Intelligent medical systems in diagnosing and treating inflammatory diseases of the pancreas (systematic review)

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Key words: intelligent decision support system, artificial neural networks, acute and chronic pancreatitis, diagnostics, treatment

1. Introduction

Inflammatory diseases of the pancreas occupy the first place in the structure of diseases of the pancreas [29]. Particularly acute problem is, its time of diagnosis, objectification severity, outcome prediction and treatment of acute and chronic pancreatitis (AP and CP). This is due to the layer x NOSTA Dunn's diseases, high morbidity and mortality from pancreatic necrosis and CP complications [3, 18].

Use in clinical practice to the modern personal computer's m allowed to expand the possibilities of predicting the course of the ref and so AP and CP, as has become available rapid analysis of relatively large on the composition and the number of groups the disease parameters [10, 22, 27]. Highly relevant now considered computer systems support decision making based on algorithms developed using mining techniques Medici n Sgiach data [5, 12, 20].

It is known that in making medical decisions problems are lack of knowledge, limited time resources, lack of possibilities in attracting a large number of competent experts, incomplete information about the state of the patient, and others. [12, 20]. Currently retains so Xia large percentage of medical errors, followed by a further loss of the patient's health or death due to inaccuracies in the assessment of his standing with, the complexity of the process, I make good decisions due to a multiple of the STI factors and signs of diseases and their interactions. H and the state PAC cient and can be influenced by certain factors, not only on the individual about STI, but also in certain combinations. Aboutbrabotat large amount of info r mation and identify patterns clinician often can not afford. Cope with this can only Modern computer techniques and with th t wo sponding software [12]. At present there is a necessity e n greater use of computer support various methods decision [4, 7, 20]. T he system Intelligent Decision Support (DSS) allow the doctor to not only check their own prognostic and diagnostic assumptions, but also to use the suit with governmental intelligence in complex clinical situations [7]. One example is the DSS system, using software implementations art neural networks [1, 13].

The aim of the article was a systematic review of the literature on the effectiveness of various STI intelligent medical decision support system based on artificial neural network in the diagnosis and treatment of inflammatory diseases Podge e ludochnoy gland.

2. Methods

2.1. Literary search.

With the systematic Search literature was carried out by online m database am of data PubMed, using string search: "automatic data processing" [MeSH Terms] OR "computer systems" [MeSH Terms] OR "artificial intelligence" [MeSH Terms] OR "medical informatics" [MeSH Terms] OR "computer security" [MeSH Terms] OR "information storage and retrieval "[MeSH Terms] A ND" pancreat i tis "[MeSH Terms] AND" humans "[MeSH Terms] AND (" 1990/01/01 "[PDAT]:" 2017/02/28 "[PDAT]),and also eL ibrary: «and skusstvennye neural network » AND " N ankreatitis " at these same terms publication. The resulting publication venture with m pa under considerationon the basis of pre-defined inclusion and exclusion criteria.

2.2. Criteria exception I exceptions.

All works published in medical journals on the use of artificial neural networks (ANN) in AP and CP in the human population were included. They were excluded publkatsii and before 1990, the description of cases (case reports), the editorial board posts (editorials), and article-commentary (commentaries).

3. Basic concepts

Artificial neural networks are mathematical models that enable you to claim, as a rule, a little better classify objects than stochastic models [2, 9, 11]. The method of constructing ANN is based on some of toryh principles of information processing in biological systems. The basis of each ANN is relatively simple, in most cases one of thetypical elements that simulate the work of brain neurons. Each art ny n neuron is characterized by its current state, by analogy with in brain cells that can be excited or p but mozheny. Artificial neuron has a group of "synapses" — One Path in PARTICULAR input connections are connected to the outputs of other man-tron is not the first, and also has an axon — output relationship of the neuron, which si nal g (stimulation or inhibition) arrives at synapses following iskuss m governmental neurons [2]. An INS is characterized by the principle of parallel processing of signals, which is achieved by combining a large number of neurons into so-called layers and connections in a certain way by neurons of different layers. The strength of synaptic connections during modified receptacle extraction and Nij from the training set data (training mode), and then used in the preparation of the new data on the result (execution mode) [9]. Neural networks allow decisions to be made on the basis of hidden patterns discovered in multidimensional data.

Neural networks have been used in many fields of human de telnosti I, where they are used to solve numerous applications of cottages and [9, 17]. In connection with the rapid growth of the technical capabilities of modern computers, INS is currently experiencing another renaissance [17]. Examples of the use of computer prediction based ontehn ogy ANN in medicine are also numerous enough in t th including medical and surgical gastroenterology [6, 14, 15, 21, 26, 28].

4. Results

4.1. Search.

During the initial search and th were identified s 3 49 works on the PubMed database and 4 minutes at 5 Publication eL ibrary basis of data from which 11 wo t fied our inclusion and exclusion criteria (Fig. 1).

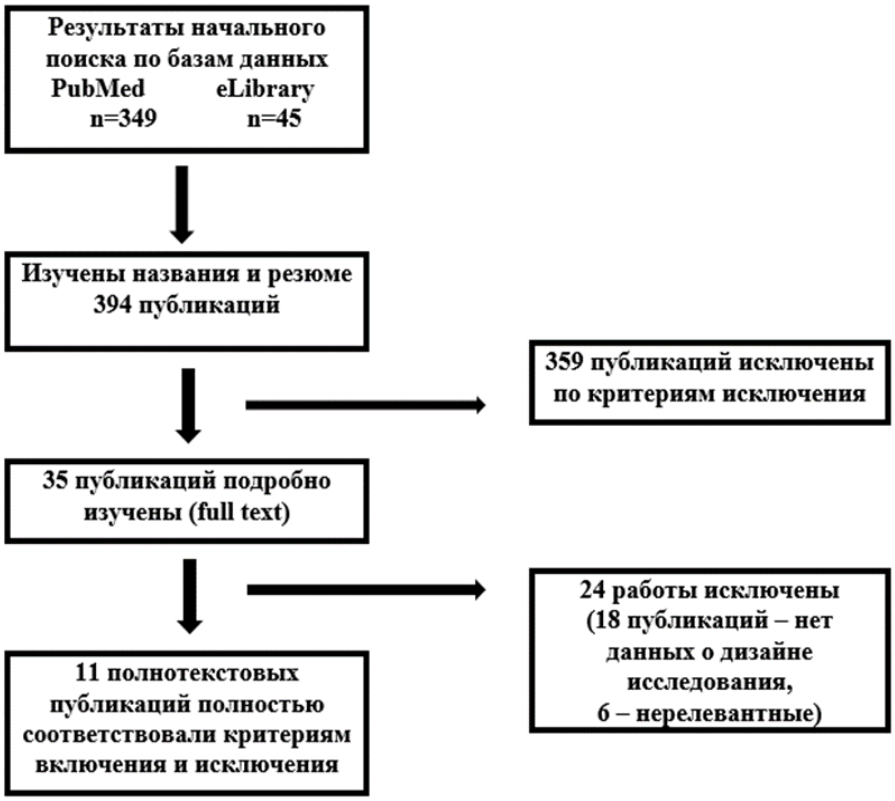

Fig. 1. The process of selecting publications for analysis.

4.2 Analysis.

The first attempt at forecasting severity AP and exacerbation CP INS undertaken by S. C. Kazmierczak et al. (1993) by analyzing the activity of pancreatic enzymes of blood serum [23]. Pancreatic lipase was the best prognostic e skim heavy AP factor, its accuracy was 8 2% (95% CI: 77 — 87). That h NOSTA prediction using the valuesamylase serum was sufficiently low th — 76% (71 — 81), the combination of the same indicators such as lipases but also amylases and not allowed to significantly increase the accuracy of the created INS — predictive accuracy was 84% (79 — 89).

The M study. T. Keogan et al. (2002) neural network model was used to predict the duration of treatment of AP dol s Chez average was 8.4 days [24]. Since a large number(23) of input variables with respect to a small number of patients (n=92) created a risk of a so -called retraining ANN number of variables have been abbreviated e but using stepwise discriminant analysis, from 23 to 6: Ms d bone deficit; serum creatinine level ; the presence of heavy collateral and diseases; blood pressure ; degree of inflammation according to CT ; serum calcium level. The above data were subjected to neural network and linear discriminant analysis. ANN pointed at and the best predictive accuracy (AUC= 0,83±0,05 [1]) in

[1] Here and below are the standard errors in the AUC estimate.

comparison with E scales and Ranson (AUC=0,68±0,06; P <0.02) and Balthazar (AUC=0.62±0.06; P <0.003). About Dr. Nako compared to secondharmonic motion second discriminant function s significant differences in predicting the duration of treatment was not detected AP (AUC=0,82±0,05; P=0.53). The disadvantage of this model and the INS and all Resea Niya was the fact that she has been trained and tested on the same data set, so the results should be tested in other and withthe follow up.

KI Halonen et al. (2003) on the basis of a retrospective analysis of the case histories of 234 patients with severe AP developed two prediction models for prediction a possible fatal outcome in pancreatic necrosis [23]. In the first model, called "LR4" lethal outcome predicted by logistic regression analysis based on four parameters — age, presence of heart — vascular disease, respiratory failure and a higher level and serum creatinine 72 hours aces from the moment of receipt. The second model based on ANN («ANN8») besides the aforementioned lane e variables included four: the need for vasopressor subtree w ki, gender, body mass index and the lowest level of hemoglobin within nep O aces 72 hours after admission. The predictive accuracy of various m DeLay was compared using ROC-analysis. The greatest prognostic accuracy was shown by "LR4" (AUC=0.862) and "ANN8" (AUC=0.847). Remaining scale showed the following results in predicting the outcome of Nogo s flown with severe CP: scale G l a sgow — AUC=0,536, Ranson — AUC=0,655, MODS — AUC=0,781 and APACHE II — AUC=0, 817. P Rich simpler model «LR4», which consists of four conventional display and of Tell, had the highest accuracy [25].

WE Pofahl et al. (1998) used ANN to predict DURATION v Nosta stay of patients with pancreatitis in the hospital [31]. In his issled about Vania they compared with INS systems Ranson, APACHE II criteria for chuvs t pheno-, specificity, positive predictive value and accuracy. Symptoms of the neural network input (input neurons) 71 served as the indicator of clinical, instrumental and laboratory methods obsl e dovaniya, estimated at 156 randomly selected patients on admission. The results at the output of the ANN consisted of index "DURATION v Nosta stay in hospital" with two possible values "≥ 7 days" (heavy AP) and "<7 days' (not heavy AP). Trained ANN was tested and in 39 patients with AP. The authors provide information about high sensitivity of STI (75%), specificity (81%) and accuracy (79%) of the ANN to determine the extent OD, gravitydetected by the predicted duration of hospitalization [31].

In 2007, R. Mofidi et al. We developed a neural network model for classifying and katsii AP gravity forecasting organ failure and death [22]. To do this, the authors carried out a retrospective analysis of 664 case histories of patients with AP, including 181 patients with cord lym e AP (27.3%). For the development of ANN Execu IAOD multilayer perceptron (four layers, two of them are invisible intermediate layer) with a return of the camshaft roubleshooting errors. 60% of the data allocated to the ANN training, 15% — are tested on the Bani, 25% — validation. Pre dimension Prizna and kovogo space was reduced from 29 to 10 characters. As a result, p azrabotannaya ANN Bazirabout valas 10 clinical parameters (age, presence of hypotension, two and b of Lee signs SIRS, level PaO

2, LDH, glucose, urea, calcium hemato to Rta and the number of blood leukocytes) defined at admission and after 48 hours. This model showed significantly better results than the APACHE II and Glasgow systems : INS was more accurate than APACHE II and Glasgow when predicting heavy th OD (P <0.05 and P <0.01, t sootvets venno) predicting the development of multiple organ failure I (P <0.05 and P <0.01) and in the prediction of death (P <0, 05). This work of m differs from the inclusion of a large number of patients (n=664) discussed above, and in that the training and validation were performed at different groups of patients. No less important advantage is that all d e syat input variables are available for the doctor on duty in the pre crystals ie the first 6 hours after admission.

B. Andersson et al. (2011) conducted a study and whose purpose was to develop and validate the effectiveness of the ANN model for early prediction of the severity of AP [27]. The authors conducted a retrospective and an lys s results of treatment of 208 patients with AP (from 2002 to 2005, n=139, from 2007 to 2009, n=69). The severity of the AP was determined in accordance with the criteria proposed at the OT conference in Atlanta. Of the 23 bp potentially AP severity, the authors of the ANN selected six most informative criteria: duration of pain attack, blood creatinine, hemoglobin, alanine, frequency se p dechnyh rate and blood leukocytes. Area under the ROC curve the Neuros eteva model was a 0.92 (95% CI: 0.85-0.99), 0.84 (0.76-0.92) — cal and y logist regression (P=0,030, $\chi^{2)}$ and 0.63 (0,50-0,76) — In assessing e severity of AP with APACHE II (P < 0.001, χ^{2}). The authors concluded that pa s INS worked them based on the data received by the patient and entering the hospital data is sufficiently accurate to predict the severity of the AP [27].

P.I. Mironov et al. (2011) also evaluated the opportunities INS in opred e lenii severity and predicting outcome OD [10]. The study included 10 0 patients with severe AP,which were under the supervision of the authors from 2004 to 2010 was to construct e Nia INS were selected parameter 33 to 5 categories (demographic yes n nye, physiological variables, laboratory tests, a period of change N nye, disease outcomes). Subsequently, the number of input data has been reduced by stepwise logistic regression analysis to 6.spolzova were standard three-layer perceptrons with a compound of AZD th hidden and output neurons with all elements of the preceding layer. Neural networks have been trained in all cases from the database with the use and Niemi algorithm backpropagation. The authors concluded that pre and su- ability ANN (AUC=0.83±0.04) in the early identification of patient groups, threatened by the development of heavy AP, substantially (P < 0.001, χ^{2}) exceeds the capabilities of the Ranson evaluation systems (AUC=0.55±0.06), Glasgow (AUC=0.58±0.06), TFS (AUC=0.53±0.06), APACHE II (AUC=0.58±0.06), and ultrasound/CT criteria (AUC=0.68±0.06). When a predictorof death risk SRI authors revealed that the area under the ROC-curve for equal ANN 0.83±0.04, scale Ranson — 0.55±0.06, Glasgow — 0.58±0.06, TFS — 0.53±0.06, APACHE II — 0.58±0.06, SOFA — 0.72±0.05 and cr and US/CT teriev — 0,68±0,06. The predictive value of ANN in determining the risk of developing a lethal outcome was higher than all other systems (P <

0.001, for the Ranson, Glasgow, TPS, APACHE II scales), (P=0.033 for ultrasound/CT criteria), (P=0.046 for the SOFA scale) [10].

A.A. Litvin et al. (2012) have developed a system and the prediction-skilled inf pancreatonecrosis based on survey data obtained during the first day after admission to the hospital with AP [6]. To do this, use retrospective clinical, laboratory and instrumental data s nye 398 patients who were treated from 1995 to 2005. In Bork s of objects 398 is divided arbitrarily in two groups: the contents of the first group were used to teach ANN (298 examples); objects of the second group were used for testing the trained ANN (approx 100 th pit). In order to determine the validity of the developed forecasting systems and Nia produced outcomes analysis in the examination of a sample of 128 patients with severe AP observed in 2006 -20 08 g g. Using the genetic algorithm for feature selection t ma authors have highlighted the 12 most informative features possible development of infectious complications of pancreatonecrosis: 1) time from onset of the disease to admission to hospital; 2) "early," Op e radio in the history of patients; 3) severe pain syndrome (docked by narcotic analgesics); 4) body mass index; 5) heart rate; 6) respiratory rate; 7) acute fluid clusters (according to ultrasound and CT) or palpable infiltration; 8) bloating (according to clinical data); 9) number of rod-shaped forms of blood leukocytes; 10) The level of PS glitch; 11) serum urea level; 12) Effect of intensivetherapy to the complex m within 24 hours of hospitalization [6].

The computer program for sufficiently high predictive power for infected pancreatic necrosis in a sample of patients with severe CP: sensitivity — 8 5 5% (95% CI:73.3 — 9 3, 5) specificity — 9 1 8% (83.0 — 9, 6, 9). This system was more accurate than comparable scales s to determine the risk of infectious complications of severe CP: differences M-APACHE II and the scale of DA Tag and Novichev were found with P=0.005, Z- criterion, with SI scale. Tretyak et al. — P=0.003, Z- criterion [6].

The same as the second also developed a system of diagnosis of infected pancreatic necrosis, is used in the process of follow-up of patients with severe AP for detecting the transition of Sterilization s Foot infected necrotizing pancreatitis in. With the help of ANN, 14 features were identified which, when used as input parameters, INS allow the diagnosis of infectious complications of pancreatic necrosis with a high probability. The number of informative parameters entered trad and translational clinical studies ("time of onset", "early operation history," "patient treatment AP history", "BMI", "body temperature", "heart rate" "frequency stomach and Nij", "bloating", "the effect of medical treatment for 24 hours and cos"); laboratory indicators ("blood leukocytes", "ESR", " "Number fell h koyadernyh forms leukocytes", "serum glucose") and instrumental s nye data ("availability infiltration or liquid accumulations"). ANN has demonstrated very good quality diagnostic model in recognizing and SRI infected pancreatonecrosis — the area under the ROC- curve was 0.854 (95% CI: 0.791-0.917). INS in the test sample of patients prodemo n equiv- sensitivity of 81.8% (75,3-88,3) specificity — 89.0% (83,5-94,5). In a comparative study of the diagnostic capabilities of ANN with M-APACHE II, I nfection Probability Score and SIRS 3-4 revealed

statistically receptacle and chimye differences — P=0,03, P=0,001 and P=0,005 (Z-test), respectively [6].

Hong Wan-dong et al. (2013) developed based on SATD ANN for f-cast on zirovaniya persistent (greater than 48 hours) in organ failure and PAC ENTOV with AP [32]. The sample included 312 patientswith AP, as a result of factor analysis, 13 most informative were selected on the first day from the moment of admission to hospital. Endpoint tre ply INS (5-5-1) with five input parameters: age, hematocrit, blood glucose, urea, calcium, was trained on 312 examples. Feelings and telnost trained network was 81.3%, specificity — 98.9%, accuracy — 96.2%. The predictive accuracy have created INS (AUC=0,96±0,02) was significantly better than the model constructed on the basis logistich e tion regression (AUC=0,88±0,03, P <0,001, χ2) and APACHE II (AUC=0.83±0.03, P <0.001, χ2). The authors conclude that the established INS can be useful for predicting the development of persistent organ failure in patients with AP [32].

I.I. Lutfarahmanov et al. (2016) compared the discriminatory ability of the ANN with opportunities SOFA scales, RISSC and APACHE for prognosis and tion of cases of abdominal sepsis in patients with pancreatitis. Area under the curve di and operational characteristics made for the neural network model — 0,79±0,04; SOFA scales — 0,76±0,05; p=0.032, APACHE II scales — 0.67±0.05; p=0.036, RISSC scales — 0.60±0.06; p=0.001. According to the conclusion of the authors, the model of an artificial neural network made it possible to predict the development of abdominal sepsis with high efficiency in patients with severe AP [8].

Y. Fei et al. (2017) used ANN to predict the development of TPO m Bosa portal vein in patients with pancreatitis. The INS was more accurate in predicting the portal vein thrombosis as compared with the method logistich e tion regression. The area under the ROC curve was 0.849 (95% CI, 0.807-0.901) from the ANN, using logistic regression — AUC=0.716) (95% CI, 0.679-0.761) [16].

5. Discussion

ANN are used for the diagnosis and treatment of patients with inflammatory diseases of the pancreas GOVERNMENTAL s almost 25 years. Initially developed for the INS of claim definiteness informativeness laboratory indicators in the diagnosis of acute AP and CP [23]. In the following, the main focus of research was the early prediction of disease severity AP with allocation of patients who on the last e blowing will be diagnosed and lightweight AP (mild acute pancreatitis) or I am a heavy OD (severe acute pancreatitis). At the same time, the definition of severity of AP was first carried out indirectly through the length of stay of patients in the hospital [24, 31], the likelihood of a lethal outcome [25]. E V after blowing researchers classification SS "Atlanta 1992" was used to the prediction, primarily heavy AP [10, 22, 27]. INS have also been used to predict the possible development of infectious complications AP for the purpose of timely prospect of prophylaxis, as well as for the diagnosis of transition sterilepancreatic necrosis in infected pancreatic necrosis for the purpose of treatment correction [6].

In recent years, there has been an improvement in the prognostic accuracy of INS in AP and exacerbation of CP compared with traditional scales (Ranson,

Glasgow), the severity scales of the physiological state of patients (APACHE II). If the first publications on the use of ANNs artificial no minutes ronnye network not demonstrated significant differences with conventional scales [23, 24, 25, 31],then in the subsequent all authors noted prognostic e skoe superiority ANN [6, 8, 10, 16, 22, 27, 32].

However, all of the research on the use of ANN in the n th turn-down Pancreatology has certain drawbacks and limitations. First, the data of all studies were evaluated retrospectively, which could lead to known biases in the results. Second, the data is received and were in hospitals of different levels, which raises questions about the Play izvodimosti techniques based on data from other clinics. Third, the sample size in most studies was insufficient to carry out an in cheniya and testing ANN, not all studies ANN training and testing was carried out in different patient populations. Finally, development problems pancreatitis conjugate greatly with the appearance of various camping vmeshivayuschi x factors (konfaunderov), mainly related to pa pluricausal Vitia of inflammatory diseases of the pancreas expressedheterogeneous samples of patients with AP and CP. Assess the degree of influence on the end result of various intervening factors is usually extremely difficult [19, 30].

6. Conclusion

The development and implementation of intelligent DSS based on the use of ANN is a promising direction for improving the prognosis, d and agnostics of AP and CP and their complications. However, further improvements are needed in view of the disadvantages the INS previous studies, the development of simple, accurate and maximally approx and conjugated to a workplace computer specialist doctor decision support systems in the diagnosis and treatment of pancreatic diseases.

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Intelligent medical systems in diagnosing and treating inflammatory diseases of the pancreas (systematic review)

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Keywords: intelligent decision support system, artificial neural networks, acute and chronic pancreatitis, diagnostics, treatment

This paper is a systematic review of the literature on the use of intelligent medical systems in the diagnosis and treatment of acute inflammatory pancreatic diseases. The author provides modern literature data on the efficacy of decision support systems based on artificial neural networks to determine the severity, diagnosis and outcome prognosis of pancreatitis and complications.