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Comparing Amyotrophic Lateral Sclerosis (ALS) Patient Characteristics from the National ALS Registry and the Massachusetts ALS Registry, Data through2015

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Abstract

Objective: To compare, for completeness, ALS patients identified in the National ALS Registry (National Registry) from MA to those in the Massachusetts ALS Registry (MA Registry) through 2015.

Methods: Sensitivity analyses were conducted to determine the completeness among patients reported in both registries. Patients were matched on first and last name, month and year of birth, sex, as well as Soundex name matching. Demographics for matching and nonmatching ALS patients were also examined using bivariate analyses and logistic regression.

Results: There were 1,042 ALS patients in the MA Registry, and 642 patients matched (61.6%) in the National Registry. Sensitivity analyses found the National Registry had a sensitivity of 87.7% and specificity of 60%. For these matched patients, 522 (81.2%) came from Medicare. Of the 400 patients in the MA Registry not matched to the National Registry, 11.1% were non-White, compared to 6.0% in the matched group) ($p=0.0091$) and 59.2% were diagnosed before age 60, compared to 28.6% in the matched group ($p<0.0001$). Multivariate logistic regression analysis showed being an ALS case ($p<0.0001$) and having an ALS diagnosis at age 60 or later ($p<0.0001$) were associated with being more likely to match between the two registries.

Conclusions: These findings show that ALS's non-notifiable condition status at the national level continues to pose a challenge in identifying all ALS patients. This analysis also showed missing cases at the state level even with a reporting statute. Additional strategies are needed for better patient-ascertainment to quantify all ALS patients in the U.S.

Keywords

ALS; registry; patient-ascertainment; epidemiology

Disclaimer: The findings and conclusions in this presentation have not been formally disseminated by the Centers for Disease Control and Prevention/the Agency for Toxic Substances and Disease Registry and should not be construed to represent any agency determination or policy.

Introduction

Amyotrophic lateral sclerosis, also known as ALS, is a rare and fatal neurodegenerative disease that mainly affects the upper and lower motor neurons. On average, approximately 80% of people with the disease die within 2-5 years of diagnosis [1]. Excluding familial ALS, which accounts for 5-10% of cases, there are no known confirmed causes of ALS. While the etiology of these sporadic ALS cases (non-familial) is unknown, previous studies have identified environmental risk factors of ALS to include a history of military service, smoking history, heavy metal exposure, rigorous exercise, agricultural chemicals, and electrical exposures, among others [1, 2]. Recent estimates suggest that approximately 32,000 people may be living with ALS in the United States (U.S.) and the disparity of the disease across the world has been documented [3, 4].

Population-based registries are important for rare diseases like ALS because they can help assess the epidemiology of the disease, evaluate geographic trends, identify risk factors, outline the clinical spectrum of the disease, measure the public health burden, and be utilized as data banks for biological and clinical materials [5]. In the U.S., the congressionally mandated National ALS Registry was established to determine the epidemiology of ALS, describe the patient demographics, and examine potential risk factors. The National ALS Registry is the only population-based ALS registry in the U.S. for all eligible ALS patients. At the state level, the Massachusetts (MA) ALS Registry is currently the only active statewide ALS registry. Its purpose is to collect information on patients with ALS across the state and determine the incidence and prevalence of the disease. Each registry uses a different case-ascertainment method and operates independently.

The main objective of this paper is to compare ALS patients and their characteristics from the MA ALS Registry with MA ALS patients in the National ALS Registry during 2011-2015. Previous studies have been conducted to identify and understand ALS in other, often smaller, geographic areas in the U.S., such as metropolitan cities and states. To our knowledge this is the first analysis to examine the overlap of ALS patients in the National Registry with ALS patients in a state registry, which are two large-scale population-based registries [6].

The National ALS Registry

In 2008, the 100th Congress authorized the ALS Registry Act (P.L. 110-372) [5]. In October 2010, the Agency for Toxic Substances and Disease Registry (ATSDR), an environmental health agency part of the Centers for Disease Control and Prevention (CDC), launched the congressionally mandated, population-based National ALS Registry (National Registry) [6].

ALS, like most noncommunicable diseases, is a non-notifiable condition in the U.S., meaning that state and local health departments do not notify CDC/ATSDR about new or existing ALS patients. Because of this non-notifiable status, ATSDR developed a novel method for patient ascertainment, which has been described in detail previously [8]. In brief, the National Registry uses a combination of national administrative data (i.e., Centers for Medicare and Medicaid Services [CMS], the Veterans Heath Administration [VHA], and the Veterans Benefits Administration [VBA]) and a public ALS web portal as data sources. The

web portal approach was designed to capture patients not found through the administrative databases. Additionally, the web portal allows patients to answer up to 18 brief online surveys regarding risk factors [7]. Patients from both the national administrative databases and the web portal are merged and de-duplicated annually and then a final dataset is created for analysis.

The Massachusetts ALS Registry

In MA, ALS is a reportable condition, meaning that healthcare professionals are required by state law to report ALS patient data annually to the MA ALS Registry [10]. The MA Registry data collection began on January 1, 2008, with retrospective collection of patients diagnosed, evaluated, or treated for ALS in 2007. Each year, medical records for MA residents diagnosed with or evaluated for ALS are requested from all providers and major hospitals in MA. A neurologist specializing in ALS completes a verification form that includes assigning of an El Escorial criteria (EEC) and determination of the dates of onset of weakness and diagnosis [8]. This information is then sent to the state for processing. In addition, patients are also identified through secondary sources such as vital records death certificates which helps to ensure higher patient ascertainment.

Diagnostic Type/Nomenclature

The MA Registry uses the original EEC diagnostic classification, which classifies ALS patients into “definite,” “lab-supported probable,” “probable,” “possible,” and “suspected.” These categories are supplemented with registry categories called “indeterminate” (not enough information to determine whether the person has ALS), “late-stage ALS” (for people with a clear diagnosis and history of ALS, but whose progression or notation does not allow appropriate ascertainment of EEC) and “not ALS” categories (Table 1). In the MA Registry, only “definite,” “lab-supported probable,” “probable,” “possible,” and “late-stage ALS” are considered, and here forward referred to as, cases (i.e., those counted in the numerator towards state ALS prevalence and incidence calculations). Those “suspected,” “indeterminate,” or “not ALS” patients are referred to as “non-cases” for purposes of this paper (Table 1).

The National Registry does not use the EEC, largely because most ALS patients come from administrative databases (e.g., Medicare) and the records do not contain pre-assigned diagnostic classifications. As such, the National Registry uses its own classification system of “definite,” “potential,” or “not ALS/indeterminate” categories [9]. Only those classified as “definite” are considered, and here forward referred to as, cases (i.e., those counted in the numerator towards national prevalence and incidence calculations). Those “potential” or “not ALS/indeterminate” patients could eventually be classified as definite cases, when or if subsequent classifying information becomes available, but for purposes of this paper they are referred to as “non-cases” (Table 1).

Methods

Data Acquisition

Since ALS is a non-notifiable condition at the federal level, MA is not currently required to notify the National Registry about their ALS patients. Therefore, to achieve the objectives of this analysis, the National Registry staff applied to the MA Institutional Review Board (IRB) to obtain MA Registry data to conduct a comparison of MA ALS patients (i.e., cases and non-cases) in both registries. The National Registry acquired the following patient data from the MA Registry: first and last name, middle initial, sex, race, birthdate, date of ALS diagnosis, year entering registry, and diagnosis type. ALS patients from the National Registry were then identified and the same demographic characteristics were abstracted for comparison purposes. Data was included from the MA Registry for the dates of entry January 1, 2011 – December 31, 2015, but the dates of diagnosis could be prior to 2011. Data for the National Registry were included from its launch on October 18, 2010 through December 31, 2015. ALS patients in the National web portal could also have a diagnosis date prior to 2011.

Diagnostic Type/Nomenclature Comparison

When comparing data across registries, it is important to make sure the comparisons are as equivalent as possible when assessing registrants. Therefore, it was assumed that National Registry and MA Registry ALS patients, which include cases and non-cases, were equal for comparison purposes. Similarly, it was assumed that National Registry cases (i.e., “definite”) and MA Registry cases (i.e., “definite,” “lab-supported probable,” “probable,” “possible,” and “late-stage ALS”) were equal for comparison purposes. Finally, it was assumed that those patients who are non-cases in the National Registry (i.e., “potential” and “indeterminate/not ALS”) and the MA Registry (i.e., “suspect”, “indeterminate,” and “not ALS”) were equal for comparison purposes.

Data Analysis

Patients from the MA Registry and the National Registry were matched through SAS programming on first name, last name, month and year of birth, sex, as well as Soundex (phonetic algorithm) name matching and compared. Only adult patients 18 years or older were examined. Race and ethnicity were defined by standard U.S. Census definitions: a primary race was noted and if more than one race was chosen, participants were categorized as non-White [10].

Bivariate analyses using chi-square tests were performed to examine associations among patients in the MA Registry and the National Registry before considering matches between the two registries. Characteristics such as age at diagnosis, sex, race, year entering the Registry, and diagnosis type were analyzed for comparison. Unconditional, multivariate logistic regression models were calculated to determine which characteristics were associated with matching in both registries. Odds ratios (ORs) and 95% confidence intervals (CIs) were used to estimate t variables were more likely to be associated with being both in the MA Registry and the National Registry. Manual backward elimination was used to establish the final reduced logistic regression models that would predict a matched status.

Variables were included in the final model only if their p-value was <0.05. The excluded variables did not meaningfully impact the magnitudes of the betas of variables retained in the final model. The models included Registry, race, sex, year entering the Registry (dichotomized entry through 2012 vs. 2013-2015) and age at diagnosis (dichotomized as diagnosed before or after age 60 years). All data analyses were performed using SAS 9.4 [11].

Results

Between October 19, 2010, and December 31, 2015, 64,208 unique patient records were entered into the National Registry from the CMS, VBA, VHA databases, or the Registry's web portal. Of these 64,208 patients, 1,606 (2.5%) patients had a Massachusetts address. From January 1, 2011 to December 31, 2015, 1,042 patients were entered into the MA Registry. Demographic and other characteristics of these two groups are displayed in Table 2. Just over 79% of the patients in the National Registry entered at or after age 60 years compared to 58.8% of patients in the MA Registry (p<0.0001). The MA Registry and the National Registry matched almost exactly for gender (55.2% vs. 54.7% male, p=0.7790). For race, the National Registry had a higher proportion of White patients than the MA Registry (86.9 vs 69.8% White, p=0.5432) (Table 2). MA Registry patients were more likely to enter the MA Registry prior to 2012 compared to the National Registry (p<0.0001) and had a greater percentage of ALS cases by diagnosis type compared to the National ALS Registry (p<0.0001) (Table 2).

After matching the MA Registry patients (1,042 patients) with the National Registry, 642 matched using our criteria (name, DOB, sex, and name soundex). These 642 matched patients accounted for 61.6% of the patients in the entire MA Registry. Patient characteristics from the two registries among the 642 matched patients are presented in Table 3. Of the matched patients in both registries, 552 patients from the MA Registry (86.0%) and 535 patients from the National Registry (83.3%) were categorized as "cases" (Table 3). Some 396 of the matched MA Registry patients (62.7%) entered the state registry before 2013 compared to 295 of matched National Registry patients (45.9%). Of the 642 matched patients, over 80% (n=522) came from the Medicare dataset in the National Registry.

Next, we compared the 642 matched patients with patients that did not match in the MA Registry (n=400) and the National Registry (n=962) (Table 4). Of the 400 MA Registry patients that did not match to the National Registry, 235 patients (59.2%) were less than 60 years of age compared to 181 (28.6%) of the matched patients (p<0.0001). Patients from the matched analysis compared to those not matched to the National Registry are slightly more likely to be non-White (11.1%) compared to MA patients in the National Registry (6.0%) (p=0.0091) (Table 4). Of the 964 patients in the National Registry that did not match the MA Registry, patients were more likely to be older (p<0.0001), non-White (p=0.0836), be defined as a non-case (p<0.0001) and enter the National Registry in 2015 (p<0.0001) (Table 4).

Table 5 depicts the odds of ALS patients matching in both registries compared to those ALS patients who did not match in both registries. To determine which patient characteristics were the best predictor of a match, multivariable regression analyses were conducted for the patients in the MA Registry (1,042) and the National Registry (1,606). Our findings showed that after controlling for other covariates, an ALS diagnosis at age 60 or later (OR=2.0, 95%CI: 1.7-2.4) and being an ALS case (OR=4.3, 95%CI: 3.5-5.2) were the best predictors of a match (Table 5).Patients entering the Registry after 2012 (OR=0.8, 95%CI: 0.7-0.9) and being in the National Registry (OR=0.5, 95%CI: 0.4-0.6) were associated with being less likely to match (Table 5).

The results from sensitivity analysis showed the sensitivity and specificity of individuals in the National Registry by case status compared to the MA Registry were evaluated (Table 6). Using the MA Registry as comparison, the National Registry had a sensitivity of 86.6%, specificity of 33.0% and a positive predictive value (PPV) of 88.6% compared with the MA Registry.

Discussion

The establishment of the National ALS Registry and the Massachusetts ALS Registry provides a some understanding of ALS cases in their respective geographic areas. The national approach allows for comprehensive epidemiological analyses of cases in the U.S. while the state approach offers an estimation of local disease burden. Knowledge of the disease burden in a population, is essential for securing resources needed for necessary services and programs.

The findings from this comparative analysis show that the demographic characteristics of ALS in residents in Massachusetts and those in the National Registry are similar. The percentage of males and females found in both databases is almost identical. Patients from the MA Registry have a higher percentage of younger patients, that is, those less than the age of 60, than those from the National Registry. This could be explained by the higher proportion of older ALS patients found in the CMS and VA databases in the National Registry and better ascertainment of younger cases by the MA Registry method. This lower percentage of younger patients in the National Registry is also consistent with the National Registry having a higher percentage of patients above the age of 70 at over 50% while the MA Registry had only 27%. The age discrepancy among the National Registry and MA Registry could be a result of delivery of health care options.

The National Registry matched almost two-thirds of cases in the MA Registry. Most matching records were among those detected via CMS followed by the VBA/VHA. This percentage of matching from the administrative databases was expected. While just under 40% of patients in MA did not match with the National Registry, this may be explained by these patients seeking care outside of CMS and/or VHA/VBA, specifically from private insurance as hypothesized above. From 2011 to 2015, the approximate time to qualify for CMS coverage was around five months [12]. This delay could have resulted in many patients choosing to remain on their private insurance during their initial disease course. In addition, a higher percentage of non-Whites in the MA Registry did not match with the National

Registry. This difference may be due to potential under-ascertainment of minorities in the National Registry [16].

Missing patients, regardless of the disease or condition, can be problematic for any population-based surveillance system. As the National Registry receives almost 75% of data from CMS, patients with private insurance, especially younger patients, will not necessarily be captured by the CMS data. Additionally, if these younger patients are not aware of the National Registry web portal to register themselves, they will not be captured in the National Registry. To counter missing ALS patients in the U.S., the National Registry is taking several approaches to make the data more complete. One approach is to use statistical techniques such as capture-recapture to estimate the number of missing patients. The National Registry recently used this technique and found up to 44% of cases may be missing, many largely due to patients using private healthcare (e.g., HMOs, PPOs) to which the Registry has no access [3]. Another approach is to use supplemental datasets to identify new patients. For example, it may be possible for the MA Registry and National Registry to share data with one another, where allowable, once IRB approved and appropriate data use agreements are in place. Similarly, using patient lists from state and national ALS organizations, again where allowable, would likely help fill in missing data in population-based systems. Another option may be to follow models established by cancer and lead registries and to have states notify CDC/ATSDR of ALS patients [13, 14]. However, few states have passed legislation to make ALS a reportable condition, which would be a prerequisite to national notification of CDC/ATSDR. Besides MA, two other states in the Northeast have also passed legislation for their own registries, Vermont and Maine, but have not yet started to actively collect data at the time of this publication [15, 16].

This comparison analysis is subject to several limitations. First, because ALS is not a nationally notifiable disease in the U.S., it is difficult to track the disease on a national level. Second, both registries are passive systems, which makes collecting data on rare diseases, like ALS, much less conducive. The National Registry relies on three national administrative databases (CMS, VHA, and VBA) from which most cases are ascertained and a web portal where ALS patients can voluntarily register. Last, although every attempt was made to deduplicate ALS cases, differences in fields collected from the various sources, misspellings of names, and miscoding could have prevented records from merging correctly. However, it is unlikely that this occurred in numbers sufficient to affect the overall conclusions due to regular spot checks of the data.

Conclusion

MA-based patients in the National ALS Registry matched almost 2/3 of patients from the MA ALS Registry. These findings show that ALS's non-notifiable condition status at the national level continues to pose a challenge for the National Registry in identifying all ALS patients in the U.S. The matching also found that not all patients were found in the MA Registry showing possible gaps in communication with neurologists in the state. However, to help address missing ALS cases on the national level, the National Registry is taking various approaches to make the data more complete such as using capture/recapture statistical techniques and partnering. These and additional strategies are needed for better

patient ascertainment at the national level to quantify all ALS patients more accurately in the U.S.

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Table 1.

Diagnosis Type/Classification Comparison: National ALS Registry vs. MA ALS Registry

Cases[a]	Diagnosis Type[b]	
	National ALS Registry Patients[c]	MA ALS Registry Patients[d]
Yes	Definite	Definite Lab-supported probable Probable Possible Late-stage ALS
No	Potential Indeterminate/not ALS	Suspected Indeterminate Not ALS

[a] Case-status is determined by ALS diagnosis type. Cases-only are used in the numerator to determine incidence and prevalence rates.

[b] MA Registry ALS patient diagnostic type is based on the El Escorial Criteria, whereas the National Registry is based upon its own diagnostic type criteria.

[C] National ALS Registry patient diagnostic classification definitions:

Definite: met one or more of the following criteria: 1. any two of the following: 1) an encounter* coded for ALS (International Classification of Diseases, Ninth or Tenth Revision (ICD-9 335.20 or ICD-1012.21) in 1 or more years in the same source, or 2)a death certificate listing ALS as a cause of death, or 3) a prescription for Riluzole; OR 2. an encounter coded for ALS (ICD-9 335.20 or ICD-10 G12.21) in ≥2 years for which at least one visit must be with a neurologist visit in the same source; OR 3. a person aged <65 years with an encounter coded for ALS (ICD-9 335.20 or ICD-10 G12.21) in Medicare where at least one visit is with a neurologist visit; OR 4. an encounter coded for ALS (ICD-9 335.20 or ICD-10 G12.21) in ≥1 year(s) for which at least one visit must be with a neurologist visit in the same source and an encounter coded for ALS in another source; OR 5. an encounter coded for ALS (ICD-9 335.20 or Veterans Benefits Administration 8017 codes) in three or more sources; OR 6. an encounter coded for ALS (ICD-9 335.20) in 1 year and five or more neurologist visits in the same source.

* A record of a health care service (e.g., a visit to a physician, hospitalization, x-ray, or laboratory test).

Indeterminate/not ALS: meeting one or more of the following criteria: 1. no encounter coded for ALS (ICD-9 335.20 or ICD-10 G12.21) in any source and no prescription for Riluzole; OR 2. an encounter coded for ALS (ICD-9 335.20 or ICD-10 G12.21) in only 1 year but no neurologist visit in the same source; OR 3. a person aged <18 years.

Potential: category include everyone not determined to be either “definite ALS” or “Indeterminate/not ALS.”

[d] MA ALS Registry patient diagnostic classification definitions:

Definite: Presence of upper motor neuron (UMN) and lower motor neuron (LMN) signs in three regions.

Lab-supported probable: UMN and LMN dysfunction are in only one region or when UMN signs alone are present in one region and LMN signs defined by EMG criteria are present in at least two limbs, with proper application of neuroimaging and clinical laboratory protocols to exclude other causes.

Probable: UMN and LMN signs in two regions with some UMN signs rostral to the LMN signs.

Late-state ALS: Patient is known to have ALS, but an EEC classification cannot be assigned based on lack of sufficient medical records.

Possible: UMN and LMN signs are found together in only one region or UMN signs are found alone in two or more regions; or LMN signs are found rostral to UMN signs and the diagnosis of Probable -Laboratory-supported ALS cannot be proven by evidence on clinical grounds in conjunction with electrodiagnostic, neurophysiologic, neuroimaging or clinical laboratory studies.

Suspected: May be suspected in many settings where the diagnosis of ALS could not be regarded as sufficiently certain to include the patient in a research study.

Indeterminate: Need more information before a diagnosis/classification can be made.

Not ALS: any diagnosis other than ALS.

Table 2.

Characteristics of Patients in the National ALS Registry and the MA ALS Registry, Through 2015

Characteristic	MA ALS Registry Patients		National ALS Registry MA Patients		
	N = 1,042	%	N = 1,606	%	p-value
Age at Diagnosis					<0.0001
18-39	44	4.2	40	2.5	
40-49	108	10.4	84	5.2	
50-59	265	25.4	213	13.3	
60-69	328	31.4	453	28.2	
70-79	205	19.7	484	30.1	
80+	80	7.7	325	20.2	
Missing	12	1.2	7	0.5	
Sex					0.7790
Male	576	55.2	878	54.7	
Female	466	44.7	728	45.3	
Race					
Non-White	62	5.9	131	8.2	0.5432
White	728	69.8	1,395	86.9	
Missing	251	24.1	80	5.0	
By Year Entering Registry					<0.0001
Prior to 2012	453	43.4	416	25.9	
2012	146	14.0	279	17.4	
2013	150	14.4	229	14.3	
2014	136	13.0	336	20.9	
2015	145	13.9	346	21.5	
Unknown	12	1.2			
By Diagnosis Type					<0.0001
Case	870	83.5	951	59.2	
Non-Case	172	16.5	655	40.8	

Table 3.

Registry Characteristics Among the 1,042 MA ALS Registry Patients Found in the National ALS Registry (n = 64,208) (Through 2015)

Characteristic	Matched Patients: n=642[a]			
	MA ALS Registry		National ALS Registry	
By Diagnosis Type[b]	**n**	**%**	**n**	**%**
Case	552	86.0	535	83.3
Non-case	90	14.0	107	16.7
By Year Entering Registry				
Prior to 2012	295	46.7	201	31.3
2012	101	16.0	94	14.6
2013	97	15.3	105	16.3
2014	81	12.8	100	15.6
2015	58	9.2	142	22.1
Unknown	10	-		
Data Source				
Medicare Only	N/A		522	81.2
VBA/VHA or Web Portal Only	N/A		32	5.0
Both Admin & Web Portal	N/A		88	13.7

[a] 4 patients matched that did not have a Massachusetts address in the National Registry database

[b] See Table 1 for case/non-case definitions.

Table 4.

Comparison Among U.S. Adults in the MA ALS Registry and Those Matching and Not Matching with the National ALS Registry (Through 2015)

Characteristic	MA Registry matched with National ALS Registry		MA Registry not Matched with National ALS Registry			National ALS Registry MA residents Not matched with MA Registry		
	n = 642	%	n = 400	%	p-value	n = 964	%	p-value
Age at Diagnosis					<0.0001			<0.0001
18-39	21	3.3	23	5.8		31	3.2	
40-49	45	7.1	63	15.9		45	4.7	
50-59	115	18.2	149	37.5		117	12.2	
60-69	217	34.3	111	28.0		232	24.2	
70-79	174	27.5	31	7.8		286	29.9	
80+	60	9.5	20	5.0		246	25.7	
Missing	10	-	3	-		7	-	
Sex					0.1488			0.2785
Male	343	53.4	232	58.0		543	56.3	
Female	299	46.5	168	42.0		421	43.7	
Race					0.0091			0.0836
Non-White	30	6.0	32	11.1		76	8.5	
White	473	94.0	255	88.9		816	91.5	
Missing	139	-	113	-		72	-	
By Diagnosis Type					0.0065			<0.0001
Case	552	86.0	319	79.6		416	43.2	
Non-Case	90	14.0	82	20.4		548	56.8	
By Year Entering Registry					<0.0001			<0.0001
Prior to 2012	294	46.5	159	40.0		217	22.5	
2012	101	16.0	45	11.3		184	19.1	
2013	97	15.4	53	13.4		128	13.3	
2014	140	22.2	54	13.6		235	24.4	
2015	0	-	86	21.7		200	20.7	

Table 5.

Logistic Regression Analyses for the Odds of Matching Between the MA ALS Registry and the National ALS Registry[^], Through 2015

Variable	Parameter Estimate	p-value[*]	OR[*]	95% CI
National ALS Registry patient[a]	−0.6977	<0.0001	0.5	(0.4, 0.6)
Age group at Diagnosis[c]	0.6996	<0.0001	2.0	(1.7, 2.4)
Year Entering Registry[d]	−0.2511	0.0033	0.8	(0.7, 0.9)
Diagnosis Type[e]	1.4545	<0.0001	4.3	(3.5, 5.2)

[^] - 2,648 ALS patients (1,606 patients from the National Registry, 1,042 patients from the MA Registry)

[*] - Adjusted model, covariates include race and sex

[a] - referent = MA Registry

[c] - referent = Diagnosis before age 60

[d] - referent = Year of entering 2011-2012

[e] - referent = not considered a case (see Table 1)

GEE analysis with significance at p<0.05

Table 6.

Calculation of Accuracy of Prevalent ALS 642 matchedpatients in the National ALS Registry in Comparison to the MA ALS Registry, Through 2015

		MA Registry	
		ALS cases	**Non-ALS cases**
National	ALS cases	474	61
ALS Registry	non- ALS cases	77	30

Sensitivity = 86.3%

Specificity = 33.0%

PPV = 88.6%

NPV = 28.0%