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Создание набора данных с диспозицией и транспозицией наложения электрокардиографических электродов при записи электрокардиограммы в 12 отведениях

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АННОТАЦИЯ

Обоснование. Электрокардиография — одна из наиболее простых, широко распространённых, недорогих и информативных методик в функциональной диагностике, однако её диагностическая ценность резко снижается при неправильном проведении. Предпринимались попытки систематизировать ошибки и отклонения при наложении электродов, но все они касались наиболее частых вариантов (перестановка электродов красного и жёлтого, жёлтого и зелёного, грудных — выше или ниже стандартной схемы.

Цель — создать набор данных электрокардиограмм с разными вариантами транспозиций и диспозиций электродов при регистрации электрокардиограммы для обучения и тестирования систем машинного обучения.

Материалы и методы. В исследование включены пациенты в возрасте от 18 до 75 лет, 27 мужчин и 22 женщины. Все пациенты давали добровольное информированное согласие на проведение регистрации электрокардиограммы. Кардиограмму регистрировали на приборе «Модульная система для регистрации и дистанционной передачи электрокардиограммы «EASY ECG»». Каждому пациенту во время одного визита последовательно регистрировали электрокардиограммы с корректным наложением электродов и различными вариантами дис- и транспозиций.

Результаты. Всего зарегистрировано 488 электрокардиограмм у 49 пациентов. Полученные результаты свидетельствуют о значительной вариативности картины электрокардиограммы. При визуальном анализе зарегистрированных электрокардиограмм определение транспозиции, связанной с перестановкой отведений на руках и в грудных электродах C1–C2, не вызывало затруднений. Реже надёжно определялась установка грудных электродов в контакте друг с другом, диспозиции с переносом грудных отведений выше или ниже на 2 межреберья по сравнению со схемой Wilson. Транспозиции жёлтого и зелёного конечностных электродов, изменение положения грудных электродов, когда их «выстраивают» по прямой линии, «задирают» по межреберью, путают местами C5–C6, затруднительно определять даже при сопоставлении рядом двух кардиограмм — с правильным и транспозиционным наложением электродов. Вероятно, это зависит как от исходных изменений на электрокардиограмме, так и от типа телосложения, размеров молочной железы или наличия имплантата.

Заключение. Получен набор данных электрокардиограмм с различными вариантами дислокаций электродов. Набор данных состоит из серий электрокардиограмм, зарегистрированных у каждого пациента с различными вариантами наложения электродов (в наборе представлены не только нормальные электрокардиограммы, но и различные варианты электрокардиографических отклонений).

Ключевые слова: электрокардиограмма; ЭКГ; дефекты регистрации электрокардиограммы; искусственный интеллект; алгоритмы; функциональная диагностика.

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Creation of a training and test dataset with the disposition and transposition of overlaying electrocardiographic electrodes when recording electrocardiograms-12

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ABSTRACT

BACKGROUND: Electrocardiography is one of the simplest, most widely used, inexpensive, and informative methods in functional diagnostics; yet, if performed poorly, its diagnostic value is sharply reduced. Several attempts were made to systematize errors and deviations in electrode application, but all concerned the most common options (rearrangement of red and yellow electrodes, yellow and green electrodes, and chest electrodes — above or below the standard scheme).

AIM: To create an electrocardiogram dataset with different options for transpositions and dispositions of electrodes during electrocardiogram recording.

MATERIALS AND METHODS: The study included patients aged 18–75 years (27 males and 22 females). All patients provided informed consent for electrocardiogram registration. During one visit, the cardiogram was recorded on the device “Modular system for recording and remote transmission of electrocardiograms (EASY ECG)” for each patient.

RESULTS: In all, 488 electrocardiograms were recorded in 49 patients. The results obtained indicate a significant variability of the electrocardiogram pattern. Visual analysis of the electrocardiograms revealed no difficulties in determining the transposition associated with rearranging the leads on the arms (RY) in the thoracic C1–C2. The placement of thoracic electrodes in contact cheek-to-cheek dispositions with the transfer of thoracic leads above or below two intercostals was reliably determined compared with the Wilson scheme. The transpositions of the yellow and green limb electrodes and the change in the position of the thoracic ones when they are “lined up” in a straight line, “bullied” between the ribs (curved), and confused in places C5 and C6 are difficult to determine even when comparing two cardiograms next to each other, with the correct and transpositional superposition of the electrodes. The initial changes on the electrocardiograms, physique type, breast size, or the presence of an implant most likely determine it.

CONCLUSION: An electrocardiography dataset was obtained using various electrode dislocation variants. The dataset consists of a series of electrocardiograms obtained for each patient with several electrode placement options and contains both normal and pathological electrocardiograms.

Keywords: electrocardiogram; ECG; defects in the registration of the electrocardiogram; artificial intelligence; algorithms; functional diagnostics.

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在记录12导联心电图时，创建一个具有心电图电极应用配置和转置的数据集

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简评

论证。心电图是功能诊断中最简单、最常见、最便宜和最有信息量的方法之一，然而它的诊断价值在错误操作中急剧下降。试图使电极应用时的错误和偏差系统化，但这些错误和偏差都涉及到最常见的变体（把红色和黄色、黄色和绿色、胸腔的电极移动到高于或低于标准方案的位置）。

该研究的目的是在记录心电图时创建一个具有不同电极配置和转置的心电图数据集，以训练和测试机器学习系统。

材料和方法。年龄在18至75岁的患者被纳入本研究，其中男性27人，女性22人。所有患者都自愿知情同意记录心电图。心电图是在《记录和远程传输心电图的模块化系统“EASY ECG”》设备上记录的。每位患者在一次就诊中都依次接受心电图检查，其中有正确的电极应用及不同的配置和转置的变体。

结果。一共有49名患者，记录了488张心电图。研究结果表明，心电图模式有很大的变异性。在对记录的心电图进行目测分析时，发现与手臂和胸腔C1-C2电极移动有关的转置并不困难。很少有胸腔电极相互接触的情况，与Wilson方案相比，胸腔导联移高或移低2个肋间的配置被可靠地发现。黄色和绿色肢体电极的转置，当“排成”一条直线，沿肋间隙“乱”，以及混入C5-C6时，胸廓电极的改变，即使并排比较两张心电图，有正确和转置的电极应用，也很难确定。这可能既取决于基线心电图的变化，也取决于体型、乳房大小或是否有植入物。

结论。我们获得了一个具有不同电极脱位变体的心电图数据集。该数据集由一系列记录在每个病人身上的不同电极应用变体的心电图组成（数据集中不仅有正常的心电图，还有不同的心电图异常变体）。

关键词：心电图；ECG；心电图记录失误；人工智能；算法；功能诊断。

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BACKGROUND

Electrocardiography (ECG) is one of the simplest, most widespread, inexpensive, and informative techniques in cardiology; however, its diagnostic value is dramatically reduced if it is not performed correctly. The most common change in the recording technique is electrode displacement (dislocation). A disposition (a deliberate and necessary change in electrode placement) should be distinguished from a transposition (an erroneous change in electrode placement compared with the standard overlay pattern).

Several studies have attempted to systematize errors and deviations in electrode placement; however, all of them concerned the most frequent variants, such as relocation of red and yellow, yellow and green, and precordial electrodes above or below the standard pattern. [1-7] To avoid errors in the interpretation of ECG recordings, algorithms capable of detecting such errors are developed. Machine algorithms stably recognize right–left (RL) transposition.

To assess the quality and determine the criteria for the possibility of using such algorithms, ECG datasets should be created for training and testing both algorithms for automatic ECG analysis and by healthcare specialists, i.e., doctors and nursing staff.

This study aimed to create an ECG dataset with different electrode transpositions and dispositions during ECG recording for training and testing machine-learning systems.

MATERIALS AND METHODS

Inclusion criteria

Patients aged 18–75 years (27 men and 22 women) were included in the study. All patients gave voluntary informed consent for ECG recording.

Settings

The study was performed in the Moscow State Budgetary Institution City Clinical Hospital No. 67 named after L.A. Vorokhobov of Moscow Healthcare Department.

Description of treatment

The patients were divided into the following six arms:

1) Patients with normal ECG (recordings starting with 101, 102, 103, 104, 105, 106, 107, 108, 109, and 110).
2) Patients with ECG signs of left ventricular hypertrophy or complete left bundle branch block (recordings starting with 201, 202, 203, 204, 205, 206, 207, 208, and 209).
3) Patients with ECG signs of right bundle branch block (recordings starting with 301, 302, 303, 304, 305, and 306).
4) Patients with recorded ST (–) depression (recordings starting with 401, 402, 403, 404, 405, 406, 407, 408, and 409).
5) Patients with recorded ST(+) elevation, including the phenomenon of early ventricular repolarization (recordings starting with 501, 502, 503, 504, 505, 506, and 507).
6) Patients with any nonsinus rhythm that are preferably characterized by negative *P* waves in I, II, V1, and V2 leads (recordings starting with 601, 602, 603, 604, 605, 606, 607, and 608).

Cardiograms were recorded using EASY ECG Modular System for Recording and Remote Transmitting of ECGs according to TU 9441-001-42447560-2012 with Accessories (ATES MEDICA SOFT LTD, Russia, Registration Certificate No. RZN 2018/7062).

For ECG recording, operating silver/silver chloride electrodes were used with 26 × 47-mm plates (for limb ones) and 22-mm cups (for precordial ones).

Digitized cardiac signals were recorded in the European data format. [8] Recordings were made in 12 common leads with a sample rate of 500 Hz, the recording lasted for 10 s, and the signal magnitude was 10 mV. No signal filtering was performed, and the bandwidth was from 0.05 to 150 Hz.

Ethical review

The study was approved by the independent ethical committee of the Moscow Regional Branch of the Russian Society of Roentgenologists and Radiologists (RSRR MRB IEC).

RESULTS

Each patient underwent sequential ECG recording during one visit with correct electrode placement and different variants of dis- and transpositions. The coding and description of overlay patterns are provided in Table 1.

In total, 486 ECGs were recorded in 49 patients. The structure of the recorded ECGs is shown in Table 2.

After recording, all results were anonymized and pseudonymized[1], placed, and annotated on the ECG.RU platform using a unified thesaurus. [9] Each ECG file was named according to the following principles: the first three digits referred to the patient subgroup number and serial number, and subsequent letters referred to the coding of electrode placement.

For example, the file name “101_dis_st” meant that this ECG was recorded in a patient with an unchanged ECG, and the electrodes were placed correctly. The file name “203_trns_crv” contains the ECG of a patient with left ventricular hypertrophy, and the C4, C5, and C6 electrodes are placed along the intercostal line (not along the horizontal line, but curved upward). The file name “602_trns_yg” contains the ECG of a patient with nonsinus rhythm, and the yellow and green electrodes are reversed. Examples of recorded

[1] GOST R 55036-2012/ISO/TS 25237:2008. P85 Group. National Standard of the Russian Federation. Health Informatics. Pseudonymization. Access: https://docs.cntd.ru/document/1200100339.

Table 1. Electrode placement variants and their coding

Russian wording	English equivalent	Part of the ECG filename	Comment	Incorrectly displayed leads
Стандартное расположение электродов	Standard electrodes' arrangement	dis_st	Correctly applied electrodes	All leads are correct
Грудные электроды: на 2 межреберья выше стандартной схемы	Precordial electrodes' misplacement: up to 2 intercostal spaces above the standard arrangement	dis_u2	Occasionally required for clinical indications, but in general, it is the most common electrode misplacement	Correct: I, II, III, aVR, aVL, and aVF. Dislocated: V1, V2, V3, V4, V5, and V6
Грудные электроды: на 2 межреберья ниже стандартной схемы	Precordial electrodes' misplacement: below to 2 intercostal spaces down the standard arrangement	dis_d2	Occasionally required for clinical indications, but in general, it is electrode misplacement	Correct: I, II, III, aVR, aVL, and aVF. Dislocated: V1, V2, V3, V4, V5, and V6
Перепутаны красный (R) и жёлтый (L) электроды	Reversal of the two arm electrodes	trns_ry	Misplacement	Incorrect: I, II, III, aVR, aVL, and aVF. Correct: V1, V2, V3, V4, V5, and V6
Перепутаны жёлтый (L) и зелёный (F) электроды	Reversal of the left arm and left leg electrodes	trns_yg	Misplacement	Incorrect: I, II, III, aVR, aVL, and aVF. Correct: V1, V2, V3, V4, V5, and V6
Все грудные электроды расположены на прямой линии от C1–C6	All chest electrodes are placed at the same line	trns_ln	Misplacement	Correct: I, II, III, aVR, aVL, aVF, and V1. Incorrect: V2, V3, V4, V5, and V6
Перепутаны C1–C2	Reversal of the C1 and C2 electrodes	trns_12c	Misplacement	Correct: I, II, III, aVR, aVL, aVF, V3, V4, V5, and V6. Incorrect: V1 and V2
Перепутаны C5–C6	Reversal of the C5 and C6 electrodes	trns-56c	Misplacement	Correct: I, II, III, aVR, aVL, aVF, V1, V2, V3, and V4. Incorrect: V5 and V6
Электроды C4, C5, C6 расположены очень близко друг к другу (соприкасаются)	The C4, C5, C6 electrodes are placed too close to each other (cheek to cheek)	trns_cls	Misplacement	Correct: I, II, III, aVR, aVL, aVF, V1, V2, and V3. Incorrect: V4, V5, and V6
Электроды C4, C5, C6 расположены по межреберью (не по горизонтальной линии, а искривляются вверх)	The C4, C5, C6 electrodes are misplaced along the intercostal space (not at a horizontal line, but curved upwards)	trns_crv	Misplacement	Correct: I, II, III, aVR, aVL, aVF, V1, V2, and V3. Incorrect: V4, V5, and V6

ECGs are shown in pairs in Figures 1–3 (overlay pattern and corresponding ECG).

DISCUSSION

The obtained results indicate a significant variability of ECG patterns depending on the initial changes and, probably, the patient's body type and state of mammary glands. Despite sufficient studies on the variability of normal ECG changes, [6–8] the variability of changes in the initial abnormal ECG is yet to be examined, which we will do in our next paper.

In the visual evaluation of the recorded ECGs, transposition was determined based on the relocation of the arm leads (red and yellow—RL) and precordial C1–C2 was not complicated. The placement of precordial cheek-to-cheek electrodes, in disposition with the transfer of the precordial leads higher or lower by two intercostal spaces than the Wilson scheme (upper2 and lower2), was less often reliably determined.

Table 2. Allocation of cardiograms recorded in patients

Placement type / Subgroup of ECG changes	Standard ECG placement	Dislocation of precordial electrodes	Transposition of limb electrodes	Transposition of precordial electrodes	Total
Normal ECG	10	20	20	49	99
ECG with LVH and CLBBB	9	18	18	45	90
ECG with RBBB	6	12	12	30	60
ECG with ST(–) depression	9	18	18	43	88
ECG with ST(+) elevation	7	14	14	35	70
ECG with any nonsinus rhythm	8	15	16	40	79
Total	49	97	98	242	486

Notes. ECG, electrocardiogram; CLBBB, complete left bundle branch block; LVH, left ventricular hypertrophy; RBBB, right bundle branch block.

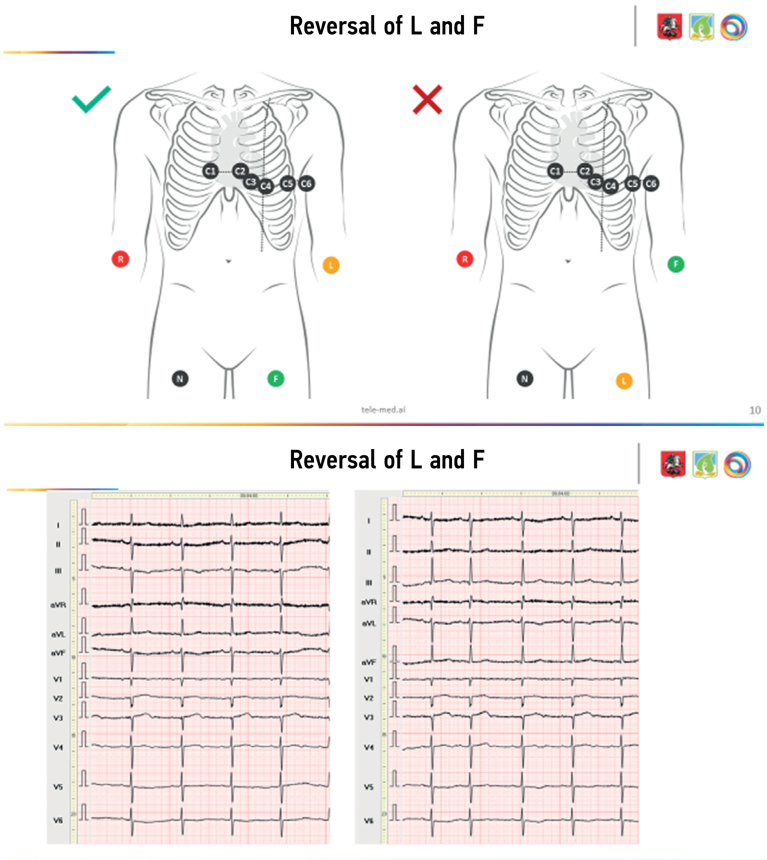

Fig. 1. Misplacement of L and F electrodes.

Transpositions of yellow and green limb electrodes (LF), changes in the position of precordial electrodes, when they are in line, curved, or C5–C6 electrodes are reversed, are difficult to determine even when directly comparing two cardiograms, with correct placement and transposition of electrodes. This probably depends on baseline ECG changes, body type (normosthenic, hypersthenic, or asthenic), breast size, or presence of an implant. Certainly, issues such as the consideration of the built, presence of a transplant, possible detailing of the initial ECG changes according to the reduced thesaurus, and comparison of the efficiency of recognition by a specialist and automatic analysis algorithms, require further evaluations.

Despite the known disadvantages, considering the high importance of the issue and difficulty of obtaining qualitatively recorded data and annotated ECGs, the obtained set of ECGs was published under an open license and used for both verification of algorithms of automatic ECG analysis and training of doctors and nursing staff.

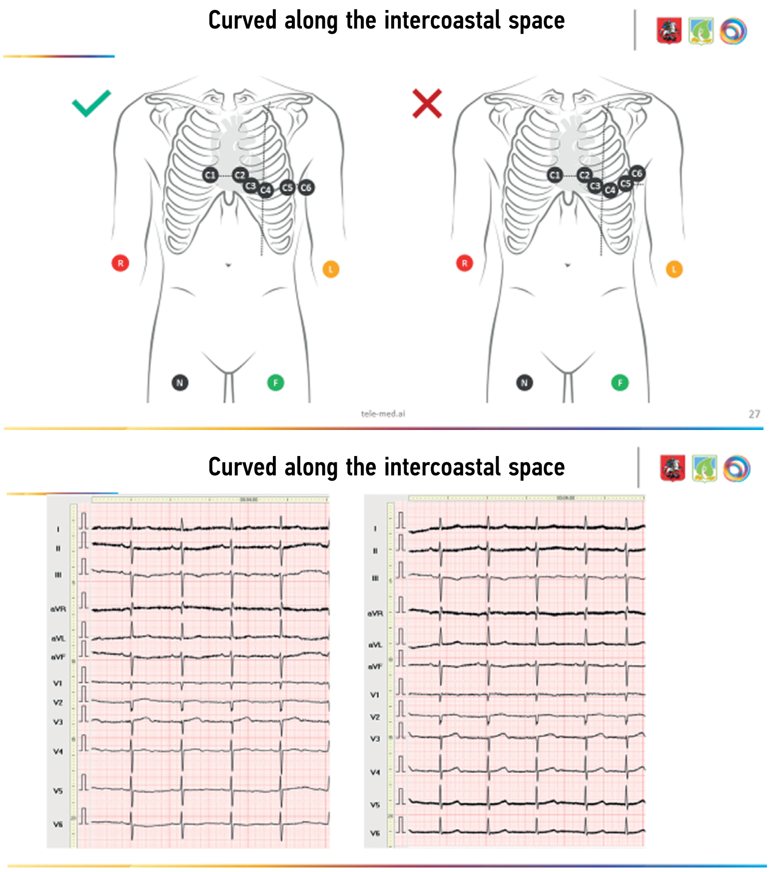

Fig. 2. Misplacement of C4–C6 electrodes.

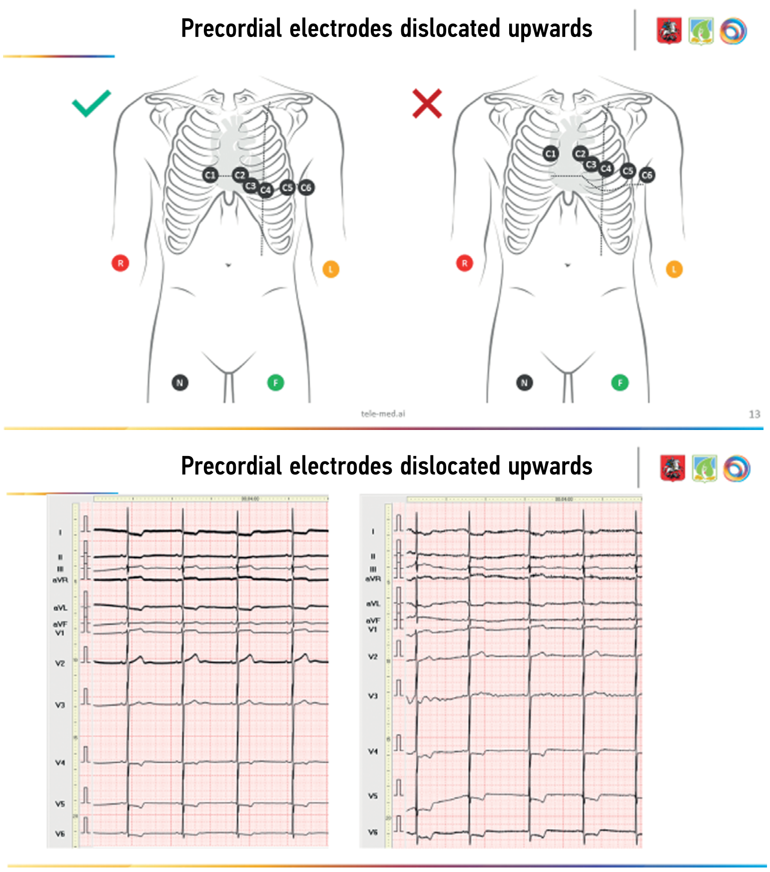

Fig. 3. Dislocation of C4–C6 electrodes.

Study limitations

On patient examination, their height, weight, and built (somatotypes) were not always considered. Taking these factors into account will probably increase the accuracy of determining the type of electrode dislocation.

CONCLUSION

In this study, an ECG dataset with different electrode dislocation variants was obtained. The dataset consists of ECG series recorded in each patient with different electrode overlap variants. The set includes not only normal ECGs but also different variants of abnormal ECGs.

ADDITIONAL INFORMATION

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Authors' contribution. All authors made a substantial contribution to the conception of the work, acquisition, analysis, interpretation of data for the work, drafting and revising the work, final approval of the version to be published and agree to be accountable for all aspects of the work. D.V. Drozdov — concept development, organization of annotation process, thesaurus development, author supervision; T.M. Gazashvili — organization of ECG registration, depersonalization and transfer of records; D.V. Shutov — concept development, organization of depersonalization, transfer, annotation, author supervision; A.S. Skoda — general management, organization of the work of the center for instrumental diagnostics.

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REFERENCES

1. Rosen AV, Koppikar S, Shaw C, Baranchuk A. Common ECG lead placement errors. Part I: Limb lead reversals. *Int J Med Students*. 2014;2(3):92–98. doi: 10.5195/ijms.2014.95

2. Rosen AV, Koppikar S, Shaw C, Baranchuk A. Common ECG lead placement errors. Part II: precordial misplacements. *Int J Med Students*. 2014;2(3):99–103. doi: 10.5195/ijms.2014.96

3. Jekova I, Krasteva V, Leberet R, et al. Inter-lead correlation analysis for automated detection of cable reversals in 12/16-lead ECG. *Comput Methods Programs Biomed*. 2016;(134):31–41. doi: 10.1016/j.cmpb.2016.06.003

4. Kania M, Rix H, Fereniec M, et al. The effect of precordial lead displacement on ECG morphology. *Med Biological Engineering Computing*. 2014;52(2):109–119. doi: 10.1007/s11517-013-1115-9.

5. Wenger W, Kligfield P. Variability of precordial electrode placement during routine electrocardiography. *J Electrocardiol*. 1996;29(3):179–184. doi: 10.1016/s0022-0736(96)80080-x

6. García-Niebla J, Llontop-García P, Valle-Racero JI, et al. Technical mistakes during the acquisition of the electrocardiogram. *Ann Noninvasive Electrocardiol*. 2009;14(4):389–403. doi: 10.1111/j.1542-474X.2009.00328.x

7. Peberdy MA, Ornato JP. Recognition of electrocardiographic lead misplacements. *Am J Emergency Med*. 1993;11(4):403–405. doi: 10.1016/0735-6757(93)90177-d

8. Kemp B, Olivan J. European data format 'plus' (EDF+), an EDF alike standard format for the exchange of physiological data. *Clin Neurophysiol*. 2003;114(9):1755–1761. doi: 10.1016/s1388-2457(03)00123-8

9. Drozdov DV, Shutov DV, Gazashvili TM, et al. Coordination of medical ECG descriptions using a thesaurus (list of standard phrases) of conclusions. *Medical Alphabet*. 2022;(10):19–26. (In Russ). doi: 10.33667/2078-5631-2022-11-19-26

СПИСОК ЛИТЕРАТУРЫ

1. Rosen A.V., Koppikar S., Shaw C., Baranchuk A. Common ECG lead placement errors. Part I: Limb lead reversals // Int J Med Students. 2014. Vol. 2, N 3. P. 92–98. doi: 10.5195/ijms.2014.95

2. Rosen A.V., Koppikar S., Shaw C., Baranchuk A. Common ECG lead placement errors. Part II: precordial misplacements // Int J Med Students. 2014. Vol. 2, N 3. P. 99–103. doi: 10.5195/ijms.2014.96

3. Jekova I., Krasteva V., Leberet R., et al. Inter-lead correlation analysis for automated detection of cable reversals in 12/16-lead ECG // Comput Methods Programs Biomed. 2016. N 134. P. 31–41. doi: 10.1016/j.cmpb.2016.06.003

4. Kania M., Rix H., Fereniec M., et al. The effect of precordial lead displacement on ECG morphology // Med Biological Engineering Computing. 2014. Vol. 52, N 2. P. 109–119. doi: 10.1007/s11517-013-1115-9

5. Wenger W., Kligfield P. Variability of precordial electrode placement during routine electrocardiography // J Electrocardiol. 1996. Vol. 29, N 3. P. 179–184. doi: 10.1016/s0022-0736(96)80080-x

6. García-Niebla J., Llontop-García P., Valle-Racero J.I., et al. Technical mistakes during the acquisition of the electrocardiogram // Ann Noninvasive Electrocardiol. 2009. Vol. 14, N 4. P. 389–403. doi: 10.1111/j.1542-474X.2009.00328.x

7. Peberdy M.A., Ornato J.P. Recognition of electrocardiographic lead misplacements // Am J Emergency Med. 1993. Vol. 11, N 4. P. 403–405. doi: 10.1016/0735-6757(93)90177-d

8. Kemp B., Olivan J. European data format 'plus' (EDF+), an EDF alike standard format for the exchange of physiological data // Clin Neurophysiol. 2003. Vol. 114, N 9. P. 1755–1761. doi: 10.1016/s1388-2457(03)00123-8

9. Дроздов Д.В., Шутов Д.В., Газашвили Т.М., и др. Согласование врачебных описаний ЭКГ с применением тезауруса (списка типовых фраз) заключений // Медицинский алфавит. 2022. № 10. С. 19–26. doi: 10.33667/2078-5631-2022-11-19-26

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