 25% had bronchiectasis, with similar proportions observed in the subgroup discharged to nursing home. A study by Henkle et al. on the natural history of NTM-PD reported that the 35% of patients had concomitant radiographic bronchiectasis and 28% had COPD [17].

The number of cases identified per year remained stable between 2016 and 2018. The geographic distribution of NTM-PD in our study was consistent with findings from Strollo et al., who reported higher prevalence in the South and coastal states, relative to landlocked Midwestern states [18] . The overall mortality rate in our study was 3.1%. This is significantly less than a 2017 study by Spaulding, et al., who reported an 11% morality rate during hospitalizations in

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patients who had clinical mycobacterial isolates [19]. This discrepancy may be due to differences in cohort years, with our study focusing on a more contemporary population, or the fact that the Spaulding study analyzed microbiologic isolates across the US and not the clinical disease.

Our overall LOS of 7.4 days is comparable to US and Korean studies reporting 8 [19] and 9 [20] days respectively, but lower compared to some other studies. For example, a 2013 study by Ringshausen et al. [21] reported an average LOS of 18.3 days in a German population with pulmonary NTM as their primary diagnosis. A study done by Mirsaeidi et al., covering the years 2001 to 2012, noted an average LOS of 9.2 days [22]. The shorter LOS in our cohort may suggest improvements in disease recognition and an emphasis on early discharge. Mirsaeidi and colleagues reported a mean hospital charge of $47,120, with costs rising over time. Our cohort's mean charge of $71,334 (corresponding to an adjusted cost of $15,606), despite a shorter LOS, highlights the escalating costs of healthcare, which outpace inflation.

Multivariate negative binomial regression identified several factors significantly influencing LOS in NTM-PD patients. Female sex was associated with a slightly shorter LOS compared to males, possibly due to differences in disease severity or its progression, or differences in social support. Patients with Private/HMO insurance and those who were self-pay/other had significantly longer hospital stays compared to those with Medicare, perhaps reflecting differences in care management practices, access to post-discharge resources, or financial constraints delaying discharge. The analysis also revealed that the number of diagnoses and procedures performed during hospitalization were strongly associated with longer LOS. This is expected, as a higher burden of comorbid conditions and more medical interventions typically

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extend hospital stays. While 58.2% of patients were discharged home, those discharged to a nursing home or with home health services had LOS that were 78% and 40% longer, respectively, likely due to the complexities involved in arranging appropriate care.

Chronic medical conditions such as alcohol and drug abuse, malignancy, and COPD were associated with 23%, 17% and 11% longer hospital stays, respectively. The link between alcohol use and lung health is increasingly recognized, with alcohol use disorder associated with higher risks of pneumonia [23], tuberculosis [24], and acute respiratory distress syndrome [25]. The mechanisms are thought to be mediated through alcohol-related immunosuppression or modulation [26]. Malignancy's impact on the immune system likely contributed to a longer LOS, as it is a known risk factor for NTM-PD [27]. The higher LOS in NTM-PD patients with COPD is likely related to underlying lung disease exacerbation. COPD is a recognized risk factor for NTM-PD [27] due to structural lung disruption, immune system impairment [15], or corticosteroid use (inhaled or oral) [28] to manage underlying disease.

Conversely, hypothyroidism was associated with a shorter LOS, a finding not replicated in other studies and difficult to explain without further data. It is possible that hypothyroidism may reflect a favorable profile of social determinants of health.

In the subgroup analysis of patients discharged to nursing homes, increasing age, male gender, and white race were strong predictors. Older age is an established factor [29] in nursing home placement due to increased frailty, comorbidities, and decreased ability to live independently. While previous studies show that females are more likely to be discharged to a nursing home

[30] and make up most nursing home residents [31], our NTM-PD population indicates that males are more likely to require nursing home care. This disparity may be linked to inherent gender-based differences in the presentation of this disease. Park et al. showed that the mean age at the time of diagnosis in women was 60 and mean age in men was 67 in a South Korean population [32]. Perhaps males are diagnosed at a more advanced disease stage resulting in high morbidity and the need for nursing home care. Non-white individuals are less likely to be placed in nursing homes, potentially due to socioeconomic factors, cultural preferences for family-based care, and distrust of institutional care settings.

Hospital characteristics also influenced discharge outcomes. Patients treated in urban teaching hospitals had 60% lower odds of being discharged to a nursing home compared to those treated in rural hospitals, possibly due to greater access to specialized care and better discharge planning resources. The number of diagnoses, as a proxy for overall illness severity, was also a significant factor.

Interestingly, the presence of malignancy was associated with a decreased likelihood of discharge to a nursing home. This counterintuitive finding might reflect the intensive outpatient care required for malignancy, leading to better-prepared discharge plans and alternatives to nursing home care. COPD and bronchiectasis were also linked to lower odds of discharge to a nursing home. Patients with these conditions often return to their baseline symptom burden after hospitalization and are discharged home, which aligns with real-world experience. This finding highlights the importance of effective management of airway diseases to prevent institutionalization.

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Population-based data on hospitalizations for NTM-PD is currently limited, making our study a valuable contribution to understanding the clinical characteristics and outcomes of this patient population. As NTM-PD becomes more common, the insights provided by this study can help healthcare providers optimize patient care and allocate resources more effectively. Although mortality among NTM-PD patients is generally low, hospitalizations for this condition represent a significant economic burden, primarily due to extended lengths of stay and complicated discharge dispositions. This underscores the importance of strategies aimed at preventing hospitalization through frequent follow-up and proactive management of comorbidities, particularly in patients with other pulmonary conditions such as COPD and bronchiectasis.

The significant role of discharge disposition in influencing LOS highlights the necessity of early and coordinated discharge planning, especially for patients likely to be discharged to nursing homes (older males with private insurance status, and a high comorbidity burden). Additionally, the rising costs of hospitalization despite shorter LOS suggest that healthcare systems must implement cost-effective strategies that maintain quality care while controlling expenses.

A recent study by Aliberti et al. [33] highlighted that one-third of patients undergoing treatment for NTM-PD experienced an unsuccessful outcome, including treatment cessation and disease recurrence. This finding underscores the critical importance of effective outpatient management, which, if improved, could lead to a reduction in hospitalization rates for NTM-PD. Overall, a multidisciplinary approach involving early diagnosis, tailored treatment, proactive discharge

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planning, and ongoing outpatient care is essential to enhance patient outcomes and reduce the burden of NTM-PD on healthcare systems.

There are several limitations in our study. First, we rely on ICD-10 coding to create our patient sample, which is limited in its ability to classify the dynamic problems faced during a hospitalization. However, a study reported by Mejia-Chew et al. suggested a good positive predictive value of code-based identification [34]. Of note, their study was done using ICD-9 codes. Code based administrative studies are prone to provider error and are not meant to replace validated diagnostic criteria. Our study included NTM-PD patients with the principal diagnostic code during hospitalization. Our study likely underestimates the problem, but we still think it provides us with key insights into this patient population. The retrospective study design limits adjustment for residual confounders. Due to limitations of the dataset, we were unable to assess patient's BMI, smoking status, baseline therapy etc., as potential factors that will impact hospital outcomes. Similarly, understanding pre-admission living status would have informed the noted association between discharge to a nursing home and longer LOS. The de-identified nature of the dataset limits our ability to track patient readmissions. Although NTM-PD is not typically associated with frequent readmissions, we estimate that approximately 5% of the entries may represent repeat hospitalizations for the same patient. This minor overlap is unlikely to significantly affect the overall results or the primary focus of our study, which is to analyze and discuss NTM-PD hospital outcomes.

Our study highlights patient variables that contribute to length of stay in hospitalizations for NTM-PD. More attention needs to be paid to clinical characteristics of patients in the outpatient

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setting that predisposes them to hospital admission, so that care can be more specifically targeted.

CONCLUSION

Our study provides valuable and novel insights into the factors influencing hospital LOS and discharge outcomes in patients with NTM-PD, a condition that is becoming increasingly prevalent but remains under-researched in terms of hospitalization data. By identifying key variables such as male gender, private insurance status, and comorbidity burden that contribute to extended LOS, our findings underscore the importance of personalized and proactive management strategies for NTM-PD patients. The study also highlights the critical role of discharge planning, particularly for older males and patients with a complex medical profile, who are more likely to require nursing home care. Overall, this research not only sheds light on the significant economic and clinical burden of NTM-PD hospitalizations but also emphasizes the need for targeted interventions in the outpatient setting to prevent hospital admissions and improve patient outcomes. These findings lay the groundwork for future studies and interventions aimed at optimizing care for this vulnerable population.

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All authors contributed to the study. Jesse Johnson and Shruti Sirapu were directly involved with literature review, writing, visualization, and project administration. Saqib Baig was involved with conceptualization, methodology, software, formal analysis, writing, validation, visualization, and supervision.

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Declaration of Interest:

Dr. Baig has received consulting fees from Ubie Pte, Regeneron, and Verona pharmaceuticals.

The remaining authors have no conflicts of interest to disclose.

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Table 1 – Baseline characteristics of NTM-PD patients.

Variable	Total cohort	NTM-PD patients who were discharged to nursing home
N	1,167 (100%)	179 (15.3%)
Age in years, Mean (SD)	66.9 (14.7)	74.6 (12.6)
Sex - male N (%)	521 (44.6%)	78 (43.6%)
Race, N (%)		
White	777 (66.6%)	138 (79.8%)
Black	124 (10.6%)	6 (3.5%)
Hispanic	100 (8.6%)	9 (5.2%)
Other	144 (12.3%)	20 (11.6%)
Median Household income, N (%)		
Very low	323 (27.7%)	50 (28.4%)
Low	292 (25.0%)	45 (25.6%)
Medium	273 (23.4%)	44 (25.0%)
High	249 (21.3%)	37 (21.0%)
Primary payer, N (%)		
Medicare	743 (63.7%)	150 (83.8%)
Medicaid	163 (14.0%)	12 (6.7%)
Private/HMO	212 (18.2%)	15 (8.4%)
Other/self pay	46 (3.9%)	2 (1.1%)
Number of diagnoses, Mean (SD)	14.5 (6.2)	17.4 (6.0)
Charlson Comorbidity Index (CCI), N (%)		
CCI 0-1	150 (12.9%)	7 (3.9%)
CCI 2-3	403 (34.5%)	46 (25.7%)
CCI 4-5	412 (35.3%)	77 (43.0%)
CCI 6 and above	202 (17.3%)	49 (27.4%)
Chronic pulmonary condition	819 (70.2%)	122 (68.2%)
COPD	455 (39.0%)	69 (38.5%)
Bronchiectasis	287 (24.6%)	42 (23.5%)
Other chronic lung disease (Asthma, Fibrosis)	78 (6.7%)	12 (6.7%)
Chronic medical conditions		
Hypertension	600 (51.4%)	114 (63.7%)
Cardio and Cerebrovascular disease	282 (24.2%)	57 (31.8%)
Hypothyroidism	179 (15.3%)	33 (18.4%)
Diabetes	168 (14.4%)	25 (14%)
Alcohol and drug use	94 (8.1%)	12 (6.7%)
Malignancy	81 (6.9%)	7 (3.9%)
Obesity	35 (3.0%)	5 (2.8%)
HIV	32 (2.7%)	3 (1.7%)
Chronic kidney disease	17 (1.5%)	3 (1.7%)
Chronic liver disease	3 (0.3%)	0 (0%)

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Table 2 – Distribution of NTM-PD patients over the US		
Variable	**NTM-PD**	**NTM-PD patients who were discharged to nursing home**
Calendar year, N (%)		
2016	379 (32.5%)	62 (34.6%)
2017	394 (33.8%)	62 (34.6%)
2018	394 (33.8%)	55 (30.7%)
Bed size of hospital, N (%)		
Large	670 (57.4%)	91 (50.8%)
Medium	317 (27.2%)	56 (31.3%)
Small	180 (15.4%)	32 (17.9%)
Location and teaching status of hospital, N (%)		
Rural	48 (4.1%)	15 (8.4%)
Urban, Non-teaching	242 (20.7%)	46 (25.7%)
Urban, Teaching	877 (75.1%)	118 (65.9%)
Region of hospital, N (%)		
Northeast	224 (19.2%)	39 (21.8%)
Division 1: Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut	41 (3.5%)	6 (3.4%)
Division 2: New York, Pennsylvania, New Jersey	183 (15.7%)	33 (18.4%)
Midwest	193 (16.5%)	35 (19.6%)
Division 3: Wisconsin, Michigan, Illinois, Indiana, Ohio	140 (12.0%)	24 (13.4%)
Division 4: Missouri, North Dakota, South Dakota, Nebraska, Kansas, Minnesota, Iowa	53 (4.5%)	11 (6.1%)
South	520 (44.6%)	80 (44.7%)
Division 5: Delaware, Maryland, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida	303 (26.0%)	45 (25.1%)
Division 6: Kentucky, Tennessee, Mississippi, Alabama	72 (6.2%)	11 (6.1%)
Division 7: Oklahoma, Texas, Arkansas, Louisiana	145 (12.4%)	24 (13.4%)
West	230 (19.7%)	25 (14.0%)
Division 8: Idaho, Montana, Wyoming, Nevada, Utah, Colorado, Arizona, New Mexico	75 (6.4%)	3 (1.7%)
Division 9: Alaska, Washington, Oregon, California, Hawaii	155 (13.3%)	22 (12.3%)

Table 3 – Outcomes of NTM-PD patients		
Variable	**Total cohort**	**NTM-PD patients who were discharged to nursing home**
Number of procedures, Mean (SD)	1.4 (2.2)	1.7 (2.8)
Length of stay in days, Mean (SD)	7.4 (8.0)	11.4 (13.2)
Cost in US dollars, Mean (SD)	15,606 (22,989)	20,781 (27,702)
Died during hospitalization, N (%)	36 (3.1%)	0 (0%)
Discharge disposition		
Home	679 (58.2%)	0 (0%)
Home with home health care	261 (22.4%)	0 (0%)
Skilled nursing facility	179 (15.3%)	0 (0%)
Left against medical advice	11 (0.9%)	0 (0%)

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Table 4. Multivariate negative binomial regression (backward conditional stepwise) of predictors of hospital LOS in the NTM-PD patients (variables included in the final model with a p-value of <0.10 but considered significant only if p-value is < 0.05).

Variable	Incidence Rate Ratio (IRR)	95% CI	p-value
Female sex	0.91	0.84-0.99	0.04
Payor status (Medicare is baseline)			
Medicaid	1.11	0.96-1.28	0.16
Private/HMO	1.18	1.05-1.33	0.007
Self pay/other	1.99	1.62-2.44	<0.0001
Hospital region (New England is baseline)			
Mid Atlantic	1.29	1.02-1.64	0.04
East North Central	1.04	0.81-1.32	0.77
West North Central	0.91	0.66-1.23	0.55
South Atlantic	1.06	0.84-1.34	0.61
East South Central	1.21	0.93-1.59	0.15
West South Central	1.07	0.84-1.36	0.61
Mountain	1.38	1.06-1.81	0.02
Pacific	1.33	1.04-1.69	0.02
Number of diagnoses	1.03	1.02-1.04	<0.0001
Number of procedures	1.12	1.09-1.14	<0.0001
Discharge disposition			
Home with home health services	1.40	1.26-1.55	<0.0001
Nursing Home	1.78	1.60-2.02	<0.0001
Died in hospital	1.23	0.98-1.53	0.07
Chronic medical conditions.			
Alcohol and drug abuse	1.23	1.06-1.43	0.01
Malignancy	1.17	1.01-1.37	0.05
Cardio and cerebrovascular disease	0.91	0.82-1.00	0.06
Hypothyroidism	0.84	0.75-0.94	0.003
COPD	1.11	1.09-1.14	0.02

The model was analyzed including age, gender, race, payor status, Household income, Number of diagnoses, Charlson comorbidity index, COPD, bronchiectasis, hypertension, cardio and cerebrovascular disease, hypothyroidism, diabetes, alcohol and drug use, malignancy, obesity, HIV/AIDS, chronic kidney disease, chronic liver disease, the year of hospitalization, Hospital bedsize, hospital location/teaching status, hospital region, number of procedures performed, and discharge disposition.

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Table 5: Multivariate logistic regression (backward conditional stepwise) of predictors of discharge to nursing home in the NTM-PD patients (variables included in the final model with a p-value of <0.10 but considered significant only if p-value is < 0.05).

Variable	Adjusted odds ratio (aOR)	95% CI	p-value
Age	1.05	1.04-1.07	<0.0001
Female sex	0.64	0.44-0.95	0.03
Race (Caucasian is baseline)			
Black	0.29	0.12-0.72	0.008
Hispanic	0.70	0.32-1.49	0.35
Asian/Others	1.05	0.60-1.82	0.87
Location and teaching status of hospital (rural is baseline)			
Urban, Non-teaching	0.57	0.26-1.22	0.15
Urban, Teaching	0.40	0.20-0.83	0.01
Number of diagnoses	1.10	1.07-1.13	<0.0001
Chronic medical conditions.	1.06	0.84-1.34	0.61
Diabetes	0.65	0.39-1.09	0.10
Malignancy	0.39	0.17-0.89	0.03
Bronchiectasis	0.62	0.38-0.99	0.05
COPD	0.58	0.38-0.88	0.01

The model was analyzed including age, gender, race, payor status, Household income, Number of diagnoses, Charlson comorbidity index, COPD, bronchiectasis, hypertension, cardio and cerebrovascular disease, hypothyroidism, diabetes, alcohol and drug use, malignancy, obesity, HIV/AIDS, chronic kidney disease, chronic liver disease, the year of hospitalization, Hospital bedsize, hospital location/teaching status, hospital region, number of procedures performed, and discharge disposition.

Figure 1 – Cohort selection

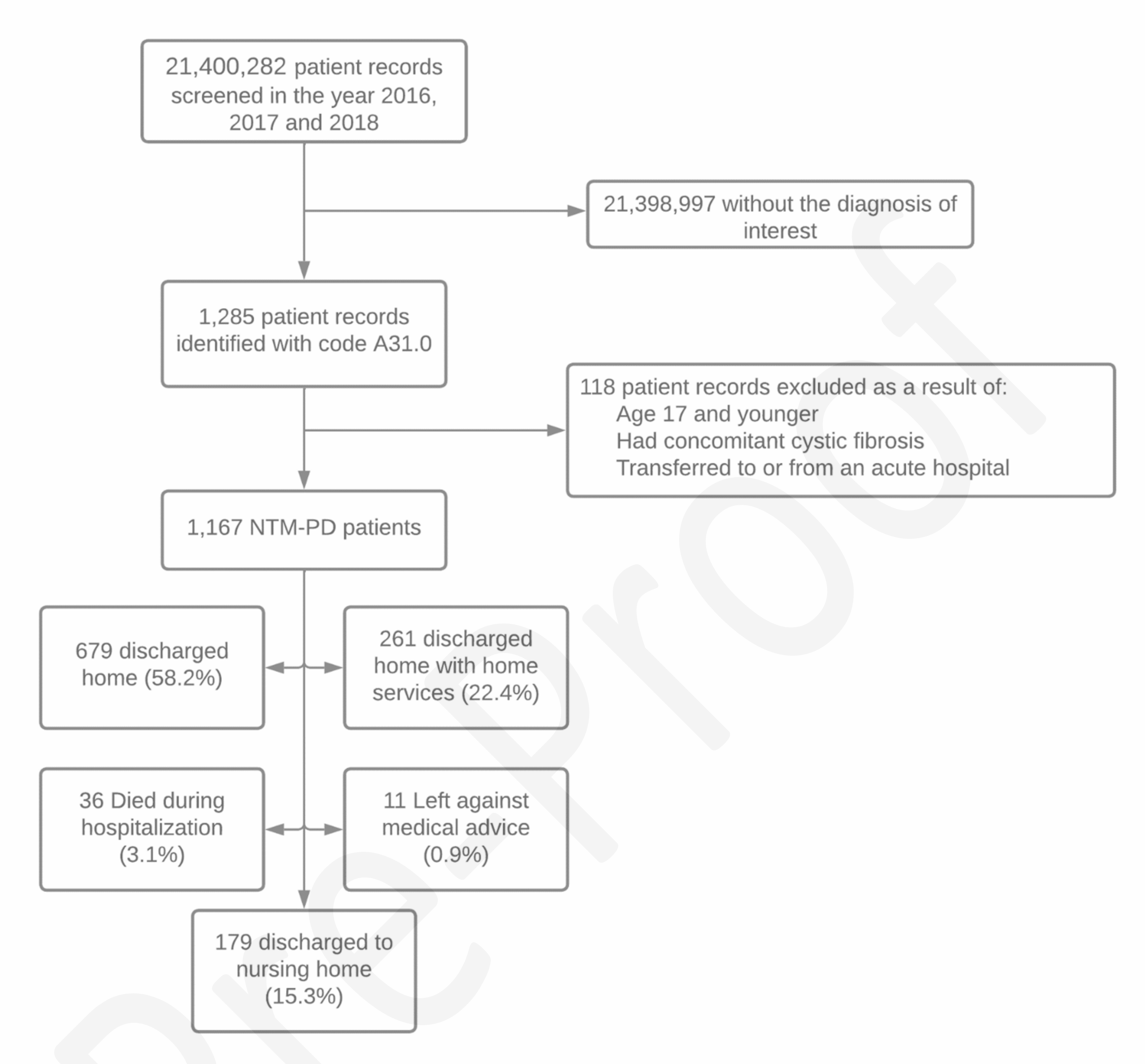

Figure 2 – Histogram plot of length of stay

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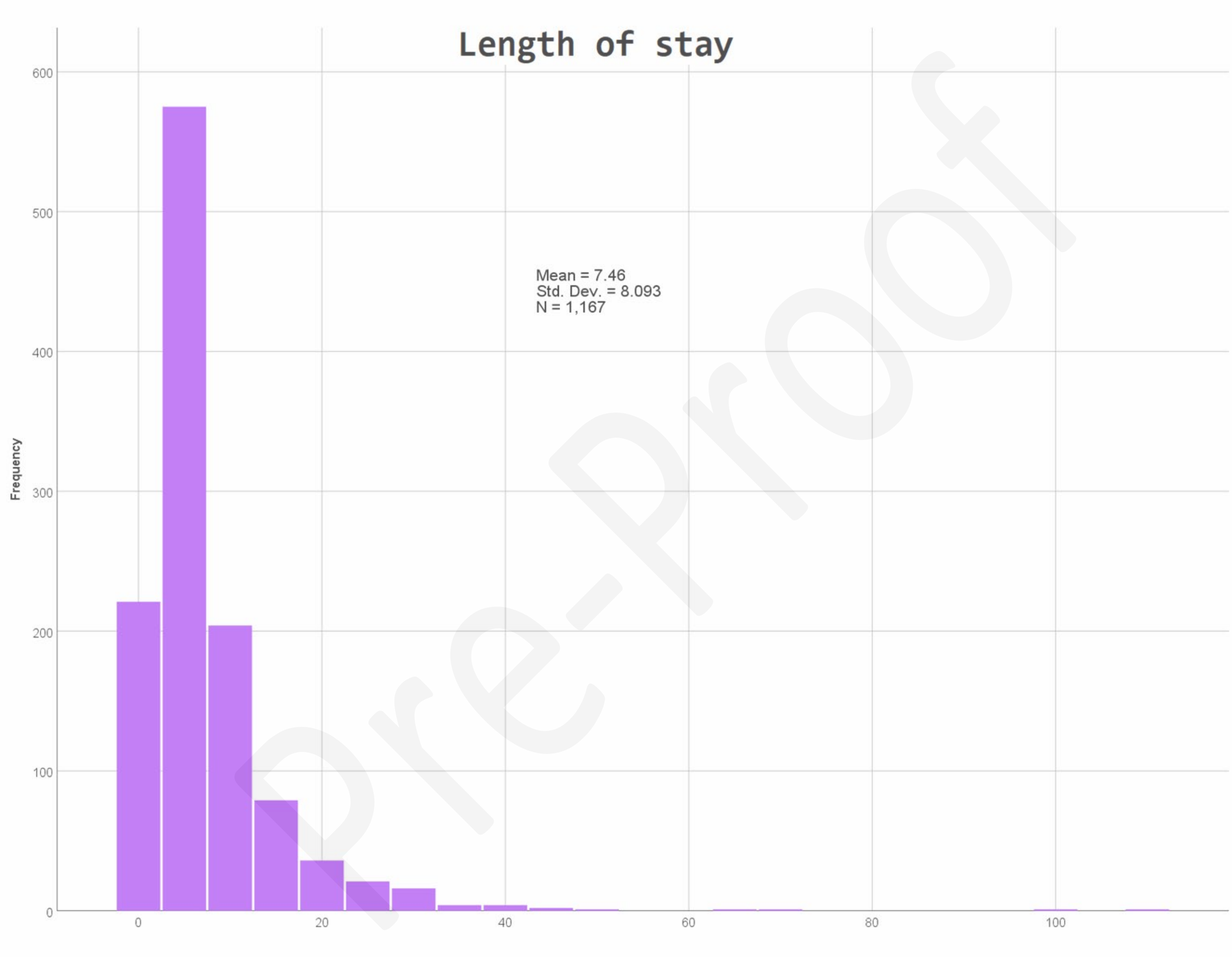

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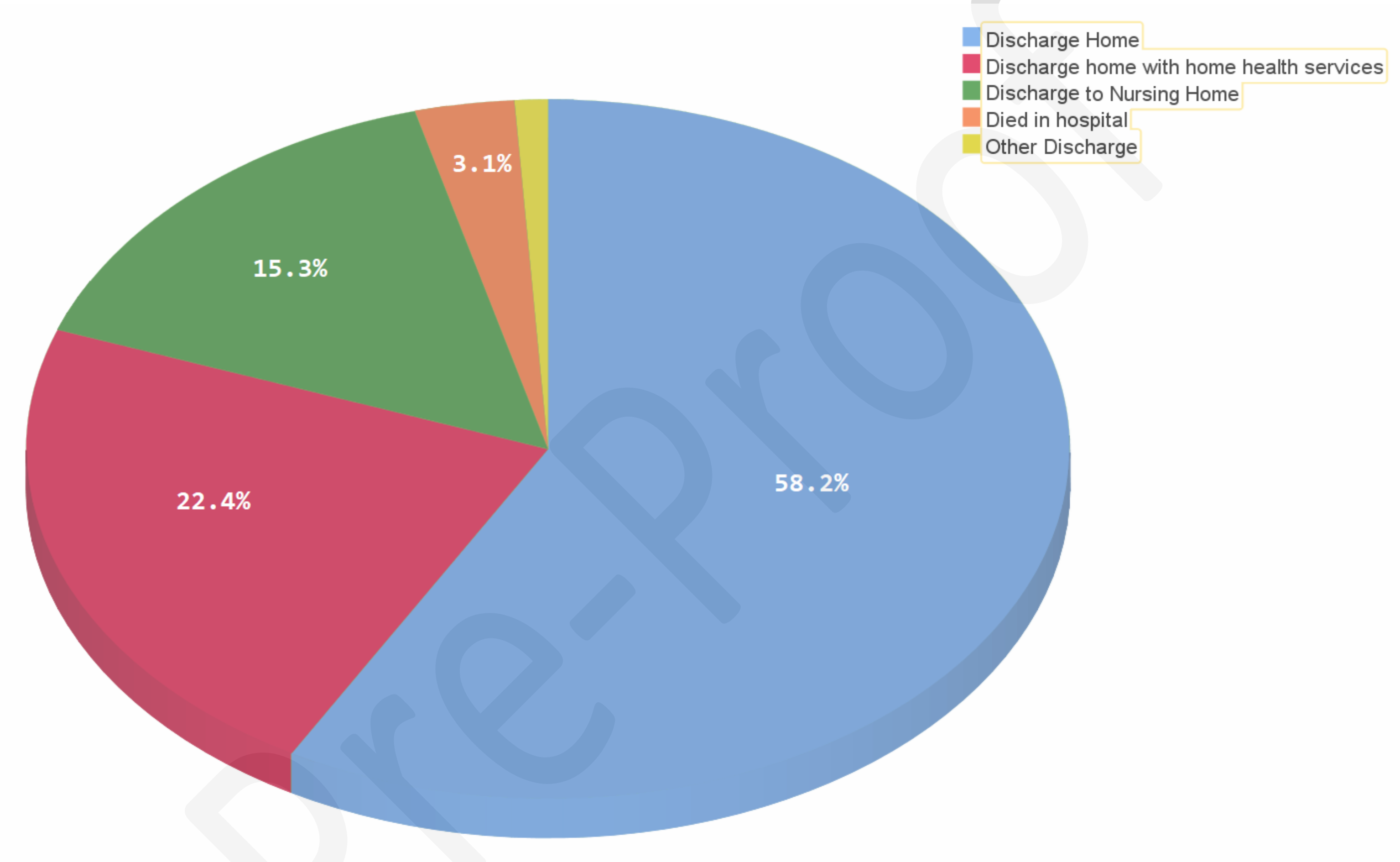
Figure 3 – Pie chart of discharge disposition of patients.



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Online Supplement
Supplementary table 1 – Diagnostic codes used to identify chronic medical conditions.

Hypertension	H35031, H35032, H35033, H35039, I110, I119, I120, I129, I130, I1310, I1311, I132, I150, I151, I152, I158, I159, I161, I674, O10111, O10112, O10113, O10119, O1012, O1013, O10211, O10212, O10213, O10219, O1022, O1023, O10311, O10312, O10313, O10319, O1032, O1033, O10411, O10412, O10413, O10419, O1042, O1043, O10911, O10912, O10913, O10919, O1092, O1093, O111, O112, O113, O114, O115, O119, O161, O162, O163, O164, O165, O169, I10, I160, I169, O10011, O10012, O10013, O10019, O1002, O1003
HIV/AIDS	B20, O98711, O98712, O98713, O98719, O9872, O9873, Z21
Chronic pulmonary conditions	J41XX, J42, J43X, J44XX, J45XXX, J47X, J60, J61, J620, J628, J63X, J64, J65, J66X, J67X, J684, J701, J703
COPD	J410, J411, J418, J42, J430, J431, J432, J438, J439, J440, J441, J449
Bronchiectasis	J470, J471, J479
Diabetes	E08XXX – E13XXX O24011, O24012, O24013, O24019, O2402, O2403, O24111, O24112, O24113, O24119, O2412, O2413, O24311, O24312, O24313, O24319, O2432, O2433, O24410, O24414, O24415, O24419, O24420, O24424, O24425, O24429, O24430, O24434, O24435, O24439, O24811, O24812, O24813, O24819, O2482, O2483, O24911, O24912, O24913, O24919, O2492, O2493
Obesity	E6601, E6609, E661, E662, E668, E669, O99210, O99211, O99212, O99213, O99214, O99215, R939, Z6830, Z6831, Z6832, Z6833, Z6834, Z6835, Z6836, Z6837, Z6838, Z6839, Z6841, Z6842, Z6843, Z6844, Z6845, Z6854
Hypothyroidism	E000, E001, E002, E009, E010, E011, E012, E018, E02, E030, E031, E032, E033, E034, E035, E038, E039, E890
Alcohol and drug abuse	F10XXX – F19XXX G621, I426, K2920, K2921, K7010, K7011, O99310, O99311, O99312, O99313, O99314, O99315, O99320, O99321, O99322, O99323, O99324, O99325, O99320, O99321, O99322, O99323, O99324, O99325
Chronic kidney disease	I120, I1311, I132, N184, N185, N186, Z4901, Z4902, Z4931, Z4932, Z9115, Z940, Z992, N183, N1830, N1831, N1832, N189, N19
Chronic liver disease	K7010, K7011, A5145, A5274, B180, B181, B182, B188, B189, B1910, B1920, B199, B251, B581, K700, K702, K7030, K7031, K709, K713, K714, K7150, K7151, K716, K717, K718, K730, K731, K732, K738, K739, K740, K7400, K7401, K7402, K741, K742, K743, K744, K745, K7460, K7469, K751, K752, K753, K754, K7581, K7589, K759, K760, K761, K762, K763, K764, K7681, K7682, K7689, K769, K77, B190, B1911, B1921, I8500, I8501, I8510, I8511, I864, K7040, K7041, K7210, K7211, K7290, K7291, K765, K766, K767, K9182, Z944
Cardio and cerebrovascular disease	I20XX – I25XX I60XX – I69XX I70XX – I75XX P91821, P91822, P91823, P91829, G450, G451, G452, G453, G454, G458, G459, G460, G461, G462, G463, G464, G465, G466, G467, G468, H3400, H3401, H3402, H3403, H3410, H3411, H3412, H3413, H34211, H34212, H34213, H34219, H34231, H34232, H34233, H34239
Malignancy	C00XXX – C80XXX C7AXX D469, E3121, E3122, E3123

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