Review

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Foreign Body Airway Obstruction: Modern Principles and Approaches to First Aid and Dispatcher Assistance on First Aid

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ABSTRACT Foreign body airway obstruction (FBAO) is one of the most common causes of accidental death in adults and children. Probability of saving a life in severe FBAO depends on the ability of the bystander to quickly recognize the problem and correctly provide first aid (FA) to the victim. However, due to the lack of knowledge and skills of the FA, bystanders rarely attempt to give necessary help. Along with mass FA training, provision of instructions on the FA to untrained bystanders over the telephone by emergency medical services (EMS) dispatchers can facilitate active involvement of the population in the process of providing FA. In this study, a detailed analysis of the modern principles and approaches to the provision of the FA in FBAO was carried out and a draft of a universal Russian-language algorithm for remote dispatch support of the FA was developed. The developed algorithm can become a component of the domestic program for remotely instructing the population on provision of FA in life-threatening conditions and is proposed for further testing and implementation in the practice of EMS dispatchers.

Keywords: algorithm, dispatcher, bystander, witness, first aid, emergency medical services, airways, foreign body, obstruction, asphyxia

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AW - airway
FB – foreign body
FBAO – foreign body airway obstruction
FA – first aid
CPR – cardiopulmonary resuscitation
EMS – emergency medical services

INTRODUCTION

Foreign body airway obstruction (FBAO) is not included in the official statistics of the Russian Federation as an independent cause of death, but is absorbed by the heading “Consequences of foreign body penetration through natural openings” [1], which does not allow us to define the place of this pathology in the structure of mortality of the country's population. Judging by foreign data, with a relatively low overall incidence of fatal FBAO (from 0.1 to 0.8 cases per 100,000 population per year [2–4]), this problem is one of five leading causes of death due to an accident [5]. Mortality from FBAO accompanied by a call for emergency medical services (EMS) among adult victims exceeds 3% [6].

The cause of fatal FBAO, as a rule, is the aspiration of food fragments into the airway (AW) [5]. In adults, death due to FBAO is often caused by obstruction of the AW lumen by meat or fish [4]; in children, by sweets, nuts, and grapes [3, 7]. There are differences between countries in the products that most often cause fatal AW obstruction, which is explained by national identity and dietary traditions [7–9]. FBAO risk factors in adults include Alzheimer's disease, Parkinson's disease, acute cerebrovascular accidents, seizure disorders, cerebral palsy and other neurological diseases, developmental disorders, including intellectual disabilities, schizophrenia, intoxication (eg, alcohol), use of psychotropic drugs, poor dental health, old age (the incidence of fatal FBAO among population age 65 and over is approximately 7 times higher than among younger adults) [2,4–6,10–15].

Children constitute a higher risk group for FBAO [11]. Unlike an adult, a child has a narrower AW lumen, and the force of expulsion of the foreign body (FB) from the AW when coughing is less [15,16]. Most FBAO cases in children (57–75%) occur in the first three years of life [16,17]. As for children choking on a piece of food, this may be due to the absence of molars and undeveloped ability to chew [3,16]. In addition, while learning about the world, young children manipulate with various objects and often introduce them into the AW. As a result, objects other than food, including toys, are often the cause of AW obstruction in children (for example, latex balloons are one of the common causes of fatal FBAO in children) [18]. Given a relatively high incidence of FBAO in children, if a child has a sudden onset of acute respiratory failure or loss of consciousness in combination with the absence of normal breathing, FBAO should be suspected [19].

Fatal FBAO in most cases develops in the presence of witnesses [4]. Timely performance of simple first aid (FA) maneuvers by FBAO witnesses has proven very effective [6] and has a clear beneficial effect on the outcome of this critical condition [20, 21]. Conversely, delay of FA reduces the chances of survival for patients with severe FBAO. The probability of FB removal from the AW decreases over time due to the progression of the AW edema and suppression of the victim’s own active attempts to expel the FB from the AW [15]. A longer duration of obstruction determines a greater risk of developing a vegetative status and death due to critical hypoxia [22]. To prevent those complications, the patency of the airway must be restored within a few minutes after the development of the life-threatening obstruction (calculated performance target - no more than 4 minutes [22]), which determines the need for assistance before EMS arrival. However, FBAO eyewitnesses often do not attempt to provide FA [5, 7, 22, 23]. This may be due to the poor awareness of the population about the problem of FBAO and the importance of providing FA in this condition, as well as a lack of knowledge and skills in FA as a result of limited coverage of the population with quality FA education. Domestic studies testify to the low availability of FA training and insufficient competence of the population in FA provision, including for FBAO [24–29].

Along with creating conditions for promoting FA and mass education in the principles and rules of FA provision [9, 11], and improving the mechanisms of legal incentives for the population to get official FA training and provide FA [30, 31], implementation of practices of providing untrained eyewitnesses with instructions on FA by emergency dispatchers over the phone can contribute to the wide involvement of representatives of the general population in the process of providing FA [22, 32]. The organization of the domestic program of FA dispatching support involves the creation of algorithms for remote interviewing and instructing witnesses of life-threatening conditions, including FBAO.

The **aim** of this work is to analyze the scientific experience that characterizes the modern principles and approaches to FA provision in FBAO, and the development of a universal Russian-language algorithm for FA dispatching support in FBAO.

MATERIAL AND METHODS

In June 2022, a search was made for original articles, scientific reviews, abstracts and practical recommendations on the research topic in Russian and English. The publication search strategy is presented in Table 1.

Table
Search Strategy of the Research

Language	Reference databases	Keyword combinations
English	*Google Scholar* *PubMed* *Scopus*	*(foreign body OR choking) AND (dispatch OR dispatcher OR telecommunicator) AND (instructions OR guidance OR assistance OR advice)*
Russian	*Google Scholar* *eLibrary.ru*	1. (инородное тело) AND (диспетчер) AND (инструкции OR консультирование OR поддержка OR рекомендации) 2. диспетчер AND первая помощь

Additionally, a web search was performed in Google for foreign sets of practical recommendations and protocols for EMS dispatchers containing pre-arrival instructions on FA provision to eyewitnesses of the incident (search keywords: (EMS) AND (dispatch OR dispatcher OR telecommunicator) AND (instructions OR guidance)).

RESULTS

The search for literature in both languages did not reveal any scientific publications describing the organization, process or effects of FA dispatching support in FBAO. It is mentioned in several papers that instructions by telephone for FA provision in FBAO is a common practice for EMS dispatchers in the USA [33, 34] and Japan [35]. Further, we will consider the modern principles of providing FA in the event of FBAO and present a draft domestic algorithm for FA dispatching support for this condition, based on the results of our analysis of international recommendations on FA and English-language practical recommendations/protocols for EMS dispatchers available on the Internet.

MODERN PRINCIPLES AND RECOMMENDATIONS FOR FA PROVISION IN CASE OF FBAO

The approach to FA provision in FBAO depends on the age of the victim and the severity of the obstruction, which, in turn, is determined by the degree of AW narrowing. Incomplete obstruction involves the movement of a certain volume of air through the AW lumen, which maintains the oxygenation of vital organs [15, 36]. In case of mild incomplete AW obstruction, consciousness and spontaneous breathing of the victim are preserved, and manifestations of obstruction may include coughing, wheezing, retching, and inspiratory stridor caused by turbulent airflow eddies caused by narrowing of the AW lumen [15, 37].

Severe (complete or almost complete) airway obstruction is characterized by the victim's inability to speak, weak cough or no cough, critical difficulty in breathing or lack of breathing, cyanosis [36, 38–40]. In severe AW obstruction, biphasic inspiratory-expiratory stridor may be heard at the level of the glottis, subglottic space of the larynx, or upper trachea [37]. Complete AW obstruction leads to rapid progression of hypoxia. If the obstruction is not removed, the initial psychomotor agitation is replaced by depression and loss of consciousness within a few minutes, and then cardiac arrest occurs [13, 36].

Early recognition of the problem by bystanders is essential for the timely FA provision in FBAO. Possible FBAO is characterized by the sudden (usually during eating, and in children also while playing with small objects) appearance of the above symptoms which can be combined with the so-called "universal sign" when the victims grab themselves by the neck with one or both hands [13, 15, 38, 40, 41]. In order to make sure that the problem is caused by FBAO, it is recommended to ask the victim the question "Are you choking?" before FA provision [13, 36, 39].

Coughing significantly increases the pressure in the AW and is an effective mechanism for FB removal, therefore, a victim with non-severe FBAO who is conscious and coughing should be instructed to continue coughing [13, 36, 39-44]. Additional actions aimed at FB removing (see below) are not recommended in such cases in order to avoid complications [13, 42], but it is necessary to constantly and closely monitor the victim' condition, since the obstruction can worsen up to the complete blocking of the AW lumen [13, 39, 41].

If the cough is ineffective and the victim, being conscious, shows signs of severe AW obstruction, it is necessary to perform up to five strong successive blows with the base of the palm between the shoulder blades, and in case this technique does not produce results, perform up to five abdominal thrusts (the Heimlich maneuver [45]) [13, 36, 39, 43, 44]. Similar to coughing, these procedures are aimed at increasing intrathoracic pressure and pushing FBs out of the AW [42]. Approximately 50% of FBAO cases cannot be managed using only one of these methods [46], therefore, it is recommended to alternate five blows between the shoulder blades and five abdominal compressions until the FB is removed, medical help arrives, or the victim's condition worsens (loss of consciousness) [13, 36, 39, 44].

For children over one year of age in consciousness, with severe FBAO, the same approach to removing FBs from the AW is recommended as for adult victims (alternating blows between the shoulder blades and abdominal compressions). However, the Heimlich maneuver is not recommended for helping children of the first year of life due to a higher risk of damage to internal organs [38, 42–44]. Abdominal thrusts should also not be used when providing FA to pregnant women due to the risk of fetal injury [43]. Chest compressions are a substitute for the Heimlich maneuver for children under one year of age and pregnant women [13, 38, 40, 42]. For infants, chest compressions are performed in the same way as in case of cardiac arrest (pressure with two fingers on the lower half of the sternum), but with less frequency, for pregnant women - by grasping and circular compression of the chest with both hands (similar to the Heimlich maneuver, but at the level of the chest) [13]. The same technique is applicable to cases of providing FA to overweight people, when people giving assistance cannot wrap their arms around the victim's stomach [13, 38].

To increase the chances of FB removal from the AW of young children, when performing blows between the shoulder blades and chest compressions, they should be placed lying (on the stomach and on the back, respectively) on the knees of the person providing assistance, so that the head of the child is located below his body [13, 41, 42, 44]. It is not recommended to turn the child upside down, holding him by the legs [13]. Adult victims during blows between the shoulder blades and the Heimlich maneuver should be in a position with the body tilted forward [39, 44].

In severe AW obstruction, the importance of FB removing to save the victim’s life prevails over the risk of possible injuries caused by the above methods [13]. However, given that abdominal and chest compressions can cause trauma to the internal organs, victims who received FA using these techniques need to undergo an urgent medical examination after the event [13, 36, 39, 44].

Along with performing techniques aimed at removing FB from the AW, in case of severe FBAO, it is necessary to call the EMS as soon as possible. The person providing FA must entrust the call to the EMS to another witness of the incident, and in the absence of another eyewitness, call the ambulance on one's own, using the speakerphone function of the phone, so as not to delay FA provision [40, 44].

If the victim with FBAO is unconscious and has no normal breathing, immediate transition to the complex of basic cardiopulmonary resuscitation (CPR) is indicated, including hand pressure on the victim's sternum and artificial breaths [13, 36, 39, 41, 43, 44]. Sternum pressure can provide an increase in AW pressure sufficient to remove the FB and is more effective than abdominal compressions [47]. When assisting a child, CPR should begin with five successive artificial breaths, followed by transition to hand pressure on the sternum [40, 42, 44]. Before starting CPR and periodically during resuscitation, a quick examination of the victim’s oral cavity is recommended [13, 36, 38, 43]. If the FB is found in the oral cavity, it should be removed with fingers under visual control. Conversely, blind fingering attempts to remove the FB are contraindicated as they may exacerbate the AW obstruction and damage soft tissues.

In the Russian Federation, FBAO is included in the list of conditions under which FA is provided, which is approved by the Order of the Ministry of Health and Social Development dated May 4, 2012 No. 477n [48] (the original wording in the Order is “foreign bodies of the upper respiratory tract”). The list of measures for FA provision approved by this Order includes techniques for restoring and maintaining the AW patency (tilting the head with chin lift, protrusion of the lower jaw and giving a stable lateral position), but it does not contain such effective measures to remove FB from the AW as blows between the shoulder blades, abdominal compressions and examination of the oral cavity with FB removal by fingers under visual control. Considering that the official list of FA activities may determine the content of FA training programs and related training materials, it is possible that these important methods of assistance will be left out of the training process for people who may face the situation of FBAO in the future. Hence the need to revise the current list of activities for FA provision in

order to form an exhaustive list of measures aimed at FB removal from the AW, which have proven their effectiveness and are recommended by the international scientific and medical community.

DRAFT ALGORITHM FOR THE DISPATCHING SUPPORT OF FA IN FBAO

In order to develop the universal Russian-language algorithm for remote dispatch support of FA in FBAO, we performed a comparative analysis of the sets of foreign practical recommendations/protocols for EMS dispatchers, which contain instructions on FA over the phone for witnesses of the incident [19, 49-52], and current international guidelines on FA. An analytical table presenting the comparison results is published online in the Mendeley Data repository [53].

The analysis showed that dispatcher recommendations/protocols have a similar structure and content, and provide for the following sequence of verbal interaction between the dispatcher and the eyewitness of the incident calling the EMS: 1) initial interviewing the eyewitness in order to determine the reason for seeking help, the address of the incident, the approximate age of the victim; 2) further interviewing the eyewitness in order to promptly assess the consciousness and breathing of the victim and identify signs that characterize the severity of AW obstruction, including the victim's ability to speak and cough; 3) identification of the telephone number and name of the eyewitness and sending the EMS team to the call; 4) offering and, if the eyewitness agrees, providing instructions on FA, appropriate to the condition and age of the victim.

It has been found out that in a number of cases, dispatcher recommendations/protocols are not consistent with the current international FA guidelines which formulate the optimal principles and approaches to FA provision based on the results of the systematic expert analysis of scientific experience. In particular, dispatcher recommendations/protocols do not include instructions for performing some of the currently recommended techniques aimed at removing FBs, namely: instruct the victim to continue coughing in case of non-severe AW obstruction (this instruction is included in 2 out of 5 sets of dispatcher recommendations/protocols analyzed); use palm-bottom blows between the shoulder blades as the first move for severe AW obstruction in children over one year old and conscious adults (0/5); alternate blows between the shoulder blades and abdominal compressions for severe AW obstruction in children over one year old and conscious adults (0/5). In addition, none of the five sets of dispatcher recommendations/protocols available contain an instruction for the eyewitness to turn on the speakerphone on the phone in order to simultaneously communicate with the dispatcher and provide FA.

It should be noted that neither the analyzed dispatcher recommendations/protocols, nor the international guidelines on FA include such measures as positioning the victim with the body tilted forward in cases of non-severe FBAO (recommended for severe FBAO when performing blows between the shoulder blades and the Heimlich maneuver [39, 44]) and oral examination to remove the FB under visual control in cases of severe FBAO in conscious victims (recommended for FBAO in unconscious victims [19, 38, 50-52]). At the same time, the latest International Consensus on CPR [43] contains a recommendation according to which people providing assistance in FBAO should consider the possibility of extracting FBs visible in the oral cavity by hand. Considering that these actions are simple, can be quickly performed, and increase the likelihood of resolution of AW obstruction [43, 54], their inclusion in the sequence of FA provision in FBAO seems appropriate.

Based on the results of our comparative analysis of dispatcher recommendations/protocols and international guidelines on FA, taking into account the methodological recommendations of the Ministry of Health and Social Development "General principles for receiving appeal requests from citizens to ambulance stations (departments) and determining the reason for calling the EMS" [55], we developed the draft Russian-language algorithm for dispatching support of FA in FBAO (Fig.1).

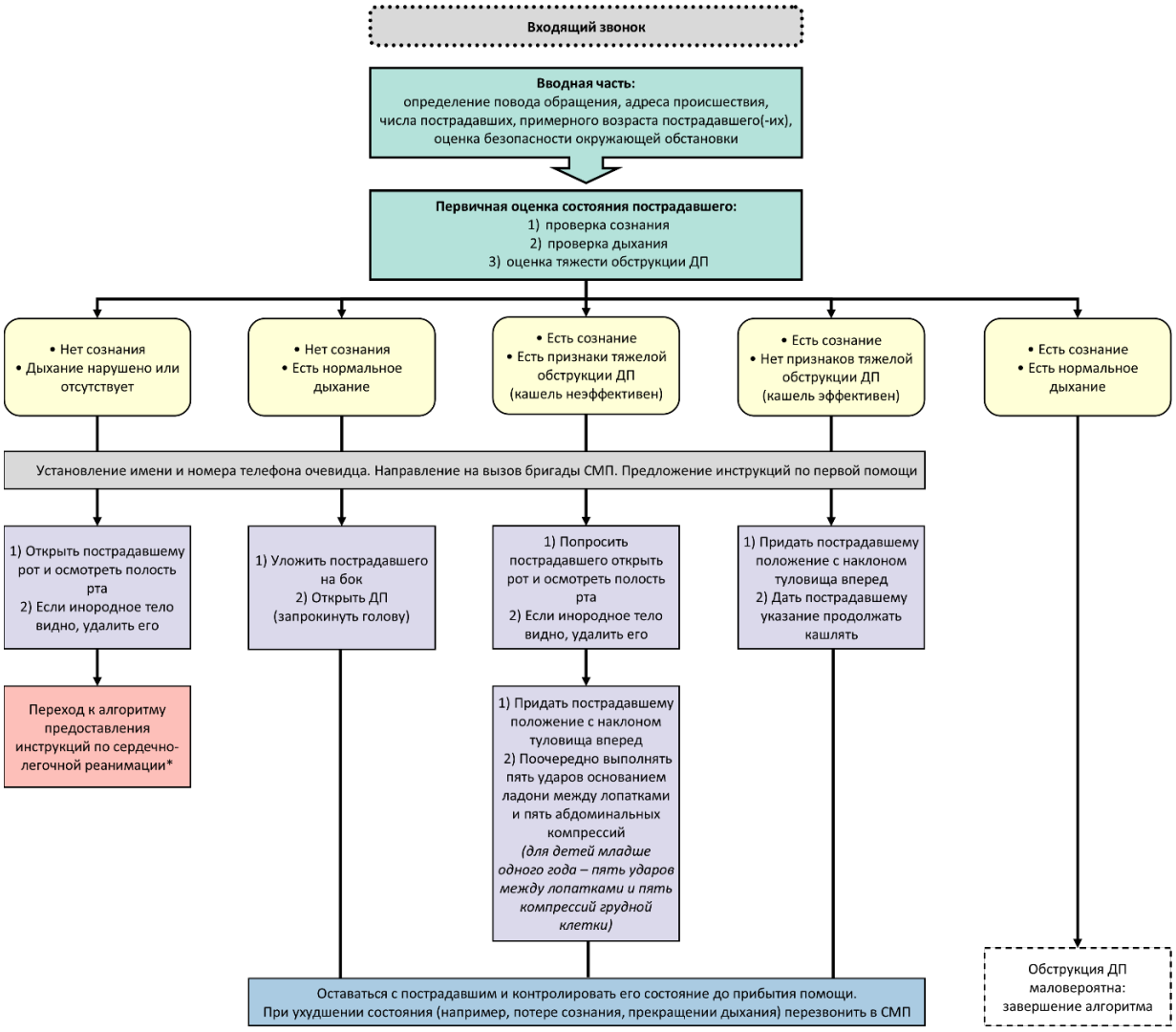

Fig. 1. Algorithm for remote dispatcher interviewing and instructing of eyewitnesses on first aid for foreign body airway obstruction

Notes: * — The principles of providing instructions for cardiopulmonary resuscitation by telephone, including the corresponding dispatcher algorithm in Russian, are described in previous publications [56–58]. ДП — respiratory tract; СМП — emergency medical services

Execution of the algorithm involves a sequential questioning of the eyewitness of the incident by the EMS dispatcher and brief instructions on FA, the volume and content of which are determined by the severity of the condition and the age of the victim.

Figure 2 shows an example of algorithmic support of FA by the EMS dispatcher over the phone in case of severe FBAO.

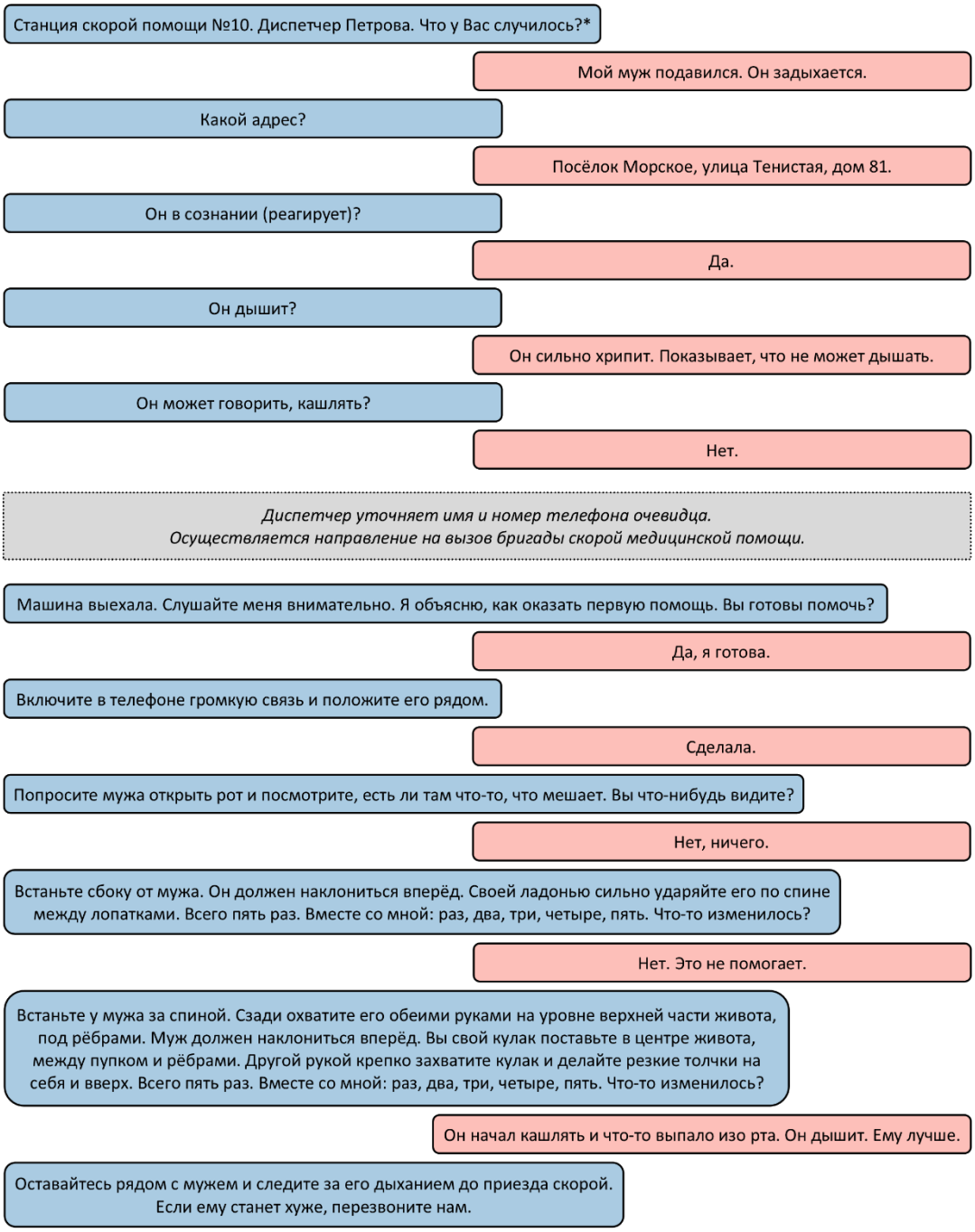

Fig. 2. The sequence of remote interviewing and instructing the eyewitness of the incident by the EMS dispatcher in case of severe foreign body airway obstruction in an adult victim

Note: * — According to the recommendations of the Ministry of Health of Russian Federation, which determine the general principles for receiving appeals from the public by ambulance dispatchers [55], upon receipt of an incoming call, the dispatcher must introduce himself (give his last name or personal number) and name the place where the call was received (name of the EMS station or department)

CONCLUSION

Foreign body airway obstruction is a potentially fatal but preventable critical condition in which the likelihood of a favorable outcome depends on the promptness and correctness of first aid provision by bystanders. The introduction of the practice of remote algorithmic questioning and giving instructions on first aid to eyewitnesses of foreign body airway obstruction by emergency medical service dispatchers should help to increase the frequency, efficiency and quality of care and reduce mortality in this condition. The developed universal algorithm for dispatching support of first aid in case of foreign body airway obstruction can be recommended as a component of the national program of remote instructing the population on first aid in life-threatening conditions and is proposed for further testing and use in the work of emergency medical service dispatchers.

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