Evaluation of the wrist tightening technique as a pre-analytical interference in the potassium dosage

Avaliação da técnica de aperto de punho como interferente pré-analítico na dosagem do potássio

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RESUMO

Objetivo: avaliar as alterações do potássio em relação a frequência de aperto de punho pelos participantes da pesquisa, buscando contribuir para um melhor entendimento sobre os aspectos quantitativos em relação ao uso da técnica de aperto de punho durante a flebotomia, para verificar com que frequência o aperto de punho poderá contribuir para a elevação do potássio. **Método**: Foram realizadas duas coletas sanguíneas de cada indivíduo. Em um primeiro momento, mantendo as mãos relaxadas durante flebotomia e, segundo, bombeando o punho durante o procedimento de flebotomia para avaliar as alterações do potássio em relação a frequência de aperto de punho. **Resultados**: De um modo geral, observa-se que houveram alterações em praticamente todas as dosagens e que indivíduos poderiam ter sido diagnosticados incorretamente com uma hipercalemia, podendo ser submetidos a tratamentos desnecessários. **Conclusão**: A técnica de aperto de punho durante a flebotomia deve ser evitada, pois uma significativa porcentagem dos casos apresentou uma elevação de potássio não condizente com o nível sérico de potássio normal do indivíduo.

Descritores: Potássio; Aperto de punho; Flebotomia; Pré-analítica; Pseudohipercalemia.

ABSTRACT

Objective: To evaluate potassium alterations in relation to wrist grip frequency by the research participants, seeking to contribute to a better understanding of the quantitative aspects regarding the use of wrist grip technique during phlebotomy, to verify how often wrist may contribute to potassium elevation. **Method**: Two blood samples were collected from each individual. At first, keeping the hands relaxed during phlebotomy and secondly, pumping the fist clenching the phlebotomy procedure to evaluate potassium changes in relation to the frequency of wrist tightening. **Results:** In general, it was observed that there were changes in practically all dosages and that individuals could have been misdiagnosed with hyperkalemia and could be submitted to unnecessary treatments. **Conclusion**: The technique of wrist tightening during phlebotomy should be avoided, since a significant percentage of the cases presented a potassium elevation that does not correspond to the individual's normal serum potassium level.

Descriptors: Potassium; Fist clenching; Phlebotomy; Pre-analytical; Pseudohyperkalemia.

ORIGINAL

Introduction

Potassium is the most concentrated cation within cells, acts to regulate many cellular metabolic processes and participates in neuromuscular excitation. Elevated (hyperkalemia) and decreased (hypokalemia) levels of serum potassium may bring several disorders. Hyperkalemia occurs in transfusion shock, acute renal failure, congestive heart failure, trauma with tubular necrosis, and severe acidosis. Hypokalemia is observed when there is potassium loss through the gastrointestinal tract (vomiting, diarrhea and fistulas), Cushing's disease, the use of diuretics, primary aldosteronism, postoperative treatment, prolonged cortisone treatment and its synthetic analogues and in alkalosis.[1]

Because it is predominantly intracellular, about 98% of the total, a small release of potassium can significantly affect its measured extracellular concentration. The intracellular to extracellular potassium ratio is approximately 40: 1 and a slight increase in this ratio of only 2.5% may increase the serum potassium concentration by 0.1 mEq / L. Blood constituents (red blood cells, white blood cells, platelets) and muscle cells can release intracellular potassium due to defective collection techniques and disease states.[1-2]

Pseudohyperkalaemia is an artificial increase in serum potassium concentration when there is no clinical evidence of electrolyte imbalance or electrocardiogram abnormalities. In general, it is characterized by an increase in serum potassium concentration by more than 0.4 mmol / L compared to plasma concentration, provided that these samples are obtained under strict techniques, remain at room temperature and are tested within 1 hour. from the collection.[3-4]

Potassium release may occur during blood collection by blood cells, causing pseudohyperkalaemia to be caused by a number of factors and variables that may also be related to pre-analytical errors.[4]

Approximately 60-70% of clinical decisions are estimated to be based on laboratory-generated results and potassium is among the ten most commonly tested analytes.[5] The potassium level in the saga is able to rise due to several factors that can cause pseudohyperkalaemia (Table 1). In most cases, this elevation may be a consequence of the patient's pre-analytical care, where the puncture is performed. inadequate venous venom, such as a longer tourniquet over 1 minute and opening and closing.[6]

Table 1 - Factors that result in falsely elevated potassium levels.[4]

Factors
Hemolysis
Wrist grip
Extended use of tourniquet
Late separation
Recentrifugation
Inappropriate collection technique (traumatic venipuncture)
Excessive agitation

Pre-analytical errors can lead to a false rise in potassium levels, which can either hide a hypokalemia by raising an abnormally low potassium from a hypokalemic patient to the reference range, masking kidney disease or metabolic alkalosis, or falsely raising normal levels by subjecting patients to unnecessary treatments.[7] One of the most common pre-analytical causes of potassium increase, leading to pseudohyperkalaemia, is due to prolonged use of the tourniquet and the technique of fist clenching and / or pumping before or during venipuncture.[8]

The contraction of the forearm muscles during repeated wrist clenching causes potassium release, as there is a reduction in intracellular electronegativity during muscle cell depolarization, which favors potassium release rather than absorption and may consequently cause potassium release. , a pseudohyperkalemia.[9-10] This effect may lead to an increase of 1-2 mmol / L potassium with an increase of up to 2.7 mmol / L, which was observed in a healthy subject due to wrist tightening during phlebotomy.[11-12]

Platelets release potassium during coagulation, resulting in higher potassium concentrations (0.36 ± 0.18 mmol / L) in serum compared to plasma.[13] Pseudohyperkalaemia is suspected when the laboratory value of the measured potassium is high, but the patient shows no signs of hyperkalaemia, such as an abnormal electrocardiogram.

In a study by Gambino and Willeford8, there was an increase of 1.04 mmol / L potassium during a collection performed with pumping and wrist clenching compared to the simultaneous collection of the other arm without pumping. The same authors conducted studies in which samples of 29 healthy volunteers were analyzed at two different times: first, keeping the hand relaxed during phlebotomy, and second, opening and closing the wrist at the time of collection. Results showed that fist pumping provided an average increase of 17% (0.7 mmol / L) in potassium results, with a range of 0.0 mmol / L to 1.5 mmol / L compared to collects without winding.[8]

In 1990, Don, et al.[9] presented a case in which a university professor was hospitalized for apparent hyperkalemia. After several investigations and the discrepancy between the values found, it was found that the problem was at the time of blood collection, because it was performed using the technique of pumping with the cuff.[9]

The release of elevated potassium results should be a major concern for clinical laboratories, especially when pseudohyperkalaemia is suspected, as some pre-analytical variables may interfere with this dosage. Does the technique of opening and closing the hand during phlebotomy bring significant changes in potassium levels? Make a comparison between these values, decrease the incidence of pseudohyperkalaemia and minimize pre-analytical errors. The study has great value and relevance because it aims to minimize errors, preventing patients from undergoing wrong or unnecessary treatments.

This project aims to evaluate the potassium changes in relation to the frequency of wrist grip by the research participants, seeking to contribute to a better understanding of the quantitative aspects in relation to the use of wrist grip technique during phlebotomy, to verify with how often the wrist grip may contribute to potassium elevation, the interference of this pre-analytical procedure and its significance with respect to the results generated by the

laboratories.

Method

This research was approved by Plataforma Brasil, under opinion number 2.077.737, of May 23, 2017.

Recruitment of individuals

All research participants were instructed on the project processes and development, who agreed to participate in the study by signing the Informed Consent Form (ICF).

Fifty randomly recruited male and female students of the Biomedicine course from Universidade Paulista (UNIP) of Brasilia, aged between 18 and 25 years were recruited. Exclusion factors: patients with a previous or current history of haematological disease, acute renal failure, congestive heart failure, acidosis, who use diuretics, postoperative, prolonged cortisone treatment and its synthetic analogues and / or alkalosis.

Peripheral Blood Collection

Two blood samples were taken from each research participant. At first, 5 mL of whole blood was collected from the venipuncture of the cubital fossa of each individual, keeping the hands relaxed during phlebotomy. After one minute, 5 mL of whole blood was collected by fist pumping (opening and closing the hand) during the phlebotomy procedure. These collections were made in vacuum tubes free of anticoagulant and coagulation factors. Serum (unhemolyzed) was separated by centrifugation at 3100 rpm for 10 minutes immediately after blood coagulation in the collection tube.

The risks to research participants do not exceed the risks inherent in blood collection practice, which may include: pain, bruising, or other discomfort at the collection site. Rarely fainting or puncture site infections may occur. All research participants were informed about the risks at the time of blood collection.

Division of groups

In the second collection to evaluate potassium alterations in relation to wrist grip frequency, the 50 research participants were divided into 5 (five) groups, each group containing 10 (ten) individuals. Where, the groups differ in the amount of grip. Since the first group performed the clenching technique 5 (five) times, the second group performed the technique 15 (fifteen) times, the third group 25 (twenty five) times, the fourth group 35 (thirty five) and, lastly, the fifth group performed the fist-clenching technique 45 (forty-five) times during phlebotomy. As follows the table below.

Table 2 - Representation of group division

Groups	Amount of grip
First	5 wrist grips during phlebotomy
Second	15 wrist grips during phlebotomy
Third	25 wrist grips during phlebotomy
bedroom	35 wrist grips during phlebotomy
Fifth	45 wrist grips during phlebotomy

Potassium Measurement

Potassium was measured using Roche Diagnostics AVL 9180 Series Electrolyte Analyzers, which uses the Santa Rita Laboratory AVL 9180 selective electrode method.

Comparison of Results

It is recommended that each laboratory constitute within its target population its own range of reference values. For guidance the following values are suggested: Serum 3.6 - 5.0 mmol/L.[14]

Potassium values measured by dosing, obtained from the two peripheral blood samples of each research participant, one with wrist movement and the other with relaxed hands, were placed in tables and figures for better visualization and comparison with aids. Microsoft Office Excel program.

Place of study

The development of this project's workbench took place in the facilities of the Paulista University of Brasilia. The local structure is at a level of excellence in the region where it is located. The university has a group of technical, higher and postgraduates able to assist in the development of the activities necessary for the execution of the project in question. Where, the collections were performed and supervised by Dr. Eloisa Elena Cangiani at the Laboratory Laboratory of the Paulista University of Brasilia.

Results

The sample population consisted of 50 students from the Biomedicine course at Universidade Paulista.

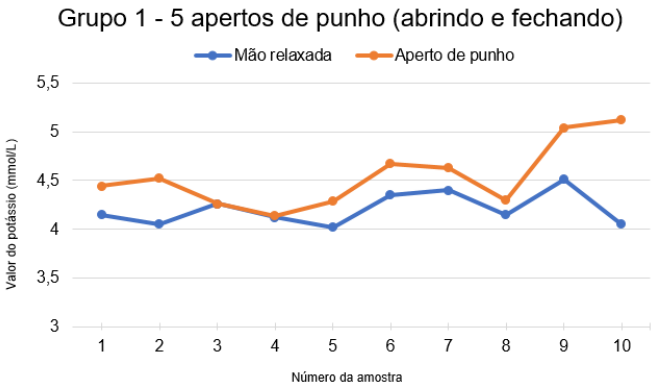

Figure 1 - Dosage of potassium with a relaxed hand and, subsequently, with five fists.

Initially, it was observed that in group 1 (Figure 1), where five fists were performed, 90% presented increase between the dosages and the individual 3 did not present alteration. The largest increase observed was 1.07 mmol / L, and the difference between the dosages ranged from 0.0 to 1.07 mmol / L. The average wrist grip was 4.54 mmol / L while the average with a relaxed hand was 4.20 mmol / L, with a standard deviation of the wrist grip of 0.33 mmol / L (Table 3).

Table 3 – Dosage with 5 cuffs.

Sample	Relaxed Hand	Clenching	Difference
1	4,15	4,44	0,29
2	4,05	4,52	0,47
3	4,26	4,26	0
4	4,12	4,14	0,02
5	4,02	4,29	0,27
6	4,35	4,67	0,32
7	4,4	4,63	0,23
8	4,15	4,3	0,15
9	4,51	5,04	0,53
10	4,05	5,12	1,07
Average relaxed hand			4,206
Average Fist Clench			4,541
Standard Deviation Relaxed Hand			0,166879864
Standard Deviation Cuff Grip			0,330031985

We also found that 80% had increased serum potassium dosage in group 2 (Figure 2), where 15 wrist grips were performed. The largest increase observed was 1.27 mmol / L and individuals 5 and 9 showed no change. The observed differences ranged from 0.00 to 1.27 mmol / l in subject 3. The average with a relaxed hand was 4.29 mmol / l and the average with the grip of the wrist was 4.79 mmol / l with a standard deviation of 0.412 mmol / L (Table 4).

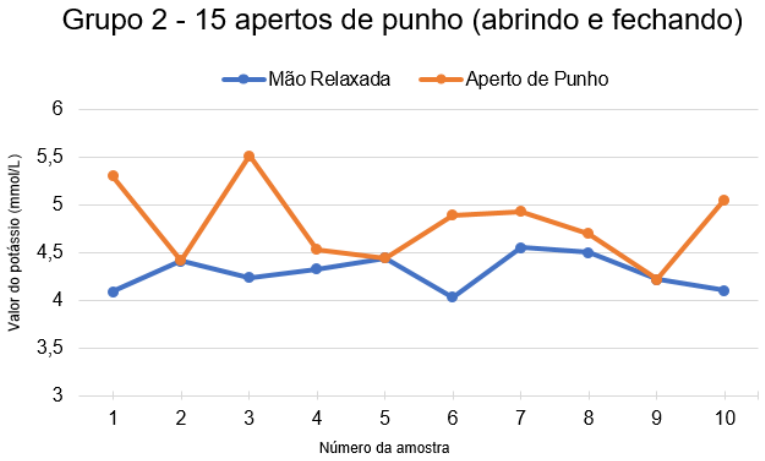

Figure 2 - Dosage of potassium with a relaxed hand and, later, with fifteen wrist grips.

Table 4 - Dosage with 15 cuff points

Sample	Relaxed Hand	Clenching	Difference
1	4,09	5,3	1,21
2	4,41	4,42	0,01
3	4,24	5,51	1,27
4	4,33	4,53	0,2
5	4,44	4,44	0
6	4,03	4,89	0,86
7	4,55	4,93	0,38
8	4,5	4,7	0,2
9	4,22	4,22	0
10	4,1	5,05	0,95
Average relaxed hand			4,291
Average Fist Clench			4,799
Standard Deviation Relaxed Hand			0,182966299
Standard Deviation Cuff Grip			0,412968925

In group 3 (figure 3), with 25 wrist grips, there was a change in 90% of the analyzed samples, where the largest increase observed was 0.97 mEq / L and only subject 4 did not show any increase. The average with the relaxed hand was 4.12 mmol / L while the average with the wrist grip was 4.57 mmol / L (Table 5). This was the group that presented the smallest difference between the dosages.

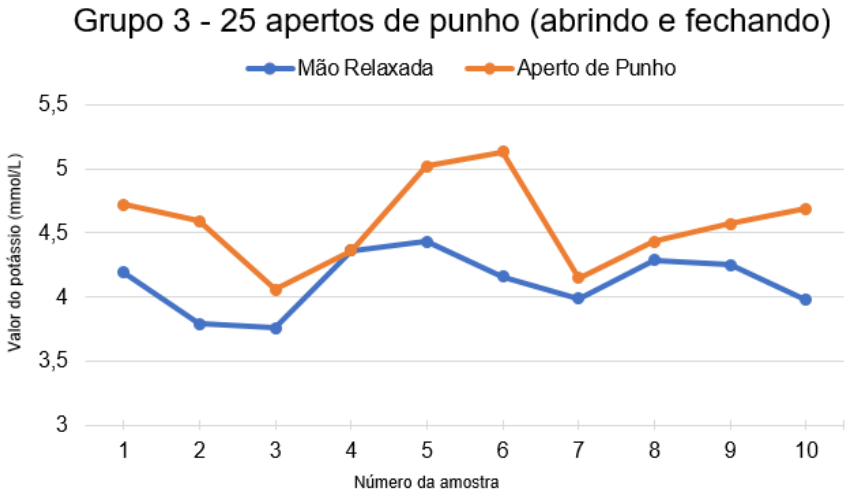

Figure 3 - Dosage of potassium with a relaxed hand and, subsequently, with twenty-five wrist grips.

Table 5 - Dosage with 25 cuffs.

Sample	Relaxed Hand	Clenching	Difference
1	4,19	4,72	0,53
2	3,79	4,59	0,8
3	3,76	4,06	0,3
4	4,36	4,36	0
5	4,43	5,02	0,59
6	4,16	5,13	0,97
7	3,99	4,15	0,16
8	4,29	4,43	0,14
9	4,25	4,57	0,32
10	3,98	4,69	0,71
Average relaxed hand			4,12
Average Fist Clench			4,572
Standard Deviation Relaxed Hand			0,231180545
Standard Deviation Cuff Grip			0,34214357

In Group 4 (Figure 4), where 35 cuffs were performed, serum potassium levels increased in 80% of the samples analyzed, 20% showed no change and the largest increase observed was 1, 73 mmol / l in subject 2. The average with the relaxed hand was 4.19 mmol / l and the average with the grip grip was 4.85 mmol / l with a standard deviation of 0.69 mmol / l (table 6). It is observed that 30% of the individuals in group 4 presented differences above 1.00 mmol / L between the dosages.

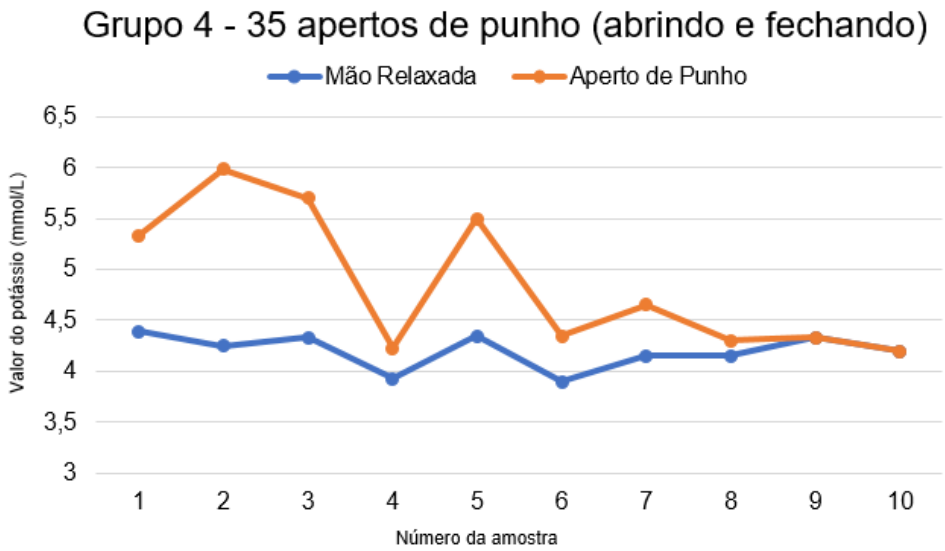

Figure 4 – Potassium dosage with relaxed hand and subsequently with thirty-five cuffs.

Table 6 - Dosage with 35 cuffs.

Sample	Relaxed Hand	Clenching	Difference
1	4,39	5,33	0,94
2	4,25	5,98	1,73
3	4,33	5,7	1,37
4	3,93	4,23	0,3
5	4,35	5,5	1,15
6	3,9	4,35	0,45
7	4,15	4,65	0,5
8	4,15	4,3	0,15
9	4,33	4,33	0
10	4,2	4,2	0
Average relaxed hand			4,198
Average Fist Clench			4,857
Standard Deviation Relaxed Hand			0,17086707
Standard Deviation Cuff Grip			0,692949413

In group 5 (Figure 5), where 45 wrist grips were performed, it was also observed that 90% of the dosages presented increase, subject 7 did not present any alteration. The largest increase observed was 3.0 mmol / L, this increase was observed in individual 10, however, it is noteworthy that his second sample, with wrist clenching, showed hemolysis. The average with the relaxed hand was 4.39 mmol / L and the average with the wrist grip was 5.29 mmol / L with a standard deviation of 1.06 mmol / L (Table 7). It was observed that 40% of the individuals in group 5 presented potassium dosages with wrist grip above the reference value, which is 5.0 mmol / L.

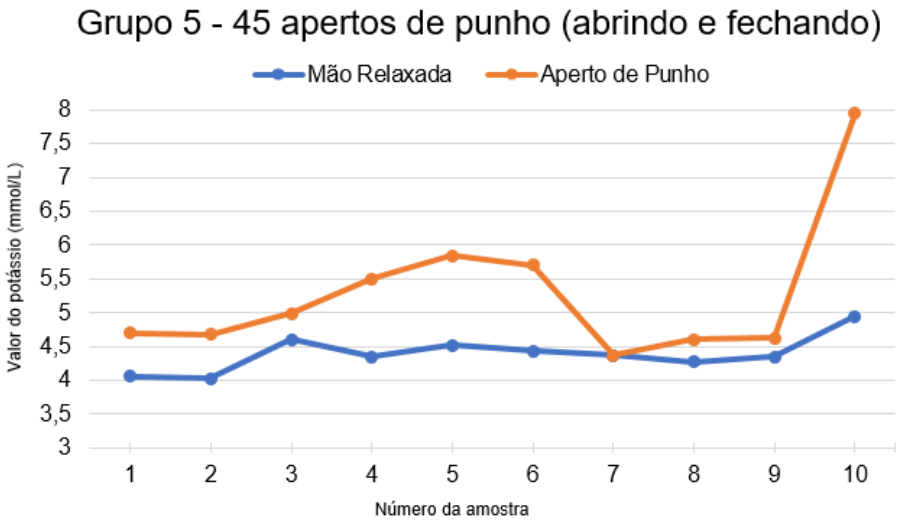

Figure 5 - Dosage of potassium with relaxed hand and, later, with forty-five cuffs.

Table 7 - Dosage with 45 cuffs.

Sample	Relaxed Hand	Clenching	Difference
1	4,06	4,7	0,64
2	4,03	4,68	0,65
3	4,6	4,99	0,39
4	4,35	5,5	1,15
5	4,52	5,84	1,32
6	4,43	5,7	1,27
7	4,37	4,37	0
8	4,27	4,6	0,33
9	4,35	4,62	0,27
10	4,95	7,95	3
Average relaxed hand			4,393
Average Fist Clench			5,295
Standard Deviation Relaxed Hand			0,265122613
Standard Deviation Cuff Grip			1,063100811

Discussion

Muscle movement is known to release potassium, and forearm exercise results in increased potassium in the blood taken from the vein. The amount that potassium can increase and the fact that this increase is of clinical significance and may lead to pseudohyperkalaemia is not generally recognized.[12]

Decreased potassium levels were not found in relation to phlebotomy with the relaxed hand and phlebotomy performed after wrist movement. Being aware that the clenching technique on most occasions, regardless of the amount of clenching, can lead to false hyperkalemia.

It can be seen that the results show that a false potassium value can be expected in almost all dosages after opening and closing the hand during phlebotomy, since 86% of the dosages performed with the handshake were increased by relation to dosage with the relaxed hand. When veins are difficult to access, it is common for practitioners to ask the patient to move the wrist for better viewing of the veins, and when this is combined with puncture of the cubital vein, the potassium level can increase considerably.

Potassium elevation due to the movement of opening and closing the hand during phlebotomy is also independent of the amount of wrist clenching, since in all groups there was an increase, to a greater or lesser extent.

Seven of the fifty subjects showed no changes between the two dosages, which may be justified by the fact that when the tourniquet is not applied sufficiently to arrest blood circulation, serum potassium levels remain unchanged compared to collection with the relaxed hand and the fist clenching.

We also observed that individual 10 of group 5 presented a difference of 3.0 mmol / L between the two dosages, the largest variation among all groups. We found that his second sample with the opening and closing of the hand was hemolyzed and this hemolysis significantly changes the potassium values due to its passage to plasma through the rupture of red blood cells, which may

justify this. big elevation.[12]

Changes in other electrolytes were not extensively investigated in the present study. Sodium and chloride are not expected to be changed as circulating levels of these ions are comparatively high and would be little changed by the cuff.

Conclusion

Wrist movement resulted in altered serum potassium levels in 86% of cases. Increase above 1 mmol / L serum potassium in 20% of the study samples. In 30% of the dosed sera, pseudohyperkalaemia was observed, that is, before the wrist movement, the values obtained in the potassium dosage were considered normal and after the wrist clamping technique, it presented a potassium higher than 5.0 mmol / L (reference value). This procedure has been shown to cause significant potassium dosage errors in phlebotomy practice for better vein visualization.

Potassium alterations in relation to wrist grip frequency by the research participants are independent of the amount of wrist grip, and the differences and means of all groups are close.

Finally, considering that normal serum potassium levels range from 3.5 to 5.0 mmol / L, it is noted that 30% of survey participants could generally have been misdiagnosed with hyperkalemia, may be subjected to unnecessary treatment.

Therefore, the present study indicates that the opening and closing of the wrist during the phlebotomy technique should be avoided, since a significant percentage of the cases presented an increase of potassium not in agreement with the normal serum potassium level of the individual.

Aknoledgements

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