DOI: 10.7860/NJLM/2020/43186:2384

Original Article

Biochemistry Section

Effect of Lipemia on Measured and Calculated Osmolality in Native Lipemic Samples and Intravenous Lipid Emulsion-Added Pools

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ABSTRACT

Introduction: Lipemia are common interferences in clinical laboratories. They particularly cause interference because of the electrolyte exclusion effect on indirect Ion Selective Electrodes (ISE) methodologies. This may produce falsely low Na and K values, thereby leading to pseudohyponatremia and pesudohypokalemia. However, the effect of lipemia on measured Osmolality (mOSM) and calculated Osmolality (cOSM) remains unknown.

Aim: To investigate the effect of lipemia on mOSM and cOSM values in naturally lipemic samples of high concentration and pools simulating lipemia according to different calculation formulae.

Materials and Methods: In the first phase, serum samples of 55 patients with Triglyceride (TG) concentrations of >7.91 mmol/L were collected from routine clinical care. The concentrations of OSM, TG, Glucose (Glc), urea, Na, and K were measured before and after high-speed centrifugation. OSM was measured with a freezing-point depression osmometer. The 18 OSM formulae that is applied was utilised for OSM calculations. In the second phase, lipemia interference was assessed in Intravenous Lipid Emulsion (IVLE) added sera.

Starting serum pools that had 0.95 mmol/L TG concentrations were prepared from fresh-clear serum. Then, by mixing of one unit of IVLE {Intralipid 20%, Clin Oleic (Baxter, Old Toongabbie, NSW)} with 19 units of starting pool, the first pool was made. This first pool with IVLE had an intralipid concentration of 10 g/L. The concentrations of OSM, TG, Glc, urea, Na, and K were measured before and after IVLE addition. Statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS®) for Windows, version 16.0 software (IBM, Chicago, USA).

Results: In the first phase of study, there were no significant differences in the mOSM concentrations between non-lipemia and lipemia samples. However, there was a significant difference between non-lipemia samples and lipemia samples for cOSM in all formulae ($p<0.001$). Further, there was a significant difference between mOSM and cOSM in the lipemia samples. There was no significant difference between the cOSM of the lipemic samples and mOSM of the non-lipemic samples according to the F11 and F18 ($p=0.651$, $p=0.841$). In the second study phase, although there was increased cOSM level dependent on diminished TG concentrations in IVLE-supplemented pools, mOSM levels were reduced.

Conclusion: This study demonstrated that lipemia does affect the accuracy of cOSM. Lipemia does not affect mOSM when performed with a freezing-point depression method. OSM should not be calculated because of interference of lipemia.

Keywords: Interference, Laboratory, Ion selective electrodes

INTRODUCTION

Lipemia, hemolysis, and icterus are common interferences in clinical laboratories [1]. Lipemia can interfere with spectrophotometric methodologies owing to increased light scatter and absorption by larger lipid molecules (e.g., chylomicrons and very low density lipoproteins). Lipids may also cause heterogeneous distribution of polarised and ionic analytes between hydrophilic (water) and hydrophobic (lipid) phases [2]. This mechanism strongly affects measured concentration of electrolytes. Lipemia affects the OSM measurement, because osmolality is a measure of the total particle number in the water phase of a given quantity of body fluid.

A majority of lipids are removed prior to analysis to avoid interference from lipemia. There are several ways to eliminate lipids, including ultracentrifugation, extraction (with polyethylene glycol or cyclodextrin), and sample dilution. Ultracentrifugation is the most commonly employed technique for this process; a clear infranatant, utilised for biochemical analysis, can be obtained with ultracentrifugation [3,4].

OSM is a measure of the number of osmotically active particles (osmoles) per kilogram of water. Serum or plasma OSM can be measured by freezing-point depression or it can be calculated using formulae that consider the common osmotically active constituents of serum/plasma {sodium (Na), chloride (Cl), glucose (Glc), potassium (K) and urea} [Table/Fig-1]. The freezing-point depression method serves as a reference for OSM analysis. When the difference between the mOSM and cOSM exceeds 5mOSM/kg, it is referred to as the osmol gap, indicating the presence of unmeasured osmotically active compounds. The major use of the osmolal gap today is to screen for the possible presence of exogenous toxic substances in patients within an emergency department or intensive care unit [5-7].

Several formulas are employed to calculate OSM in the literature [5-7]. The OSM=2*Na+Glc+BUN (Blood Urea Nitrogen) formula is the most common owing to its ease of use. Lipids present in samples interfere with the determination of analytes included in the calculation of OSM [3,4] through various mechanisms, for example the increased light scatter with spectrophotometric methods or interference based on the electrolyte exclusion effect on indirect potentiometric methods. They also particularly cause interference because of the electrolyte exclusion effect on indirect ISE methodologies. This may produce falsely low Na and K values, thereby leading to pseudohyponatremia and pesudohypokalemia. However, the effect of lipemia on mOSM and cOSM remains unknown.

There is no standardised material to imitate native lipemia. Commonly, studies of lipemia interference are performed with

commercially present IVLE. Based on these data, it was aimed to investigate the effect of lipemia on mOSM and cOSM in both native lipemic samples of high concentration and simulated lipemia pools to evaluate the impact of lipemia on OSM calculations according to various formulae.

MATERIALS AND METHODS

This methodological study was performed in the Clinical Biochemistry Laboratory of Ankara Training and Research Hospital (Turkey) (between June 2010 and July 2010), The study approved by the local Ethics Committee (2009/348). All patients were informed of the study and signed written approvals. This study was divided into phases. During the first phase, the study included a total of 55 patients. The serum samples were obtained from patients with TG concentrations of >7.91 mmol/L that were randomly selected from an out-patient populations attending the laboratory. These samples were drawn into evacuated serum separator tubes containing clot activator (SST Vacutainer®, Becton Dickinson, Franklin Lakes, NJ, USA). The samples were utilsed fresh and analysed the same day.

Participants were excluded if they had renal failure, diabetes mellitus, kidney disease, liver disease, thyroid dysfunction according to their laboratory results. Additionally, the samples with hemolysis or icterus were also excluded. These samples were next used to investigate interference of native lipemia.

During the second phase of the study, a starting serum pool with a triglyceride concentration of <0.99 mmol/L was created from approximately 20 randomly selected samples. These samples were selected from fresh and clear serums and all samples were mixed completely.

During the first phase, serum samples from 55 patients were high-speed centrifuged in a fixed-angle rotor at 30.000 g for 30 minutes (Sigma 3K30 centrifuge, Sigma Laborzentrifugen, Osterode am Harz, Germany) and the upper lipid layer was separated. In addition, concentrations of OSM, TG, Glc, urea, Na, and K were measured before and after high-speed centrifugation. OSM was measured with a freezing-point depression osmometer (Knauer Semi-Micro Osmometre K-7400, Berlin, Germany). The osmometer was calibrated with a Kauner calibrator (400 mOSM/kg) and deionized water (0 mOSM/kg). Concentrations of OSM, TG, Glc, urea, Na, and K were measured with Beckman Coulter reagents using an Olympus AU-2700 analyser (Beckman Coulter, Tokyo, Japan) with indirect ISE The cOSM was obtained employing the common formulae reported in the literature [Table/Fig-1] [7-9]. The 18 formulae that is frequently applied, was utilised for OSM calculations when comparing mOSM and cOSM. The Coefficient of Variation (CV) for between-days (n = 21) at 300 mOSM/kg was 1.02% for OSM. The CVs in both normal and pathological control materials (Beckman Coulter control serum, n=21) were <5% for other analytes.

During the second phase of the study, starting serum pools that had 0.95 mmol/L TG concentrations were prepared from fresh and clear serum. Mixing of one unit of IVLE {Intralipid 20%, Clin Oleic (Baxter, Old Toongabbie, NSW)} with 19 units of starting pool, the first pool was made. This first pool with IVLE had an intralipid concentration of 10 g/L. Four more pools were obtained by serial dilutions of the pool at ratios of 1:2 (pool 2), 1:4 (pool 3), 1:8 (pool 4), and 1:16 (pool 5). The six serum pools used had TG concentrations ranging between 1.19 and 25.19 mmol/L [Table/Fig-2].

STATISTICAL ANALYSIS

Statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS®) for Windows, version 16.0 software (IBM, Chicago, USA). The Kolmogorov-Smirnov test was applied to assess the normality of distribution for each variable. The values for TG, Glc, urea, Na, and K, which were normally distributed, were expressed in mean±Standard Deviation (SD). The paired t-test was employed to evaluate significant differences between all parameters

	Formulae
F1	OSM=2* (Na^+)+Glc+0.93*BUN
F2	OSM=1.86* (Na^++K^+)+Glc+BUN+10
F3	OSM=1.90* (Na^++K_+)+Glc+BUN
F4	OSM=1.90* (Na^++K_+)+Glc+BUN+5
F5	OSM=1.86* (Na^+)+Glc+ BUN
F6	OSM=1.86* (Na^+) +Glc +BUN+5
F7	OSM=2* (Na^++K_+)+Glc+0.93*BUN
F8	OSM=2*(Na^+) +18/20 Glc+2.8/3BUN
F9	OSM=1.75* (Na^+)+Glc+BUN+10.1
F10	OSM=2* (Na^++K_+)+Glc+BUN
F11	OSM=2* (Na^+)+0.9*Glc+ 0.93*BUN+8
F12	OSM=1.86* (Na^+)+Glc+BUN +9
F13	OSM=2* (Na^+)+Glc+BUN
F14	OSM=2* (Na^+)+Glc
F15	OSM=2* (Na^+)+BUN
F16	OSM=2*Na^+
F17	OSM=2*(Na^+)+7
F18	OSM=2.63*(Na^+)-65.4

[Table/Fig-1]: The analytes and formulae for calculating osmolality.
For each formula, the units for the serum constituents are mmol/L

before and after high-speed centrifugation. The mOSM and cOSM values, which were abnormally distributed, were expressed in median±Interquartile Range (IQR). The Wilcoxon signed-rank test was utilised to assess the significant differences between cOSM and mOSM concentrations between groups. With respect to the serum pools, the effect of TG concentration on OSM was determined through repeated-measures analysis of variance (ANOVA) within each group. A p-value of <0.05 was considered statistically significant for the compared groups. Bias (%):{(measured value in non-lipemic samples-measured value in lipemic samples)/measured value in non-lipemic samples}. The error limit for OSM bias (%) was considered to be a biologically desirable bias (%) [10].

RESULTS

The OSM, TG, Glc, urea, Na, and K results before and after high-speed centrifugation of the serum samples are presented in [Table/Fig-3]. There was a statistically significant decline in Na and K with rising triglyceride concentrations. However, there was no statistically significant difference in Glc and urea values before and after high-speed centrifugation.

Although lower mOSM values were observed in non-lipemic samples compared to lipemic, this decline was not statistically significant (p=0.193). In addition, cOSM values were higher than cOSM values in lipemic samples, indicating a statistically significant difference (p≤0.001). Furthermore, there was a statistically significant difference between mOSM and cOSM of the lipemia samples (p=0.013).

Moreover, Na, K, Glc, and urea values were measured in patient samples before and after high-speed centrifugation. The results of the calculation of OSM using 18 different formulae exhibited no significant difference between cOSM values according to the F1, F2, F3, F4, F8, F13, F14, and F17 formulae and mOSM in samples freed of lipemia after high-speed centrifugation. There was no significant difference among the cOSM according to the F11 and F18 formulae and mOSM of the lipemic samples [Table/Fig-4]. There was a significant difference among cOSM values for all formulae before and after high-speed centrifugation. The median values of the calculated osmolal gap for all formulae are listed in [Table/Fig-5].

In the second study phase, although there was increased cOSM dependent on diminished TG concentrations in IVLE-

	Glucose mmol/L	Triglyceride mmol/L	Urea mmol/L	Sodium mmol/L	Potassium mmol/L	mOSM mOsm/kg	cOSM mOsm/kg
Starting pool	4.3	0.95	7.50	136	4.40	282	280
Pools-added IVLE							
Pool 1 (Bias %)	4.2 (2.33)	25.19	7.99 (6.53)	124 (8.8)	3.82 (13.2)	305 (8.16)	256 (8.57)
Pool 2 (Bias %)	4.2 (2.33)	13.26	7.79 (3.87)	126 (7.3)	3.95 (10.2)	295 (4.61)	260 (7.14)
Pool 3 (Bias %)	4.3 (0.00)	6.59	7.64 (1.87)	129 (5.2)	4.15 (5.7)	288 (2.13)	266 (5.0)
Pool 4 (Bias %)	4.2 (2.33)	4.28	7.55 (0.67)	132 (2.9)	4.28 (2.7)	282 (0.00)	271 (3.21)
Pool 5 (Bias %)	4.2 (2.33)	1.19	7.42 (1.07)	135 (0.7)	4.45 (1.1)	281 (0.35)	277 (1.07)
p-value	0.004	0.004	0.105	0.027	0.043	0.102	0.006

[Table/Fig-2]: mOSM and cOSM as well as triglyceride, Glc, urea, Na, and K concentrations in serum pools-added IVLE.
cOSM was calculated according to the OSM= 2* (Na+)+Glc+BUN formula. Pools-added IVLE were compared according to the starting pool. ANOVA for statistical analysis was used; p<0.05 indicating statistical significance Bias (%):{(Measured value in starting pool-measured value in lipemic pools)/Measured value in starting pool}* 100

Analytes (measuring units)	Non-lipemic Samples			Lipemic Samples			Bias (%)	p
	Median±IQR	Min	Max	Median±IQR	Min	Max		
mOSM (mOSM/kg)	294.7±15.5	272	357	297.6±12.7	269	346	1.16	0.193
cOSM* (mOSM/kg)	294±9.8	280	312	286±9.8	265	315	2.76	0.001
	Mean±SD	Min	Max	Mean±SD	Min	Max		
Glucose (mmol/L)	8.3±5.1	4.1	32.3	8.52±5.4	3.7	32.3	2.2	0.447
Urea (mmol/L)	12.1±5.9	6.4	122	11.9±6.3	6.1	128	2.0	0.885
Sodium* (mmol/L)	140±3.5	133	150	136±3.6	128	143	3.1	0.001
Potassium* (mmol/L)	4.63±0.51	3.13	6.0	4.37±0.53	2.83	5.70	6.23	0.013
Triglyceride* (mmol/L)	4.91±1.55	2.4	11.4	17.98±4.18	7.9	21.6	18.6	0.001

[Table/Fig-3]: Comparison of mOSM and cOSM values, as well as Glc, urea, Na, K, and TG concentrations in patients' lipemic samples before and after high-speed centrifugation (N=55).
: Comparison of groups were used the Paired t-Test. P<0.05 indicating statistical significance. cOSM was calculated according to the OSM= 2 (Na+)+Glc+BUNformula. Bias (%):{(Measured value in non-lipemic samples-measured value in lipemic samples)/Measured value in Non-lipemic samples}* 100. IQR: Interquartile range SD: Standard deviation. Min: Minimum. Max: Maximum

	Non-lipemic Samples			Lipemic Samples			
N=55	Median (mOSM/kg)	IQR	p*	Median (mOSM/kg)	IQR	p**	p***
F1	293	9.0	0.071	285	10.0	0.009	<0.001
F2	292	9.6	0.211	286	8.0	0.008	<0.001
F3	288	9.0	0.293	281	9.0	<0.001	<0.001
F4	293	10.0	0.108	286	9.0	0.044	<0.001
F5	274	9.0	<0.001	267	8.9	<0.001	<0.001
F6	279	9.7	<0.001	272	8.9	<0.001	<0.001
F7	302	11.0	<0.001	285	10.0	0.008	<0.001
F8	292	9.7	0.139	284	9.9	0.007	<0.001
F9	268	9.4	<0.001	262	8.3	<0.001	<0.001
F10	302	10.3	<0.001	294	9.3	0.034	<0.001
F11	300	10.0	<0.001	292	10.0	0.651	<0.001
F12	283	9.7	<0.001	276	8.9	<0.001	<0.001
F13	294	9.8	0.052	286	9.8	0.013	<0.001
F14	289	9.0	0.480	281	8.9	<0.001	<0.001
F15	287	8.7	0.039	278	9.5	<0.001	<0.001
F16	281	8.1	<0.001	273	8.2	<0.001	<0.001
F17	289	8.9	0.176	279	8.2	<0.001	<0.001
F18	304	9.2	<0.001	292	9.5	0.841	<0.001

[Table/Fig-4]: cOSM values via the 18 different formulae as pertaining to phase 1 of the study (N=55).
p<0.05 indicating statistical significance; IQR: Interquartile range; *: Comparison of mOSM and cOSM in non-lipemic samples after high speed centrifugation with the Wilcoxon signed rank test; **: Comparison with mOSM and cOSM in lipemia samples with theWilcoxon signed rank test; ***: Comparison of cOSM values before and after high-speed centrifugation with the paired t-test

	Non-lipemic Samples		Lipemic Samples	
N=55	Median (mOsm/kg)	IQR	Median (mOsm/kg)	IQR
F1	-6	16	5	18
F2	-3	15	5	19
F3	0	15	9	18
F4	-4	14	4	18
F5	14	15	24	18
F6	9	1	19	18
F7	-13	14	5	18
F8	-4	16	6	19
F9	20	15	29	17
F10	-13	15	-5	18
F11	-12	16	-2	19
F12	5	15	15	18
F13	-6	16	4	19
F14	0	15	10	19
F15	3	19	22	17
F16	9	17	22	17
F17	2	17	15	19
F18	-14	20	1	19

[Table/Fig-5]: Osmolal gap values with the 18 different formulae as pertaining to phase 1 of the study (N=55).
IQR: interquartile range; The formula for the osmolal gap: mOSM-cOSM

supplemented pools, there were reduced mOSM levels. The Glc values significantly decreased with elevations in triglyceride concentrations [Table/Fig-2]. Urea concentrations decreased proportionally with rising triglyceride levels; however, this was not significant. The cOSM as well as Na, and K concentrations were also reduced with the increase in triglyceride levels [Table/Fig-2]. The calculated bias (%) values in the IVLE-added pools are shown in [Table/Fig-2].

DISCUSSION

Lipemia induces interferences in measurement by means of increased light scatter when applying spectrophotometric methods and reduced electrolyte concentrations with volume displacement impacts, resulting in non-homogeneity of samples as an effect of lipemia [11,12]. This study has clearly demonstrated that OSM measured through a freezing-point depression method was not influenced by naturally lipemia interference. As far as we investigate, there is no available study in the literature on this subject. Nonetheless, although this work here is the first in this research

area, further large-scale studies are required to establish a definite conclusion.

In the present study, there was no significant difference in the mOSM of native lipemic patients before and after high-speed centrifugation. However, mOSM concentrations of lipemic patients were generally significantly higher compared to the cOSM of lipemic samples. In addition, cOSM concentrations were significantly lower prior to centrifugation because of increased TG concentrations that were related to decreased Na and K. As expected, this can be explained via electrolyte exclusion by lipids. According to these findings, OSM calculations are not sufficiently accurate for lipemic samples.

The measured Na and K concentrations used in OSM calculations were significantly lower in both the native lipemic samples and serum pools supplemented with IVLE. This is in contrast to the work of Şeneş M et al., in which lipemia did not significantly impact Na and K concentrations, also assessed by indirect ISE in IVLE-supplemented serum pools [3]. In this work, while there was no significant difference in Glc or urea values after removing lipids from naturally lipemic specimens, there was significant negative interference for Glc measurement in IVLE-supplemented serum pools. In the literature, there is inconsistency between studies regarding the effect of lipid emulsion for Glc measurement [13,14]. Consistent with these findings, several previous investigations also showed that lipemia did not influence Glc or urea measurements [13,14]. In the study by Grunbaum AM et al., glucose measurement by colorimetric methodology was prone to significantly positive interference when supplemented with as little as 15% IVLE [15].

There are several formulae available to compute OSM. At present, the formula, 2*Na+Glc+BUN, arrived at by Smithline and Gardner, is commonly applied to rapid mental calculation. In the literature, 37 formulae were reviewed by Choy KW et al., [16]. In the present study, we only utilised 18 of these formulae. As well, we included relatively easy-to-calculate formulae that accounted for all analytes, including Na, K, urea, and Glc that are osmotically active. However, we also did not include formulae that could not measure lactate, magnesium, ionized calcium, or ethanol.

It appeared that just eight of the 18 formulae reflected true OSM values after lipemic removal. However, we observed a significant difference among mOSM and cOSM values for all formulae except F11 and F18 applied to the lipemia samples. When we evaluated as cut-off 4 mOsm/kg of osmolal gap lipemic specimens, the osmolal gap for the F11 and F18 formulae were below this value. The reason why there is no difference in these formulae can be multiplier coefficients of the analytes used in the calculation. Accordingly, cOSM values with the most commonly used OSM formula (2*Na+Glc +BUN) did not reflect the actual OSM values of the lipemic samples. We were unable to find any published investigation of the effect of lipemia on cOSM. In a study by Turhan G et al., they compared the lipemic effect on OSM measured with a freezing-point depression osmometer in native lipemic pools and IVLE-added pools [17]. In the current work, for the first time, we evaluated both mOSM and cOSM in 55 native lipemic patient samples and IVLE-added pools. However, common formulae to increase the number of samples can be re-examined via the lipemia index in future studies.

In present study, the bias (%) for all tested parameters was calculated. According to results of this study, mOSM, cOSM, Glc, urea, Na, K, and triglyceride were, respectively, 1.16%, 2.76% 2.2%, 2.0 %, 3.1%, 6.23 %, and 18.6%. According to Ricos C et al., the desirable bias(%) limit should be 0.4%, 2.34%, 5.57%, 0.23%, 1.81%, and 9.57% for OSM, Glc, urea, Na, K, and triglyceride, respectively [11]. Based on results of bias (%), the error limit is exceeded at OSM, Na, K, and TG concentrations. For the IVLE-added pools, the bias (%) was not higher than the desirable bias (%) limit for OSM, Glc and urea. However, when the bias (%) based on biological variation is considered (0.4%), the error limit is exceeded at 6.59 mmol/L TG concentrations for mOSM and at all triglyceride concentrations for cOSM, Na, and K.

The rapid and accurate diagnosis of toxic alcohol poisoning is important for preventing serious adverse outcomes. Therefore, the presence of an osmolal gap has been adopted as an alternative screening test. An osmolal gap above a specific threshold (threshold of positivity) suggests the presence of unmeasured osmotically active substances, which could be indicative of toxic exposure [18]. The reference limit of the osmolal gap should be close to zero. In the literature, the reference limit of the osmolal gap is descripted as 5 mOSM/kg [7]. In a review by Choy KW et al., it was posited that the osmolal gap should be below 4 mOSM/kg [16]. Yet, the reference limit of the osmolal gap has been reported to be 10 mOSM/kg in a textbook of clinical chemistry [19]. In this study, the calculated osmolal gap varied between -14 and 29 mOSM/kg in lipemic samples. For this osmolal gap, when the cut-off was 10 mOsm/kg, there was an increase with the F5, F6, F9, F12, F14, F15, F16, and F17 formulae in the lipemia samples. A close-to-zero value of the osmolal gap is clinically desirable. In the case of this work, the osmolal gap was not exhibited in just the F10, F11, and F18 formulae when we reduced cut-off to 4 mOSM/kg. Low calculated OSM values as a result of lipemia interference may cause an erroneous increase in the osmolal gap, potentially leading clinicians to misdiagnosis and treatment of toxic alcohol poisoning.

In previous studies, the IVLE has been utilised to demonstrate the effect of lipemia interference [1,15,17,20]. However, there is no standardised material to simulate native lipemia. Similarly, here, lipemia was mimicked by adding a lipid emulsion to the lipemic serum pool. The mOSM values were higher in IVLE-added pools than the original pools. However, there was not a significant difference between non-lipemic mOSM and lipemic mOSM in native lipemic patient samples. In the work of Bornhost JA et al., the authors employed native lipemic and IVLE-added pool samples and demonstrated that lipemia interference had distinct effects on the analytes [21]. In line with the aforementioned study, the effect of IVLE on OSM was similar but not identical. The reason for the difference can be attributed to the various contents of synthetic lipid emulsions, Very-Low-Density Lipoprotein (VLDL), and chylomicrons. IVLE contains soybean oil, egg yolk phospholipids, and glycerin. Additionally, sodium hydroxide (NaOH) has been added to adjust the pH [10,22]. Turhan G et al., compared OSM assessed with a freezing-point depression osmometer between native lipemic pools and IVLE-added pools, and there was a significant difference [17]. In their study, mOSM was not significantly affected by lipemia in native lipemic serum pools, and contrastingly, there was a significantly proportional increase in IVLE-added pools. These results are similar to present work. Therefore, we believe that IVLE is not a suitable solution for lipemia interference studies in terms of OSM. This situation can be considered a limitation of this work.

LIMITATION

The main limitation of this study is its relatively small sample size. In addition, Na and K were measured by the indirect ISE method and shown to be affected by lipemia interference. The impact of lipemia on native lipemic samples should be, therefore, examined with other methods when it comes to Na and K. Furthermore, we calculated OSM with 18 different formulae, where Glc, urea, Na, and K were considered. There are many formulae in the literature; however they include additional parameters, such as magnesium, Cl, lactate, bicarbonate, and ionized calcium [7]. Applying these formulae, the interference effects of lipemia can be further investigated.

CONCLUSION

Overall, an accurate assessment of lipemia interference is important for avoiding the reporting of the wrong results and arriving at an inaccurate diagnosis and, therefore, administering an inappropriate treatment. Osmometers are not available at all clinical biochemistry laboratories. As such, calculation methods are often used to determine OSM. In lipemic samples from clinical

laboratories, OSM should not be calculated because of interference of lipemia with respect to Na and K concentrations measured using the indirect ISE method. The results of present study revealed that lipemia does not affect mOSM, and, therefore, we recommend that OSM measurement be performed with a freezing-point depression method with regards to lipemic samples. Furthermore, low cOSM values as a result of lipemia interference may cause an erroneous increase in the osmolal gap clinically of other non-measured osmotically active substrates during investigations of toxic alcohol poisoning.

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FINANCIAL OR OTHER COMPETING INTERESTS: None.

Date of Submission: **Nov 08, 2019**
Date of Peer Review: **Nov 25, 2019**
Date of Acceptance: **Dec 09, 2019**
Date of Publishing: **Jan 01, 2020**