Clinical and economic outcomes in a real-world population of patients with elevated triglyceride levels

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1. Introduction

Hypertriglyceridemia (HTG) is prevalent among a third of the adult population in the United States (US) \cite{17}. HTG is defined as fasting blood plasma triglyceride (TG) levels $\geq 150$ mg/dL by the National Cholesterol Education Program Adult Treatment Panel III \cite{15,16}. The prevalence of severe HTG (TG $> 500$ mg/dL) is approximately 2\% among adult Americans \cite{27}.

HTG is a defining feature of the metabolic syndrome and is commonly encountered in patients with diabetes mellitus (DM) and chronic kidney disease \cite{22}. Severe HTG is multifactorial and a large number of genetic polymorphisms are etiologic for this metabolic phenotype. Chylomicronemia (type I dyslipoproteinemia), familial hypertriglyceridemia (type IV dyslipoproteinemia), and familial mixed hypertriglyceridemia (type V dyslipoproteinemia) arise from derangements in the metabolism of chylomicrons, very low-density lipoproteins (VLDL), or a combination of chylomicrons and VLDL, respectively \cite{7,14}.

Some studies suggest that HTG is associated with increased risk for coronary heart disease and its complications \cite{2,21,22}. In the

\textit{Abbreviations:} CVD, cardiovascular disease; HTG, hypertriglyceridemia; OR, odds ratio; TG, triglyceride.

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setting of severe HTG, serum concentrations of remnant lipoproteins (incompletely digested chylomicrons and VLDLs) are dramatically increased. Recent analyses from prospective epidemiologic cohorts strongly suggest that lipoprotein remnants are atherogenic [10,13,24] and are associated with increased risk of stroke [9] and coronary events [23]. One of the most clinically important complications of severe HTG is acute pancreatitis, an extremely painful and life-threatening condition that increases risk for chronic epigastric pain, DM, and pancreatic digestive enzyme deficiency [3,12,25,26]. Approximately 10% of cases of acute pancreatitis and 56% of cases of gestational pancreatitis occur in patients with severe HTG [1]. Other complications associated with severe HTG include lipemia retinalis, sensory neuropathy, chronic abdominal pain, tubero-eruptive xanthomas, and hepatosplenomegaly.

Treatment approaches for the management of severe HTG include aggressive restriction of dietary saturated fat intake, enriching the diet with medium chain fatty acid, relieving insulin resistance which may be contributory (weight loss, exercise, and smoking cessation), and the use of such drugs as statins, fibrates, niacin, and omega-3 fish oils [8,11,15,16,19,28]. The fibrates and fish oils can be especially helpful since they not only reduce hepatic VLDL production and secretion, but also activate lipoprotein lipase. However, challenges remain in identifying individuals at high risk for development of severe HTG complications, especially acute pancreatitis [5].

Currently, real-world data on the clinical and demographic characteristics, healthcare utilization patterns and costs associated with severe HTG are limited, and as a result this group of patients is inadequately characterized. The goal of this retrospective claims study was to examine the treatment patterns, clinical outcomes, healthcare utilization, and costs associated with severe HTG. In addition, we examined the incidence and costs associated with acute pancreatitis episodes.

2. Methods

2.1. Study design and population

The data for this retrospective cohort study consisted of medical and pharmacy administrative claims and electronic medical record results taken from the HealthCore Integrated Research Database (HIRDSM) for the period 01/01/2006 through 04/30/2013. The HIRD is a repository of longitudinal claims data from 14 geographically dispersed US commercial health plans with approximately 36 million lives. Patients with severe HTG – defined as TG > 500 mg/dL for the purposes of this study – between 01/01/2007 and 04/30/2012 were stratified into three mutually exclusive cohorts based on their first available TG measurement (index date): Cohort A (TG ≥ 1500); Cohort B (750 ≤ TG < 1500) and Cohort C (500 ≤ TG < 750 mg/dL). The index therapy for each included patient was determined as the closest relevant pharmacy fill (for fish oil, fibrates, niacin, statins or other lipid lowering agents) relative to the index date, within an allowable time period between the index date (inclusive) and index date + 120 days. Index therapy was set to missing when no relevant pharmacy fills were observed.

In this non-experimental study, all materials were handled in strict compliance with the Health Insurance Portability and Accountability Act (HIPAA). Data were kept anonymous throughout and patient confidentiality was safeguarded; researchers only accessed a limited data set devoid of any individual patient identifiers. The study was performed under the Research Exception provisions of the Privacy Rule, 45 CFR 164.514(e), which exempted it from Investigational Review Board (IRB) approval.

2.2. Inclusion/exclusion criteria

To be included in the study, patients were required to be at least 18 years of age and to have at least one result for an electronic laboratory claim with an elevated triglyceride level of at least 500 mg/dL. Inclusion also required ≥12 months (360 days) continuous medical and pharmacy enrollment before the index date (baseline period) and ≥12 months (360 days) continuous medical and pharmacy enrollment (follow-up period) after the index therapy fill (or after index date if no index therapy fill was observed). Patients who had at least one claim for pregnancy during the baseline or follow-up period were excluded as pregnancy could temporarily increase TG levels. This study did not include any patients receiving Medicare coverage.

2.3. Patient characteristics and outcome measures

2.3.1. Baseline only

Patient characteristics including age, gender, geographic location and comorbidities were evaluated for the baseline period. Mean baseline comorbidity scores were measured with the Quan-Chrson comorbidity index [20].

2.3.2. Baseline and follow-up

Treatment patterns and the prevalence of conditions associated with ICD-9-CM code 272.xx were assessed during the pre- and post–index periods. Medication utilization was evaluated around index date (index date ±30 days) and again at 6-month follow-up (index date ±150 days to index date ±210 days). Physician specialty was assessed at the time of the index therapy fill and during follow-up. In a subgroup of TG-treatment naïve patients, we evaluated treatment discontinuation, switching, and augmentation, as well as medication adherence using Proportion of Days Covered (PDC). PDC was measured as the proportion of the sum of the number of non-overlapping days with the index drug on-hand divided by the number of days in the follow-up period.

Laboratory test results were assessed around index date and 12 months follow-up for TG levels, low density lipoprotein cholesterol, high density lipoprotein cholesterol, total cholesterol, and HbA1c.

All-cause and disease-related healthcare resource utilization and costs were evaluated both at baseline and during follow-up. Disease-related utilization included all medical claims with an ICD-9-CM code for dyslipidemia (272.xx) and all pharmacy claims for TG-related medications including fibrates, fish oils, and niacin. Pancreatitis-related health care resource utilization and costs included all medical claims with an ICD-9-CM code of 577.0x and all pharmacy claims for digestive enzymes. Costs were computed as the total of plan paid plus patient paid amounts, and presented at constant 2013 US dollars. All utilization and cost measures were stratified by place of service (inpatient hospitalizations, stand-alone emergency room visits, physician office visits, and other outpatient visits).

2.4. Statistical analysis

Descriptive analyses included means (standard deviations [SD]) and relative frequencies for continuous and categorical variables, respectively. No comparisons were made across cohorts defined by TG levels. Within Cohort A, subgroups defined by the presence or absence of acute pancreatitis at follow-up were compared with two-sample t-tests or non-parametric tests as appropriate for continuous variables, and with chi-square tests or Fisher’s exact tests for categorical variables.

A multivariable logistic regression was performed on Cohort A using acute pancreatitis over follow-up as the outcome and TG level
on index date (in continuous form) as the main predictor of interest. A second multivariable logistic regression was performed on the combined sample (Cohort A plus B plus C) using acute pancreatitis over follow-up as the outcome and TG level on index date (in categorical form) as the main predictor of interest. Lastly, a multivariable generalized linear regression model (GLM) with a log link and gamma distribution was used to assess differences in the sum of all-cause total medical and pharmacy costs across patients with and without an acute pancreatitis episode during follow-up in Cohort A. All multivariable models also included adjustments for baseline demographic, clinical, and economic characteristics as applicable (see Online Data Supplement for a complete list of covariates for each model). All analyses were conducted in SAS 9.2 (SAS Institute Inc., Cary, NC, 2008).

3. Results

3.1. Patient disposition

Overall, 53,627 patients with ≥1 laboratory claim for TGs with values between >500 mg/dL and <15,000 were identified in the study database. Following the application of inclusion requirements, 1964 patients were identified with TG ≥1500 (Cohort A), 7432 patients with TG levels between 750 and 1500 mg/dL (Cohort B), and 17,500 patients with TG levels between 500 and 750 mg/dL (Cohort C), as shown in Fig. 1.

3.2. Demographic and clinical characteristics at baseline

Patients were young (mean age 46–48 years) and predominantly male (75–80%) in each cohort. The prevalence of diabetes was greatest among patients in Cohort A (37.4%) followed by Cohort B (29.2%) and Cohort C (24.3%). Slightly less than half of the patients in each of the three cohorts had hypertension. The prevalence of mental health disorders was consistent across the three cohorts at approximately 21%. Patients in Cohort A had a higher mean Quan-Charlson comorbidity index score versus the other cohorts, as shown in Table 1. The prevalence of pancreatitis was four times greater among patients in Cohort A compared to the other two cohorts (4.1% vs. <1%).

3.3. Diagnosis and treatment patterns

The majority of patients in each cohort were diagnosed with “Other and unspecified hyperlipidemia” at both baseline and follow-up. “Hypertriglyceridemia” was noted in <10% of patients at baseline and ~20% of patients at follow-up (Tables 1 and 2). Between 30 and 50% of TG-treatment-naïve patients did not initiate any pharmacotherapy within 4 months of the index date. Among those who did, approximately half received statins as their first-line therapy, with only 30% receiving fibrates and approximately 8% receiving fish oils. Almost half of the patients in each cohort discontinued their index therapy. Only about one-fifth of the patients in each cohort were medication adherent (PDC ≥80%). Approximately two-thirds of the patients in each cohort had a visit with a primary care physician (PCP) during the initial care phase, while less than 10% saw a specialist. Of those visiting a PCP during the initial care phase, less than 20% had visits with a specialist during follow-up. At 6 months of follow-up within the full sample, a similarly high proportion of patients had no pharmacy claims for TG medications (from 45% in Cohort A to 57% in Cohort C). Statins and fibrates remained the most often prescribed drugs. More than 20% of patients in Cohort A received two or more drug classes, compared to 11% in Cohort C (Fig. 2).

3.4. Laboratory results around index date versus 12-month follow-up

Overall, laboratory values improved for patients in all three cohorts during the 12-month follow-up period. The most notable improvements were found in mean TG values, total cholesterol and
HbA1c levels, as shown in Table 3. Still, during follow-up, TG levels remained higher than 150 mg/dL in all three cohorts, and substantial proportions of patients in each cohort had HDL-C levels <30 mg/dL, representing residual risks for pancreatitis and CVD, respectively.

### 3.5. Pancreatitis comparison at follow-up

Of the 1964 patients in Cohort A, a total of 131 patients were found to have acute pancreatitis events during follow-up (Table 4). Mean age was 44–47 years, and patients were predominantly male. Patients with pancreatitis were likelier to have diabetes (52.7 vs. 36.3%), hypertension (61.1% vs. 47.2%) and dyslipidemia (70.2% vs. 55.3%). In addition, patients with pancreatitis were significantly more likely, relative to patients without the condition, to have liver disease (16% versus 2.3%), alcohol abuse (21.4% versus 7.5%) and acute and chronic pancreatitis (29.8% versus 2.3%) at baseline (all p < 0.001). Patients with acute pancreatitis were found to have higher mean TG (3622 mg/dL) and total cholesterol (492 versus 383 mg/dL) than patients without a pancreatitis event over follow-up (OR 1.04; 95% CI 1.03–1.05; p < 0.0001). A similar multivariable logistic regression model was created in a sample combining patients from Cohorts A, B, and C, and using as the main predictors a set of 6 indicator variables based on TG ranges on index date. Higher TG ranges were typically associated with a higher risk of acute pancreatitis, with a pronounced risk increase for TG levels >2000 mg/dL (OR 12.8; 95% CI 8.8–18.6; p < 0.0001; see Fig. 3).

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Demographic and clinical characteristics of severe HTG patients at baseline.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cohort A</td>
<td>Cohort B</td>
</tr>
<tr>
<td>TG (\geq 1500) (n = 1964)</td>
<td>TG (750 &lt;)TG (\leq 1500) (n = 7432)</td>
</tr>
<tr>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>Baseline demographics</td>
<td></td>
</tr>
<tr>
<td>Female, n (%)</td>
<td>383 (19.5)</td>
</tr>
<tr>
<td>Age, mean (SD)</td>
<td>46.4 (8.8)</td>
</tr>
<tr>
<td>Baseline comorbidities, n (%)</td>
<td></td>
</tr>
<tr>
<td>Quan-Charlson comorbidity score, mean (SD)</td>
<td>0.89 (1.4)</td>
</tr>
<tr>
<td>Diabetes</td>
<td>734 (37.4)</td>
</tr>
<tr>
<td>Renal disease</td>
<td>44 (2.2)</td>
</tr>
<tr>
<td>Liver disease</td>
<td>81 (4.1)</td>
</tr>
<tr>
<td>Hypertension</td>
<td>945 (48.1)</td>
</tr>
<tr>
<td>Obesity</td>
<td>159 (8.1)</td>
</tr>
<tr>
<td>Alcohol abuse</td>
<td>166 (8.5)</td>
</tr>
<tr>
<td>Hypothyroidism</td>
<td>123 (6.3)</td>
</tr>
<tr>
<td>Mental health disorders</td>
<td>416 (21.2)</td>
</tr>
<tr>
<td>Pancreatitis (acute or chronic)</td>
<td>81 (4.1)</td>
</tr>
<tr>
<td>Dyslipidemia diagnoses at baseline, n (%)</td>
<td></td>
</tr>
<tr>
<td>Hypercholesterolemia</td>
<td>378 (19.3)</td>
</tr>
<tr>
<td>Hypertriglyceridemia</td>
<td>161 (8.2)</td>
</tr>
<tr>
<td>Mixed hyperlipidemia</td>
<td>255 (13.0)</td>
</tr>
<tr>
<td>Chylomicronemia</td>
<td>8 (0.4)</td>
</tr>
<tr>
<td>Other and unspecified hyperlipidemia</td>
<td>674 (34.3)</td>
</tr>
<tr>
<td>Any dyslipidemia diagnosis</td>
<td>1105 (56.3)</td>
</tr>
</tbody>
</table>

3.6. Healthcare resource utilization and costs at baseline and follow-up

At baseline, approximately 10% of patients in all cohorts had ≥1 all-cause inpatient hospitalizations and 90% had physician office visits; the mean number of Rx fills was 27. Between 41 and 46% of patients had physician office visits with an ICD-9-CM diagnosis code for dyslipidemia (272.xx), but the mean number of Rx fills for TG-related medications (fibrate, fish oils, niacin) was <2 across all cohorts (Appendix Table A1). Utilization increased across all cohorts during follow-up, in particular for inpatient hospitalizations and Rx fills, although the number of mean TG medication fills was still low (2–4 fills) (Appendix Table A2). Cohort A usually had the highest utilization during both time periods.
All-cause costs were broadly similar in all three cohorts at baseline (mean total medical and Rx costs $8305–$8850, of which approximately $2600–2800 are Rx related), while disease-related costs appeared highest in Cohort A ($1963; Appendix Table B1). At follow-up, the distinction between Cohort A and Cohorts B/C became more pronounced for both all-cause and disease-related costs, and in particular for inpatient costs ($4025 vs. $3180 vs. $2879, all-cause; Appendix Table B2).

Upon adjusting for baseline confounders, the presence of one or more acute pancreatitis events at follow-up was associated with a >300% increase in total all-cause costs (pseudo-OR 3.69; 95% CI 2.96–4.60; p < 0.0001), with mean costs among patients with acute pancreatitis events of $31,993 vs. $11,259 among patients without events (Table 4).

### Table 3

<table>
<thead>
<tr>
<th>Laboratory results around index date versus 12 months follow-up.</th>
<th>Cohort A</th>
<th>Cohort B</th>
<th>Cohort C</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Baseline laboratory valuesa</strong></td>
<td>TG≥1500</td>
<td>750&lt;TG&lt;1500</td>
<td>500&lt;TG&lt;750</td>
</tr>
<tr>
<td>Triglycerides, mean (SD)</td>
<td>2483 (1348)</td>
<td>975 (609)</td>
<td>589 (71)</td>
</tr>
<tr>
<td>LDL-C, mean (SD)</td>
<td>96 (50)</td>
<td>101 (39)</td>
<td>109 (39)</td>
</tr>
<tr>
<td>Total cholesterol, mean (SD)</td>
<td>390 (159)</td>
<td>263 (63)</td>
<td>235 (50)</td>
</tr>
<tr>
<td>HDL-C, mean (SD)</td>
<td>36 (14)</td>
<td>34 (11)</td>
<td>36 (10)</td>
</tr>
<tr>
<td>Patients with HDL-C&lt;30 mg/dL, n (%)</td>
<td>666 (35.2)</td>
<td>2614 (35.8)</td>
<td>4290 (25.0)</td>
</tr>
<tr>
<td>Hemoglobin A1c, mean (SD)</td>
<td>9.3 (2.7)</td>
<td>8.4 (2.5)</td>
<td>7.7 (2.3)</td>
</tr>
<tr>
<td><strong>Follow-up laboratory valuesa</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Triglycerides, mean (SD)</td>
<td>772 (993)</td>
<td>424 (291)</td>
<td>316 (167)</td>
</tr>
<tr>
<td>LDL-C, mean (SD)</td>
<td>97 (41)</td>
<td>102 (38)</td>
<td>107 (38)</td>
</tr>
<tr>
<td>Total cholesterol, mean (SD)</td>
<td>234 (103)</td>
<td>209 (57)</td>
<td>203 (47)</td>
</tr>
<tr>
<td>HDL-C, mean (SD)</td>
<td>38 (14)</td>
<td>39 (11)</td>
<td>41 (12)</td>
</tr>
<tr>
<td>Patients with HDL-C&lt;30 mg/dL, n (%)</td>
<td>202 (24.2)</td>
<td>604 (20.0)</td>
<td>904 (13.4)</td>
</tr>
<tr>
<td>Hemoglobin A1c, mean (SD)</td>
<td>7.7 (2.0)</td>
<td>7.6 (1.9)</td>
<td>7.3 (1.8)</td>
</tr>
</tbody>
</table>

**TP – triglyceride; SD – standard deviation; LDL-C – low-density lipoprotein cholesterol; HDL-C – high-density lipoprotein cholesterol.**

* Among subset of patients with available laboratory results.

### 4. Discussion

The findings of this study represent new real-world information on the clinical and economic outcomes of patients with highly elevated TG levels. A notable number of patients with very severe HTG (defined as TG > 1500 mg/dL) in the study population experienced acute pancreatitis events, which substantially increased their healthcare utilization and costs. At baseline, patients with higher TG levels had greater health care resource utilization, including inpatient hospitalizations, and costs than those with lower TG levels. During follow-up, healthcare utilization and costs increased markedly across all cohorts. Episodes of pancreatitis were associated with a threefold increase in total all-cause costs among patients with TG ≥ 1500 mg/dL. One of the reasons for this may be the need for costly diagnostic procedures such as ultrasound and CT and MRI scans of the pancreas in these patients.

While this patient population has not been studied extensively and data on health care utilization and costs are scarce, the results in this study are directionally consistent with the findings of earlier assessments of this population [4,6,17,18]. As of now, however, this appears to be the first study to evaluate healthcare utilization and costs for a large real-world population with highly elevated TG across different severity levels.

A study by Christian et al. [4] investigated changes in clinical events and healthcare utilization and costs for patients who had severely elevated TG levels but whose TG levels dropped below 500 mg/dL at follow-up, within two large US-based healthcare databases. The study reported that patients whose TG levels remained ≥500 mg/dL had greater rates of pancreatitis, cardiovascular events, diabetes-related complications, and kidney disease versus patients with lower TG levels. While our study did not assess patients with TG < 500 mg/dL, our results were directionally consistent with the findings by Christian et al. in that both studies showed that higher TG levels were associated with greater disease risk and costs. Underscoring the need for treatment, Christian et al. concluded that at TG levels <500 mg/dL, there was a reduction in the risk of clinical events as well as in costs and the use of healthcare services.
Similar findings were reported by Nichols et al. [18] in a study that compared costs for patients whose TG levels decreased by 60%, 45%–59%, 30%–44%, 15%–29%, or 0%–14% over 5 years of follow-up. Patients who reduced their TG levels by 60% had a mean annualized cost reduction of $471 from baseline, while costs increased for patients in all the other categories. While cost differences between groups were most noticeable in the first three years, the differences were not statistically significant.

Our results are also consistent with the findings of Gaudet et al. [6], which used a large US claims database to conduct a 1:1 matched case versus control study, in which the cases were patients with chylomicronemia of varying etiology (≥2 diagnoses with ICD-9-CM code 272.3) and the controls were free of the condition. The study reported that the annual per patient medical costs were greater by $809 for chylomicronemia cases without pancreatitis compared with the control patients ($8029 versus $7220, Table 4).
The presence of pancreatitis was associated with higher rates of inpatient hospitalizations, more severe clinical burden such as abdominal pain and higher overall medical costs relative to controls ($33,587 vs. $4402, p < 0.01).

In a study to describe the independent contribution of hypertriglyceridemia on healthcare costs using an observational cohort drawn from the Kaiser Permanente health system, Nichols et al. [17] concluded that 33–38% greater medical costs per year were attributable to severe hypertriglyceridemia independent of other costly related conditions such as cardiovascular disease and diabetes.

In our study, the majority of patients were not diagnosed with hypertriglyceridemia. In addition, we found that fibrates and fish oils are underutilized for the treatment of these patients. The low rates of drug utilization, switching, augmenting, and medication adherence suggest that severe hypertriglyceridemia is undertreated and that patients are not adequately counseled on the importance and need for long-term adherence. Furthermore, the low rate of utilization of specialists suggests a considerable need for greater awareness of how severe hypertriglyceridemia increases the risk for cardiovascular and pancreatic disease. This treatment gap would likely benefit from a more multidisciplinary approach to treat severe hypertriglyceridemia and reduce its adverse consequences.

Lipid profiles and HbA1c values differed across cohorts, but consistently improved at 12 months from initial measurement. TG and HDL-C remained suboptimal for a significant percentage of patients, especially among those with the most severe hypertriglyceridemia, implying potential residual cardiovascular and pancreatitis risks. Acute pancreatitis occurred in a substantial number of patients with very severe hypertriglyceridemia (TG ≥ 1500 mg/dL). Among patients with acute pancreatitis, there is a significant prevalence of cardiovascular comorbidities. Acute pancreatitis was also associated with a dramatic increase in total all-cause costs by >300%.

Among other real-world implications for payers and providers, these results suggest that healthcare utilization and costs scale directly with the level of TG elevation. It is conceivable that with the rising rates of obesity and diabetes and their links to cardiovascular events, the management of conditions such as hypertriglyceridemia, chylomicronemia, and pancreatitis would require considerably greater healthcare resources and costs in the future. Timely and appropriate treatment could impact both clinical and economic outcomes. Patients with more severe hypertriglyceridemia require substantively more medical intervention and pharmacotherapy. As a result, effective and timely treatment of severe hypertriglyceridemia and the prevention of acute pancreatitis may result in substantial cost savings.

4.1. Limitations

A number of factors must be considered in the interpretation of the findings reported here. This study relied on secondary data from large commercial health plans across the US. While they may be applicable to other commercial health plans, they may have limited external validity to other types of patient populations such as the Medicaid and Medicare programs in the US and government sponsored health services in other countries. The secondary data source was a large administrative claims data repository; as a result, no information was available on race and ethnicity nor on risk factors capable of influencing outcomes such as family history, smoking status, body mass index measures, diet and exercise and educational and socioeconomic levels.

It is possible that the disease codes in the claims database used to identify dyslipidemia and acute pancreatitis may not correspond entirely to the true presence of these conditions since these codes are initially entered by health care providers for the purpose of insurance billing. Utilization of over-the-counter medications, including most fish oils and niacins, could not be assessed. Lastly, the study population was defined using a single observed TG level to maximize capture. As a result, the sample could include patients with error in measurement or non-fasting TG level; the vast majority of lab results, however, may be assumed to be fasting based on clinical experience. Furthermore, requiring at least 2 elevated TG levels is expected to compromise sensitivity as testing occurs infrequently and treatment initiation may have affected TG levels between measurements.

5. Conclusions

The findings of this study suggest that severe hypertriglyceridemia is undertreated. At current treatment levels important residual pancreatitis risks may remain unattended, especially among patients with the most severe hypertriglyceridemia (TG ≥ 1500 mg/dL). Acute pancreatitis occurred in a substantial number of patients with severe HTG and is associated with a significant number of comorbidities and increased health care utilization and cost burdens. There is a clear unmet need for additional disease education targeting both providers and the patient population as well as for the development of new treatments for HTG. Additional research on the clinical and economic outcomes associated with these conditions in larger populations and over longer time horizons is also indicated.

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Conflict of interest statement

Peter P. Toth, MD, PhD, is a member of the Speakers Bureau for Amarin, AstraZeneca, GSK, Kowa, Merck and Co; is a Consultant/Advisory Board Member for Amgen, AstraZeneca, Atherotech, Kowa, LipoScience, Merck and Co, and Novartis Pharmaceuticals Corporation; and has no Off-Label/Investigational Product Use Disclosures.

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Nadia Ramey, MPH, was an employee of HealthCore, Inc., at the time the study was conducted.

Keiko Higuchi, MPH, is an employee of Novartis Pharmaceuticals Corporation.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.atherosclerosis.2014.09.029.

References


