Published in final edited form as:

Clin Rheumatol. 2016 June ; 35(6): 1541–1547. doi:10.1007/s10067-016-3242-9.

Causes of Creatine Kinase Levels Greater Than 1,000 IU/L in Patients Referred to Rheumatology

David Leverenz, M.D.¹, Oana Zaha, M.D.¹, Leslie J. Crofford, M.D.¹, and Cecilia P. Chung, M.D., M.P.H.¹

¹Department of Medicine, Vanderbilt University Medical Center, Division of Rheumatology and Immunology, 1611 21st Avenue South, T-3113 MCN, Nashville, TN 37232

Abstract

Introduction—Patients with severely elevated creatine kinase (CK) concentrations are commonly referred to rheumatologists to evaluate for the presence of an idiopathic inflammatory myopathy (IIM). However, no studies have evaluated the frequency with which IIMs are encountered in this clinical scenario.

Methods—The Vanderbilt Synthetic Derivative, a de-identified copy of over 2 million patient records, was searched to identify adult patients with a CK greater than 1,000 IU/L who had been evaluated by a rheumatologist. Each patient was assigned a diagnosis using a pre-determined algorithm. The records were then reviewed for pertinent demographic data and clinical characteristics.

Results—A total of 192 patients were included for analysis. Of these patients, 105 (55%) were diagnosed with an IIM. The non-IIM causes were drug/toxin exposure (n=16, 8%), infection (n=12, 6%), trauma (n=10, 5%), myocardial injury (n=5, 3%), hypothyroidism (n=4, 2%), muscular dystrophy (n=4, 2%), neuropsychiatric disorder (n=3, 2%), metabolic myopathy (n=2, 1%), idiopathic CK elevation (n=11, 6%), and other diagnoses (n=20, 10%). Several characteristics were found to be significantly different between IIM and non-IIM cases. In particular, patients with an IIM were more likely to be female, have a positive ANA, have interstitial lung disease, and have proximal, symmetric weakness.

Conclusion—This study found that approximately half of patients referred to our division of rheumatology with a CK greater than 1,000 IU/L were diagnosed with an IIM. Given the importance of prompt diagnosis and treatment of these disorders, rapid assessment by the consulting rheumatologist for these patients is recommended.

Keywords

idiopathic inflammatory myopathies; creatine kinase; polymyositis; dermatomyositis; myositis

Corresponding author: Cecilia P. Chung, M.D., M.P.H, 1611 21st Avenue South, T-3113 MCN, Nashville, TN 37232, Phone: 615-322-4746, Fax: 615-322-6248, c.chung@vanderbilt.edu.

Conflict of Interest

The authors declare they have no conflicts of interest.

Introduction

Creatine kinase is an enzyme primarily found in muscle tissue that catalyzes the conversion of creatine and adenosine triphosphate (ATP) into phosphocreatine and adenosine diphosphate (ADP). This reaction is reversible and thus phosphocreatine serves as a rapidly available source of ATP. When muscle is stressed or inflamed, the sarcoplasmic membrane becomes permeable and leaks cytosolic enzymes like creatine kinase into the bloodstream [1].

The differential diagnosis of an elevated CK concentration is long and complex. Musculoskeletal trauma, myocardial injury, infections, and drug-induced myositis are the most common causes encountered in general clinical practice [2, 3]. However, there are many other endocrinologic, neuropsychiatric, neuromuscular, metabolic, and rheumatologic etiologies that must be considered when CK concentrations are severely elevated [4-9]. Due to the complexity of distinguishing between these disorders, patients with elevated CK concentrations are often referred to rheumatologists for further evaluation.

The primary rheumatologic causes of elevated CK levels are the idiopathic inflammatory myopathies (IIMs), a group of diseases characterized by abnormal inflammation in muscle tissue. Disorders generally considered to be a part of the clinical IIM spectrum are dermatomyositis (DM), polymyositis (PM), inclusion body myositis (IBM), overlap syndromes, and necrotizing myopathies. Patients may also be classified according to myositis-specific or myositis-associated antibodies such as the antisynthetase antibodies [10]. Patients with DM or PM often have high CK concentrations, usually more than 10-fold and sometimes up to 50-fold the upper limit of normal values [10]. Patients with necrotizing myopathies often have even higher CK concentrations than patients with DM or PM, while patients with IBM typically have lower CK concentrations, usually no greater than 12 times the upper limit of normal. It should be noted that in 5-10% of DM or PM patients the CK can be normal, often in the context of long-standing disease in which the muscles are thought to be too atrophic and destroyed to release a large amount of CK [10-12].

To our knowledge, no previous studies have reviewed the prevalence of IIMs in patients with markedly elevated CK concentrations who have been referred to rheumatology for consultation. There is also a lack of knowledge about the features that distinguish patients with an IIM versus a non-IIM etiology in this specific referral population. Therefore, we reviewed cases referred to rheumatology at our medical center with a CK greater than 1,000 IU/L with the purpose of better defining the differential diagnosis and clinical characteristics of these patients and to determine if any clinical or laboratory parameters could be used to distinguish patients with IIM from those who present with other conditions.

Materials and Methods

Data collection was performed using the Vanderbilt Synthetic Derivative, a de-identified copy of over 2 million patient records. This database was searched for records with a CK concentration greater than 1,000 IU/L and the word “rheumatology” in a clinical note, problem list, discharge summary, clinical communication, or letter. The cut-off of 1,000

IU/L was chosen in order to remain consistent with the existing literature reviewing the causes of severely elevated CK concentrations in a general adult population [2, 3], and also because in our experience a CK concentration greater than 1,000 IU/L is often concerning enough to other providers to prompt a rheumatology referral, even in the absence of other clinical features of an IIM.

The records were then screened further to include only those in which a rheumatologist had evaluated the patient. Patients were excluded if they were younger than 18 at the time of the CK elevation greater than 1,000 IU/L, if the rheumatology consultation was unrelated to the elevated CK (ie – a patient followed by rheumatology for rheumatoid arthritis who suffered a myocardial infarction between rheumatology clinic visits), or if there was not enough data or follow-up to reach an adequate diagnosis. These criteria identified 192 patients for inclusion in the final analysis (Fig 1).

Using a pre-defined algorithm, cases were first evaluated to determine if they met the Bohan and Peter criteria for PM or DM or the Griggs criteria for IBM [13-15]. Cases not meeting these criteria were then evaluated for a clinical diagnosis of overlap syndrome, necrotizing myopathy, PM, DM, IBM, or an unspecified IIM. The remaining cases were then reviewed for an alternate cause of elevated CK levels. These cases were grouped into the following categories: trauma, myocardial injury, infection, drug or toxin exposure, endocrine disorders, neuropsychiatric disorders, neuromuscular disorders, metabolic myopathies, or idiopathic CK elevation. These categories were chosen based on published review articles on the differential diagnosis of IIM and severely elevated CK levels [4-9]. Cases that could not be classified in the above categories were labeled “other.” To ensure consistency and accuracy of case classification, a second reviewer independently analyzed 10% of records included in the final analysis.

Each record was manually reviewed for pertinent demographic data, past medical history, and clinical characteristics. CK concentrations were recorded as the peak level achieved during the initial rheumatologic evaluation. Data were also collected on the location of the initial rheumatology evaluation (inpatient versus outpatient), duration of symptoms, motor and skin exam findings, the presence of interstitial lung disease by imaging or pulmonary function tests, serum creatinine levels, liver function tests, antinuclear antibody levels, anti-Jo-1 antibodies, electromyography findings, and muscle biopsy results.

The study protocol was designated as non-human subject research by the Vanderbilt IRB. Data are presented as median and interquartile ranges for continuous or as frequencies and percentages for categorical variables. We compared clinical variables between patients with IIMs and those without using Fisher’s exact and Wilcoxon rank sum tests for categorical and continuous variables, respectively. All statistical analyses were conducted using STATA software version 13.1 (StataCorp, College Station, TX). A 2-sided significance level of 5% was used.

Results

A total of 192 patients were included for analysis. Of these patients, 105 (55%) were diagnosed with an IIM and 87 (45%) were diagnosed with a non-IIM etiology (Table 1). The number of patients meeting Bohan and Peter criteria for DM was 24 (24/192 = 13% of all included subjects), with 12 (6%), 11 (6%), and 1 (<1%) patients meeting criteria for definite DM, probable DM, and possible DM, respectively. The number of patients meeting Bohan and Peter criteria for PM was 41 (21%), with 11 (6%), 18 (9%), and 12 (6%) patients meeting criteria for definite PM, probable PM, and possible PM, respectively. Only one patient (<1%) met the Griggs criteria for IBM and this patient was further classified as having definite IBM. There were 39 patients diagnosed with an IIM that did not meet the Bohan and Peter or Griggs criteria. The majority of these patients were diagnosed with an overlap syndrome (n=28, 15%). The remaining IIM patients were clinically diagnosed by the consulting rheumatologist with PM (n=3, 2%), a necrotizing myopathy (n=2, 1%), or an unspecified IIM (n=6, 3%).

The most common non-IIM etiology was drug or toxin exposure (n=16, 8% of all 192 included subjects). Thirteen of these cases were attributed to statin exposure, one to cocaine use, one to crushed intravenous opioid use, and one to a combination of a statin, ezetimibe, itraconazole, and rocuronium. Infections accounted for 12 non-IIM cases (6% of all 192 included subjects). The majority of these cases were due to an unspecified severe viral infection or a bacterial infection with bacteremia and severe sepsis. Trauma accounted for 10 (5%) cases and myocardial injury accounted for 5 (3%) cases. Hypothyroidism was the only endocrinologic etiology encountered in this study, accounting for 4 (2%) cases. Neuromuscular disorders accounted for 4 (2%) cases. All of these were muscular dystrophies with two cases of fascioscapulohumeral dystrophy and two cases of x-linked recessive muscular dystrophy. Neuropsychiatric disorders accounted for 3 (2%) cases with one case of neuroleptic malignant syndrome, one seizure, and one case of serotonin syndrome. There were 2 (1%) cases of a metabolic myopathy. Idiopathic CK elevation accounted for 11 (6%) cases.

Finally, there were 20 (10%) cases placed in the “other diagnoses” category that were unable to be classified elsewhere. Within this category there were three cases of a suspected metabolic myopathy but without enough symptoms to warrant pursuing a formal diagnosis, two cases of graft-vs-host disease causing myositis, two cases of severe acute gout with a concomitant elevated CK of unclear significance that self-resolved, two cases of a steroid-responsive disorder that could not be definitively classified as a rheumatologic disease, two cases of malignancy and concomitant elevated CK but without evidence of a paraneoplastic IIM, one case of a severe rheumatoid arthritis flare, one case of rheumatoid vasculitis in combination with a non-ST segment myocardial infarction, one case of macrophage activation syndrome, one case of macro-CPK type 1, one case of critical illness myopathy and polyneuropathy, one case of hypoperfusion and calciphylaxis in a patient on hemodialysis, one case of post-partum cardiomyopathy leading to cardiogenic shock and hypoperfusion, and two cases with combinations of infection, musculoskeletal trauma, and/or drug toxicity that could not be easily placed in one category.

In comparing the demographic data of the IIM versus non-IIM cases (Table 2), patients with IIMs were younger (median age 47 versus 55, $p = 0.04$) and more likely to be female (68% versus 40%, $p < 0.001$). Both groups were predominantly Caucasian (60% versus 67%, $p = 0.65$). Regarding pertinent past medical history, patients with IIM were less likely than non-IIM patients to have cardiac disease like ischemic heart disease, heart failure, or hypertension (31% versus 61%, $p < 0.001$), renal disease (3% versus 16%, $p = 0.002$), or a history of statin use (12% versus 26%, $p = 0.02$). There were no statistically significant differences in the percentages of IIM versus non-IIM patients with a past history of rheumatoid arthritis (7% versus 6%, $p = 1.0$), systemic lupus erythematosus (6% versus 3%, $p = 0.52$), other rheumatologic diseases (8% versus 7%, $p = 1.0$), diabetes (12% versus 20%, $p = 0.23$), pulmonary disease (18% versus 25%, $p = 0.29$), or malignancy (8% versus 15%, $p = 0.16$). There were 34 cases of IIM who had a pre-existing diagnosis of an IIM at the time of CK elevation greater than 1,000 IU/L. There was one case of a patient with a pre-existing diagnosis of IIM who had a non-IIM etiology of a CK greater than 1,000 IU/L. This patient had previously received a diagnosis of IIM at another facility and had been treated as such for this condition, however in this study the patient was classified in the “other diagnoses” category as he was found to have patchy muscle atrophy of unclear etiology and without any clear evidence of inflammatory muscle disease. Furthermore he had no clinical weakness. Documentation from the medical records indicated that this patient had a possible occult metabolic myopathy that was not sufficiently symptomatic to justify pursuing more testing.

There were several statistically significant differences in the clinical characteristics of the IIM patients versus non-IIM patients. Patients with IIM were more likely to have proximal, symmetric muscle weakness (72% versus 11%, $p < 0.001$), have evidence of interstitial lung disease (19% versus 5%, $p = 0.002$), be seen in clinic as opposed to the inpatient setting (78% versus 44%, $p < 0.001$), receive systemic corticosteroids prior to the initial rheumatology evaluation (38% versus 16%, $p = 0.001$), and have a duration of symptoms longer than six months (54% versus 29%, $p < 0.001$). Note that the duration of symptoms was not able to be determined in 16 (15%) IIM and 6 (7%) non-IIM patients. There was not a statistically significant difference in the median CK levels of IIM patients and non-IIM patients (3,331 IU/L versus 2,558 IU/L, $p = 0.25$). The median alanine transaminase levels of IIM patients were significantly higher than non-IIM patients (116 IU/L versus 64 IU/L, $p = 0.009$), however there was not a statistically significant difference in aspartate transaminase levels (122 IU/L versus 90 IU/L, $p = 0.17$). Note that alanine transaminase levels were unknown in 13 (12%) IIM and 20 (23%) non-IIM patients and aspartate transaminase levels were unknown in 12 (11%) IIM and 19 (22%) non-IIM patients. The serum creatinine levels were lower in IIM patients than in non-IIM patients (0.69 mmol/L versus 1.17 mmol/L, $p < 0.001$). Note that serum creatinine levels were unknown in 13 (12%) IIM and 8 (9%) non-IIM patients.

Antinuclear antibodies of a titer greater than or equal to 1:40 were more common in IIM patients than non-IIM patients (54% versus 24%, $p < 0.001$), and anti-Jo-1 antibodies were only found in patients with IIM (11% versus 0%, $p = 0.001$).

Discussion

In this study, over half of the patients referred to rheumatology with CK concentrations greater than 1,000 IU/L were diagnosed with an IIM. This suggests that patients with a large CK elevation without an obvious non-IIM cause can benefit substantially from rheumatologic evaluation. Furthermore, it is important for rheumatologists to expedite clinical assessment of patients referred for this indication, as delays in diagnosis and treatment have been shown to lead to worse outcomes in some IIM patients [16, 17].

As discussed earlier, patients who had already been diagnosed with an IIM and later developed a CK level greater than 1,000 IU/L were included in the final analysis. This was done because not all CK elevations in patients with IIM are due to the underlying disease and clinicians must be diligent to rule out other causes of myositis when this scenario is encountered. However, in 34 of 35 of these cases, the CK elevation was indeed attributed to IIM activity and it could be argued that this created a higher than expected percentage of patients in the IIM category. Taking this into account, a sensitivity analysis in which 35 cases of pre-existing IIM were removed from the cohort showed that the percentage of patients with CK elevations due to IIM would decrease to 45% and patients with non-IIM etiologies would increase to 55%.

The most striking distinguishing feature between the IIM and non-IIM cases was proximal, symmetric muscle weakness. This feature was present in 76 (72%) IIM patients and only 10 (11%) non-IIM patients. In reviewing the 29 cases of IIM that did not have proximal, symmetric weakness, 14 patients were diagnosed by the consulting rheumatologist with an IIM or overlap syndrome due to clinically evident features of the antisynthetase syndrome (ie – arthritis, mechanic's hands, interstitial lung disease), systemic lupus erythematosus, or scleroderma. Three of the 29 patients first presented with respiratory symptoms and interstitial lung disease, three patients were already known to have IIM and developed an elevated CK without concurrent symmetric, proximal muscle weakness, and one patient was diagnosed with IBM, which is known to present with both proximal and distal asymmetric weakness. Only 8 (8%) IIM patients presented without symmetric, proximal weakness and any of the above distinguishing features. On the other hand, 10 (11%) patients with non-IIM diagnoses presented with symmetric proximal muscle weakness. Three of these patients were diagnosed with statin-induced myositis. One of these patients had a muscle biopsy without mention of widespread necrosis to suggest autoimmune necrotizing myopathy. The other two patients were followed for 1 and 4 years without recurrence. Of the remaining non-IIM patients with symmetric proximal weakness, two were diagnosed with muscular dystrophy, two were attributed to trauma complicated by an underlying neurologic disease (multiple sclerosis and polyneuropathy) that explained the proximal weakness, one patient had severe hypothyroidism with a TSH with a thyroid stimulating hormone level of 76, one patient had a self-limiting episode of myositis that was felt to be viral in etiology, and one patient had an isolated elevation in CK with a suspected metabolic myopathy but a normal muscle biopsy.

Taken together, these findings emphasize the importance of clinical features such as proximal muscle weakness, interstitial lung disease, or features of an overlap syndrome or

antisyntetase syndrome when considering an IIM as the cause of a markedly elevated CK concentration. (Fig 2) Other distinguishing features found to be significantly different between IIM and non-IIM patients like age, gender, location of consultation, duration of symptoms, medical comorbidities, antinuclear antibodies, and anti-Jo-1 antibodies can then be used to raise or lower clinical suspicion.

Statin-associated muscle symptoms have an estimated incidence of 1% to 5% in most randomized clinical trials [18, 19]. However, true statin-associated myopathy with a significant elevation in creatine kinase is rare [20]. In this enriched cohort of patients with CK levels greater than 1,000 IU/L referred to rheumatology, statins were labeled as the cause in 13 (7%) patients. The diagnosis of statin-associated myopathy was primarily based on the temporal relation of the onset and resolution of myositis with statin exposure and withdrawal, respectively. Thus, while statin-associated myopathy is rare, it is a relatively common diagnosis in the scenario examined in this study. It should also be noted that 13 of the IIM patients had a history of prior exposure to statins. Each of these patients had persistent CK elevation and weakness despite discontinuing the statin and none were restarted on a statin after the diagnosis of IIM was made. Only one patient had a biopsy with features suggestive of a statin-induced autoimmune necrotizing myopathy.

This study has some limitations. First, all patients were treated at a single medical center and therefore the findings could have been influenced by local referral practices. For example, there were very few neuromuscular disorders and metabolic myopathies found in this cohort, likely because these patients were sent to neurology without obtaining a rheumatology referral. This practice could be different in other medical centers. In addition, the study was a chart review so data were recorded for clinical purposes. As mentioned above, some patients had missing data on liver function tests, creatinine levels, and duration of treatment. Furthermore, only anti-Jo-1 antibodies were available in this cohort but other myositis specific antibodies and anti-HMGCoA antibodies are relatively new and currently are send-out tests in our institution; therefore, they were not recorded in the Synthetic Derivative database.

In conclusion, this study found that approximately half of patients referred to rheumatology with a CK greater than 1,000 IU/L were diagnosed with an IIM. Given the importance of prompt diagnosis and treatment of these disorders, rapid assessment by the consulting rheumatologist for these patients is recommended. Furthermore, when evaluating patients with severely elevated CK concentrations, clinicians should be aware that in the absence of symmetric proximal muscle weakness, interstitial lung disease, or features of an overlap or antisynthetase syndrome, an IIM is less likely to be the cause of the elevated CK.

Acknowledgements and Funding

This study was supported in part by the National Institutes of Health (K23AR064768), the Vanderbilt Physician Scientist Award, and the Rheumatology Research Foundation through the Medical and Pediatric Resident Research Award and the Career Development Bridge Funding Award: K Bridge. The Vanderbilt Synthetic Derivative database used in this study is supported by institutional funding and by the Vanderbilt CTSA grant ULTR000445 from NCATS/NIH.

References

1. Iaccarino L, Pegoraro E, Bello L, et al. Assessment of patients with idiopathic inflammatory myopathies and isolated creatin-kinase elevation. *Auto Immun Highlights*. 2014; 5(3):87–94. [PubMed: 26000160]
2. Grunau BE, Pourvali R, Wiens MO, et al. Characteristics and thirty-day outcomes of emergency department patients with elevated creatine kinase. *Acad Emerg Med*. 2014; 21(6):631–636. [PubMed: 25039546]
3. Amir KA, Chen SX, Bobba RK, Arsur EL. Elevation of serum creatine phosphokinase in hospitalized patients. *Am J Med Sci*. 2009; 338(5):353–356. [PubMed: 19773643]
4. Nirmalanathan N, Holton JL, Hanna MG. Is it really myositis? A consideration of the differential diagnosis. *Curr Opin Rheumatol*. 2004; 16(6):684–691. [PubMed: 15577605]
5. Rendt K. Inflammatory myopathies: narrowing the differential diagnosis. *Cleve Clin J Med*. 2001; 68(6):505, 509–514, 517–509. [PubMed: 11405612]
6. Hilton-Jones D. Myositis mimics: how to recognize them. *Curr Opin Rheumatol*. 2014; 26(6):663–670. [PubMed: 25105740]
7. Silvestri NJ, Wolfe GI. Asymptomatic/pauci-symptomatic creatine kinase elevations (hyperckemia). *Muscle Nerve*. 2013; 47(6):805–815. [PubMed: 23625835]
8. Liang C, Needham M. Necrotizing autoimmune myopathy. *Curr Opin Rheumatol*. 2011; 23(6):612–619. [PubMed: 21885975]
9. Zimmerman JL, Shen MC. Rhabdomyolysis. *Chest*. 2013; 144(3):1058–1065. [PubMed: 24008958]
10. Dalakas MC. Inflammatory muscle diseases. *N Engl J Med*. 2015; 372(18):1734–1747. [PubMed: 25923553]
11. Hochberg MC, Feldman D, Stevens MB. Adult onset polymyositis/dermatomyositis: an analysis of clinical and laboratory features and survival in 76 patients with a review of the literature. *Semin Arthritis Rheum*. 1986; 15(3):168–178. [PubMed: 3515559]
12. Dalakas MC. Polymyositis, dermatomyositis and inclusion-body myositis. *N Engl J Med*. 1991; 325(21):1487–1498. [PubMed: 1658649]
13. Bohan A, Peter JB. Polymyositis and dermatomyositis (first of two parts). *N Engl J Med*. 1975; 292(7):344–347. [PubMed: 1090839]
14. Bohan A, Peter JB. Polymyositis and dermatomyositis (second of two parts). *N Engl J Med*. 1975; 292(8):403–407. [PubMed: 1089199]
15. Griggs RC, Askanas V, DiMauro S, et al. Inclusion body myositis and myopathies. *Ann Neurol*. 1995; 38(5):705–713. [PubMed: 7486861]
16. Airio A, Kautiainen H, Hakala M. Prognosis and mortality of polymyositis and dermatomyositis patients. *Clin Rheumatol*. 2006; 25(2):234–239. [PubMed: 16477398]
17. Henriksson KG, Sandstedt P. Polymyositis--treatment and prognosis. A study of 107 patients. *Acta Neurol Scand*. 1982; 65(4):280–300. [PubMed: 7102257]
18. Vrablik M, Zlatohlavek L, Stulc T, et al. Statin-associated myopathy: from genetic predisposition to clinical management. *Physiol Res*. 2014; 63:S327–334. [PubMed: 25428737]
19. Kashani A, Phillips CO, Foody JM, et al. Risks associated with statin therapy: a systematic overview of randomized clinical trials. *Circulation*. 2006; 114(25):1788–97.
20. Stroes ES, Thompson PD, Corsini A, et al. Statin-associated muscle symptoms: impact on statin therapy - European Atherosclerosis Society Consensus Panel Statement on Assessment, Aetiology, and Management. *Eur Heart J*. 2015; 36(17):1012–1022. [PubMed: 25694464]

Fig 1.
Inclusion and Exclusion Criteria

Fig 2.
Proposed Algorithmic Approach to Patients With CK Greater Than 1,000 IU/L Referred to Rheumatology for Consideration of an IIM

Table 1

Causes of Elevated CK in 192 Patients Referred to Rheumatology

<u>Idiopathic Inflammatory Myopathy: 105 (55%)</u>	
Meets Bohan and Peter or Griggs classification criteria for DM, PM, or sIBM: 66 (34%)	
Meets Bohan and Peter criteria for DM: 24 (13%)	
Definite DM: 12 (6%)	
Probable DM: 11 (6%)	
Possible DM: 1 (<1%)	
Meets Bohan and Peter criteria for PM: 41 (21%)	
Definite PM: 11 (6%)	
Probable PM: 18 (9%)	
Possible PM: 12 (6%)	
Meets Griggs criteria for sIBM: 1 (<1%)	
Definite sIBM: 1 (<1%)	
Possible sIBM: 0 (0%)	
IIM diagnosed by consulting rheumatologist: 39 (20%)	
Overlap syndrome: 28 (15%)	
DM: 0 (0%)	
PM: 3 (2%)	
IBM: 0 (0%)	
Necrotizing myopathy: 2 (1%)	
Unspecified IIM: 6 (3%)	
<u>Non-Idiopathic Inflammatory Myopathy: 87 (45%)</u>	
Drug or toxin exposure: 16 (8%)	
Infection: 12 (6%)	
Trauma: 10 (5%)	
Myocardial injury: 5 (3%)	
Hypothyroidism: 4 (2%)	
Muscular dystrophy: 4 (2%)	
Neuropsychiatry disorder: 3 (2%)	
Metabolic myopathy: 2 (1%)	
Idiopathic CK elevation: 11 (6%)	
Other diagnoses: 20 (10%)	

Table 2

Demographic Data and Clinical Characteristics of Included Subjects

Characteristic	Non-IIM (n=87)	IIM (n=105)	p value
Demographics	-	-	-
Median Age (IQR, years)	55 (40-66)	47 (39-57)	0.04
Female sex	35 (40%)	71 (68%)	< 0.001
Caucasian	58 (67%)	63 (60%)	0.65
Past medical history	-	-	-
Known inflammatory myopathy	1 (1%)	34 (32%)	< 0.001
Rheumatoid arthritis	5 (6%)	7 (7%)	1.0
Systemic lupus erythematosus	3 (3%)	6 (6%)	0.52
Other rheumatologic disease	6 (7%)	8 (8%)	1.0
Diabetes	17 (20%)	13 (12%)	0.23
Cardiac disease	53 (61%)	33 (31%)	< 0.001
Pulmonary disease	22 (25%)	19 (18%)	0.29
Renal disease	14 (16%)	3 (3%)	0.002
Malignancy	13 (15%)	8 (8%)	0.16
Statin use	23 (26%)	13 (12%)	0.02
Visit characteristics	-	-	-
Initial consultation in clinic	38 (44%)	82 (78%)	< 0.001
Recent steroid use	14 (16%)	40 (38%)	0.001
Duration of symptoms > 6 mo*	25 (29%)	57 (54%)	<0.001
Proximal, symmetric weakness	10 (11%)	76 (72%)	<0.001
Median CK (IQR, IU/L)	2,558 (1,548-4,982)	3,331 (1,887-5,998)	0.25
Median AST (IQR, IU/L)	90 (56-216)	122 (73-252)	0.16
Median ALT (IQR, IU/L)	64 (41-134)	116 (59-170)	0.009
Median creatinine (IQR, mmol/L)	1.17 (0.9-1.9)	0.69 (0.51-0.85)	< 0.001
ANA >= 1:40	21 (24%)	57 (54%)	< 0.001
Anti-Jo-1 positive	0 (0%)	12 (11%)	0.001
Interstitial lung disease	4 (5%)	20 (19%)	0.002