

**ARTYKUŁ POGLĄDOWY/REVIEW PAPER**

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***A topographically oriented, simple and informative formula to describe a difficult airway: F.R.O.N.T.*****Peter Biro**

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**Abstract**

Description of airway difficulties and their subsequent (either successful or unsuccessful) handling may be a matter of lengthy prose. The involved morphological and functional elements, the severity of the airway related problems, as well as the possible technical means to cope with them may consist of many details. Therefore a different airway difficulty formula would be useful, which describes and summarizes features related to airway difficulty in a morphological and functional context. The information encrypted in the airway difficulty formula presented here should be more descriptive (eventually on the expense of accuracy in strictly quantitative terms) and also should enable the reader to imagine suitable alternative techniques of oxygenation and airway securing for the indicated specific problem. The herein proposed “FRONT” airway difficulty formula is very simple, short but contains the essential information for future handling of the case. The formula is composed by 5 capital alphabetic characters (F for “face”, R for “row of teeth”, O for “oral cavity”, N for “neck” and T for “trachea”) indicating the place of manifestation of airway related problems (called here “categories”), which in turn can be amended with an ordinal scale of subscript numerals (0, 1, or 2) that roughly indicate a degree of severity. The formula represents concentrated information about a difficult airway that has been encountered by the reporting person. Besides it can be used as a predictor for a difficult airway if the patient is examined in the frame of the pre-anesthetic evaluation by an anesthetist. *Anestezjologia i Ratownictwo 2012; 6: 182-187*

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**Introduction**

Unfortunately, most anaesthesiologists fail to produce a comprehensive and informative report about encountered airway problems. It is also difficult to obtain a helpful message about a suspected airway problem from a pre-operative evaluation done by a third person. Thus the essential information about reported, assumed or suspected airway difficulties often remains undocumented or is inadequately formulated. Hence, there is a need for a standardized, simple and concise message or formula that envisages at the first glimpse the location and degree of airway problems that might occur in a certain case. This formula

should be useful for both, to predict (a priori) a possible difficult airway based on preoperative investigations, as well as to describe (a posteriori) a difficult airway that has been encountered by the reporting person.

The idea to find such a formula is not new. El Ganzouri et al. [1] made already in the mid nineties such an attempt by suggesting an airway difficulty index. He extracted and analysed airway related risks from 10'507 cases, which became the basis of an airway difficulty prediction analysis. They identified features and circumstances such as the degree of mouth opening, thyromental distance, oropharyngeal classification (e.g. Mallampati), neck movement, ability to prognath, and body weight. From these they could define risk

factors which finally were combined with data from history of difficult tracheal intubation. The correlation of these findings with the occurring difficulties during the subsequent airway procedures resulted in the definition of a composite multivariate airway risk index derived from nominalised odds ratios. The resulting index score represents the sum of the individual risk factor weightings and is expressed as a figure between 0 (for no risk) to 12 (maximal risk). The advantage of this score is that it gives a fair quantitative prediction of the overall risk for a difficult airway. However, it does not give any indication for the location, the nature and/or the specific reason of the impending airway management problem. And in the last instance it also doesn't contain any indication about airway techniques that might be feasible to cope with the problem. In general terms, the El Ganzouri index is a tool to predict and quantify the probability of airway difficulties without indicating details about the nature of the problem.

Therefore a different airway difficulty formula would be useful, which describes and summarizes features related to airway difficulty in a morphological and functional context. The information encrypted in the airway difficulty formula presented here should be more descriptive (eventually on the expense of accuracy in strictly quantitative terms) and also should enable the reader to imagine suitable alternative techniques of oxygenation and airway securing for the indicated specific problem.

### The proposed FRONT airway difficulty formula

The herein proposed "FRONT" airway difficulty formula is very simple and short, but still informative. For the latter purpose, it was important to include 2 essential types of information: 1. an indicator for the anatomical location of the problem and 2. another one about the severity of the problem. This consideration led to the simplest possible combination of 2 denominators: a character for the first, and a subscript numeral for the second denominator, something analogue to similar codes such as the TNM classification of tumours.

Usually, there is a dilemma between quantity and perceptibility of information in the sense that the more details the message contains, the more difficult it is to perceive its essence at once. The FRONT formula lays more emphasis on perceptibility, instead of richness

in the details of the transmitted information. This is particularly important according to the conception that in airway management a rapid recognition and understanding of a problem is more relevant than the immediate knowledge of secondary details. Therefore, the main emphasis is not the quantitative aspect of the airway difficulty (predictive value), but the location and the functional perspective of the underlying problem (descriptive element), as it has been demonstrated by previous authors [1,2]. Although the herein proposed formula also contains a semi-quantitative component by displaying numerals for the severity of certain features, it's not intended to sum them up for a total score. Nevertheless, a certain quantitative aspect for expected airway problems can be sensed from the presented combination of morphological, functional and severity indications.

The formula is composed by 5 capital alphabetic characters (F, R, O, N and T) indicating the place of manifestation of airway related problems (called here "categories"), which in turn can be amended with an ordinal scale of subscript numerals (0, 1, or 2) that roughly indicate a degree of severity. By using capital characters for known details at a certain location or minuscule characters in case of uncertainty, we finally have a 3-dimensional acronym.

### The 5 topographical categories (F, R, O, N and T)

The 5 categories indicated by capital letters represent the morphological levels where a problem relevant to the airway might be located, thus not only denominating an anatomical landmark alone, but also indicating a functional aberration or pathology with a relevant effect at that specific place (Figure 1). The choice of alphabetic characters derives from the first letters of the involved anatomical landmarks. The order of mentioning from proximal (face) to distal (trachea) reflects the pathway through which airway devices are inserted. The 5 categories are:

- F = for **F**ace containing anything connected to the face such as lips, mouth, nose, cheeks, chin and in male patients the beard (that might be very relevant for face mask positioning and ventilation).
- R = for **R**ow of teeth containing anything connected to the teeth, their presence and/or absence, positioning, the alveolar gums as well as the inter-incisive distance. The latter may be caused by the

further remote located temporo-mandibular joint, however, its most relevant effect on managing the airway happens at the level of the dental ridge.

- O = for Oral cavity. Hereto belong anything behind the teeth and above the epiglottis such as the palate, palatal arches, tonsils, tongue and tongue base.
- N = for Neck considering the shape, length, and most important, the mobility of the cervical spine.
- T = for larynx and Trachea containing the upper airway below the epiglottis and above the carina, thus indicating features that might be relevant for the insertion and positioning of a tracheal tube.

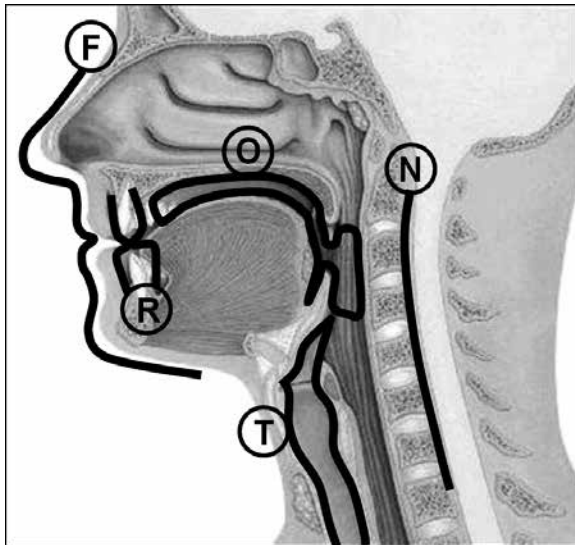


Figure 1. The 5 categories F, R, O, N and T indicating the topographic levels, where a problem relevant to the airway might be located

### Two levels of certainty

If the status of a category is unclear, inaccessible or unknown, the character should be set into the minuscule version (e.g. “t” instead of “T”). This is in particular important to distinguish it from a clearly known “normal” situation. Obviously, this marking is not to be assigned to F because facial problems are always visible. The same is probably true for N because cervical flexibility is also easily recognised. But for the categories R, O and T it might be more or less possible to remain obscure. At level R, a reduced inter-incisive gap might be related to a pain problem which would

be solved only after induction of anaesthesia – which is a circumstance that cannot be predicted by simple observation. Airway obstruction of a degree that doesn’t cause stridor (but might cause difficulties to intubation) might remain totally unnoticed, unless laborious imaging investigations are carried out in advance. For this reason, this marking for unknown severity seems to be useful and justified.

### Three subscript numerals

The subscript numerals indicate the severity degree of the problem as related to the intention to secure the airway by the usual means of airway management such as face mask ventilation, direct and indirect laryngoscopy, visualisation and recognisability of the glottic entrance and passage, insertion of a laryngeal mask and positioning of a tracheal tube (or other means of securing the airway). Thus the values represent

- 0 = normal level of (or simply no) difficulty to perform any standard airway procedure. To keep things simpler and the appearance of the whole formula better legible, the “zero” numeral is set here in parenthesis because it can be also omitted when the involved conditions are considered as normal. According to this the absence of the subscript numeral means “0” (zero).
- 1 = moderate level of difficulty to perform any of the mentioned procedures related to management of the airway, that might necessitate the application of alternatives other than the standard technique and/or the involvement of an expert.
- 2 = high level of difficulty (or probable inability) to perform any of the mentioned standard procedures related to management of the airway, that certainly will necessitate the application of alternatives to the standard techniques and the involvement of an expert.

The numerals should be principally interpreted as ordinal values, and not in a strictly mathematical sense. Therefore, multiple numerals should not be summed. Instead, they represent mere a dimensionless category such as 0 = “none” or “normal”, 1 = “moderate” and 2 = “extreme”. For this reason, the magnitude of a numeral is meant only for that specific location, and cannot be compared with the same numeral in another level (e.g. the subscript 2 in R<sub>2</sub> for a very reduced inter-incisive gap might cause less problems with managing the airway than in T<sub>2</sub> describing a severe subglottic

stenosis). Having this limitation, the formula should be viewed just as a code.

## Combinations of characters and numerals

### F for 3 facial situations:

- F = normal facial configuration.
- F<sub>1</sub> = a facial configuration that would cause a moderate level of difficult face mask ventilation (e.g. beard, obesity).
- F<sub>2</sub> = a facial configuration that would cause a high level of difficult face mask ventilation (e.g. facial scars, microstomy, tumour of the nose, dysmorphic mandible), obviously difficult or impossible access for laryngoscope, laryngeal masks or similar devices.

Indicators for difficulties of this kind are well visible aberrations of facial morphology.

### R for 3 row of teeth situations:

- R = normal (complete) row of teeth or edentulous upper and/or lower alveolar ridge in a row, which even might facilitate intubation beyond the normal situation.
- R<sub>1</sub> = a row of teeth that would cause a moderate level of difficult laryngoscopy (e.g. single teeth precluding easy laryngoscopy, prominent incisors).
- R<sub>2</sub> = a row of teeth that would cause a high level of difficult or even impossible laryngoscopy (e.g. inter-maxillar fixation), or that may cause a similar problem with the insertion of a laryngeal mask. A reduced inter-incisive gap caused by a problem at the level of the temporo-mandibular joint qualifies also for a R<sub>2</sub>, although the origin of the problem is the not at the teeth level. However, the place is relevant where the problem manifests itself as problematic circumstance to secure the airway, and in this case this happens at the level of row of teeth.

Indicators for difficulties of this kind are the dental morphology as can be seen directly and the degree of mouth opening (inter-incisive gap) as a result of temporo-mandibular joint mobility.

### O for 3 oral/oropharyngeal situations:

- O = normal oropharyngeal configuration.
- O<sub>1</sub> = an oropharyngeal configuration that would

cause a moderate level of difficult laryngoscopy and/or intubation (e.g. macroglossy, large tonsils). The insertion of a laryngeal mask or another supraglottic device can be unaffected at this level.

- O<sub>2</sub> = an oropharyngeal configuration that would either preclude laryngoscopy and intubation or that would cause a high level of difficult laryngoscopy and/or intubation, as well as difficult or impossible insertion of a laryngeal mask or another supraglottic device. This is the case e.g. in sub-mandibular or tonsillar abscess, immobile tongue as after radiation therapy, situation after operations at the level of tongue base and mouth floor.

Indicators for difficulties of this kind are the Mallampati score, various images of the mouth cavity and pharyngeal region (e.g. X-rays, CT and MRI).

### N for 3 neck (cervical region) situations:

- N = normal neck.
- N<sub>1</sub> = a neck that would be associated with a moderate level of difficult laryngoscopy and/or intubation (short neck or anterior glottis position, morbid obesity, reduced cervical mobility < 25° in each direction of the sagittal plane). The insertion of a laryngeal mask or another supraglottic device can be unaffected at this level.
- N<sub>2</sub> = a neck that precludes direct laryngoscopy and/or intubation as well as difficult or impossible insertion of a laryngeal mask or another supraglottic device (e.g. fixed cervical spine, morbus Bechterew).

Indicators for difficulties of this kind are Patil's sign, the degree of cervical mobility and the profile silhouette of the region.

### T for 3 laryngeal/tracheal situations:

- T = normal larynx and/or trachea.
- T<sub>1</sub> = a larynx and/or trachea that would be associated with a moderate level of difficult laryngoscopy and/or intubation (vocal cord paralysis, small laryngeal tumours, moderate subglottic narrowing or tracheal stenosis). The insertion of a laryngeal mask or another supraglottic device is usually unaffected at this level, but advancement of tracheal tubes might be problematic (need for a narrow tube).
- T<sub>2</sub> = a larynx and/or trachea that precludes intubation (e.g. large and vulnerable laryngeal tumours,

grossly distorted larynx, more than moderate subglottic or tracheal stenosis). The insertion of a laryngeal mask or another supraglottic device might be unaffected, but ventilation could be difficult.

Indicators for difficulties of this kind are results of fibre-endoscopic evaluations and various kinds of images of the upper airway (e.g. X-rays, CT and MRI).

An additional remark is necessary for the case of multiple problems within the same location. In this case, the problem with the higher degree of difficulty (to manage the airway) is to be accounted. Here an example: A person without teeth who has an ankylosis at the temporo-mandibular joint would qualify for both, a "R" and a "R<sub>2</sub>" too. Thus, the formula should contain a "R<sub>2</sub>" in this case.

The FRONT formula can be very useful for various purposes. One essential use would be documentation and messaging. The formula represents very short and concentrated information about a difficult airway that has been encountered by the reporting person. Secondary, the formula can be used as a predictor for a difficult airway if the patient is examined in the frame of the pre-anaesthetic evaluation by an anaesthetist. Since in this case there is no practical experience with the case available, the formula totally depends on the expertise and skilfulness of the investigating person. Depending on the availability of sufficiently evident indicators, some of the categories might remain unclear and would be therefore marked with a low case character. The ultimate use of the formula, however, would be a strong hint for which kind of airway technique seems most suitable for that case.

### Three Examples

Any combinations of findings at different locations with various severity grades are possible. The normal patient would have the plain formula FRONT where the alphabetic characters display no numeral subscript (as suggested to be written if the numeral is a zero). This is probably a person who is easiest to be dealt with in terms of airway management. In contrast, the theoretically most difficult case would be a F<sub>2</sub>R<sub>2</sub>O<sub>2</sub>N<sub>2</sub>T<sub>2</sub>, but this combination is very unlikely to happen at all.

In the following are 3 cases listed, that occurred during the last 6 weeks in our department and which display different variations of the formula. The corresponding findings are explained in prose and the

adopted airway management technique that has led to success is also briefly mentioned.

#### ▪ Case 1: F<sub>1</sub>RO<sub>1</sub>Nt

Formula interpretation: face with certain difficulties for mask ventilation, normal row of teeth (or mouth opening), moderately difficult laryngoscopy and intubation conditions at oropharyngeal level, normal neck mobility, and no information about the situation at laryngeal or tracheal level.

Brief case description: A 46y old male obese patient (BMI 38) having a beard had to be operated for fixation of a fractured tibia. He rejected the regional anesthesia technique that was proposed initially. Inspection of the oral cavity revealed an edentulous upper gum, large tonsils and a Mallampati class #3. After lengthy pre-oxygenation, face mask ventilation was expectedly difficult and could be maintained only by two-handed holding of the mask and hand-bag ventilation by a second person. Thus, a SpO<sub>2</sub> between 89 and 92 was maintained with great effort. Laryngoscopy was assessed by the anesthetist as moderately difficult (Cormack-Lehane #3). Insertion of the tube was possible at the 2<sup>nd</sup> attempt with an ETT that has been mounted on a malleable guide bended upwards in a hockey stick shape. There was no further problem encountered with passing the ETT into the larynx and trachea (for this the "t" in the formula could subsequently be converted to "T"). The further course of anaesthesia and surgery, as well as the extubation passed uneventful.

Solving the problem: Thorough pre-oxygenation, 2-person face mask ventilation, use of a malleable stylet for direct laryngoscopic intubation.

#### ▪ Case 2: FR<sub>2</sub>ON<sub>2</sub>T

Formula interpretation: normal face, severe difficulty to be expected at the level of row of teeth and mouth opening, normal oropharyngeal situation, severely reduced neck mobility, and a normal situation at laryngeal and tracheal level.

Brief case description: After a car accident, a multiply injured 19y old female has been brought into the emergency room. She wore a stabilising cervical collar, had a GCS 11, and presented with a marginal hemodynamic stability. She had to undergo extensive X-ray and CT imaging to establish a detailed diagnosis. Airway management consisted in trans-nasal flexible fiberoptic intubation under topical local anaesthesia and analgo-sedation. Under extended invasive moni-

toring and adequate volume replacement, several limb fractures were diagnosed and operated. In the CT scan, the cervical spine appeared intact and the collar was removed. Finally the intubated and ventilated patient was transferred in stable conditions to the intensive care unit.

Solving the problem: The airway problem consisted in limitations caused exclusively by wearing the external neck stabilising collar. This device permitted only a much reduced mouth opening, as well as limited neck mobility. Therefore intubation with the flexible fibreoptic was adopted.

▪ **Case 3: FR<sub>1</sub>ONT<sub>2</sub>**

Formula interpretation: normal face, moderately difficult laryngoscopy and intubation conditions at the level of row of teeth or mouth opening, normal oropharyngeal situation, normal neck mobility, and a pathological process severely inflicting laryngeal or tracheal structures.

Brief case description: A 72y old male patient with stridor on physical effort due to a subglottic stenosis was scheduled for panendoscopy. Inspection of the oral cavity revealed an incomplete row of teeth with lone upper incisives. Face mask ventilation was easy. Upon laryngoscopy large tonsils were noticed, but a Cormack-Lehane view of the laryngeal aperture of

grade 2 was found. A suspension laryngoscope was inserted and supra-glottic high frequency jet ventilation (HFJV) was performed for the duration of the intervention. A subglottic scar originating from a previous tracheostomy cannula causing a narrowing of 50% of tracheal cross section area was visible. The surgeon widened the stenosis by laser light incisions of the scar tissue. To maintain control of the airway after surgery and before end of anaesthesia, a laryngeal mask #4 was placed.

Solving the problem: The potentially difficult passing of the stenosis was solved by avoiding tracheal intubation by using supra-glottic HFJV and a laryngeal mask airway.

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**Konflikt interesów / Conflict of interest**

Brak/None

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