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Research Article

Original Acid Exposure Assessment Indicator of Gastroesophageal Reflux on the Mucous Membrane of the Esophagus

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Abstract

Aim of the Study: The aim of the study was to evaluate the diagnostic value of the traditional indicators of acidity of daily pH - grams of the esophagus: % of the time from pH < 4, the generalized DeMeester index and a new indicator of acidity of daily pH-grams of the esophagus (PCP).

Material and Methods: The results of the analysis of pH-grams of the stomach and esophagus of patients with pathological parameters of daily pH-metry (DeMeester index >14.72; % of time with pH < 4 more than 4.5%) and with normal parameters of daily pH-metry (DeMeester index < 14.72; % of time with pH < 4 less than 4.5%). As PCU per diem rn-gram of the esophagus is proposed to use the sum of average daily concentrations of H+ ions (mmol/l) are abandoned in the esophagus of reflectata in the range of pH: 0,8 - 0,9; 1,0 - 1,9; 2,0 - 2,9 and 3.0 to 3.9 pH units and the time of exposure of reluctate on the mucosa of the esophagus within the specified ranges of pH of the esophagus.

Results: The use of PEP (mmol/l x hour) can provide in the analysis of the per diem rn-grams a more accurate estimate of the influence of pathological and physiological GER in the esophagus due to the use in the calculation of the panel average of the concentrations of H+ ions in the range of pH: 0,8 - 0,9; 1,0 - 1,9; 2,0 - 2,9; 3,0 - 3,9 and the time of exposure of reluctate on the mucous membrane of the esophagus in each of the specified ranges of pH.

Conclusion: The use of the generalized indicator DeMeester and% time with pH < 4 may lead to erroneous assessment of the results of the analysis of diurnal pH-gram of the esophagus due to the fact that average daily concentration of H+ ions of reluctate and the exposure time of reluctate on the mucosa of the esophagus within the specified ranges of pH are not included in the definition of the generalized indicator DeMeester and% time with pH < 4. It was found that the use of PCP in the analysis of daily pH-grams of the esophagus can provide a more accurate assessment of the impact of pathological and normal SER on the esophageal mucosa.

Keywords: *Daily pH-Metry; Hydrogen Ion Concentration H+*

Introduction

When analyzing the pH-grams in the esophagus, it is customary to use 6 parameters of the daily pH-metry: % of the time during which the pH is < 4; % of the time during which the pH is < 4 with the vertical position of the patient's body; % of the time during which pH < 4 with a horizontal position of the patient's body; total number of gastroesophageal refluxes (GER) with pH < 4 per day; the number of GER with pH < 4 lasting more than 5 min per day; the duration of the longest GER with pH < 4 and the generalized DeMeester index. Normal

pH values in the terminal section of the esophagus are 6.0 - 7.0 units pH [1]. It is believed that the total decrease in acidity below 4.0 units. pH should not exceed 4.5% of the total time of the daily pH-gram (~ 1 hour).

The authors of [2] found that the total time during which the pH in the esophagus is lower than 4.0 (normal < 4.5%) and the generalized DeMeester indicator (normal < 14.72) demonstrate a stable steady stepwise increase in indicators associated with an increase in the severity of damage to the mucous membrane of the esophagus.

According to the fundamentals of electrochemistry [3], acids having a pH < 2.0 are strong acids. Aqueous solutions of hydrochloric acid with pH < 2.0 are strongly acidic. Depending on the pH of the stomach on an empty stomach, the following criteria for the state of the acid-forming zone of the stomach were proposed (Table 1) [4].

Stomach Condition	pH Limits	Amount of HCl (%)
Strongly acid	0.9 - 1.9	0.56 - 0.036
Medium acid	2.0 - 2.9	0.036 - 0.0036
Moderate Acid	3.0 - 4.9	0.0036 - 0.000035
Slightly acidic	5.0 - 6.9	0.000036 - 0.00000036
Alkaline	7.01 - 8.0	-

Table 1: *The distribution of the initial state of the stomach, depending on the fasting pH in the area of the main glands.*

The mucous membrane of the esophagus is irritated due to the aggressive effect of hydrochloric acid on it, which is part of the gastric juice. The minimum pH in the gastrointestinal tract is 0.8 units. pH in the range from 0.8 to 3.9 units. pH, four ranges of pH of the refluxate in the esophagus can be distinguished: 0.8 - 0.9; 1.0 - 1.9; 2.0 - 2.9 and 3.0 - 3.9 units pH In accordance with the data of table 1 [4], the first two acidity ranges of 0.8-0.9 and 1.0 - 1.9 units. pH is characterized by a strongly acidic environment, the third range is 2.0 - 2.9 units. pH - medium acid medium and the fourth range of 3.0 - 3.9 units. pH - moderately acidic environment.

The value of the average daily concentration of H^+ reflux ions in the range from 0.8 to 3.9 units. pH varies from 158.5 to 0.126 mmol/L. Moreover, the acidity in the 1st range (0.8 - 0.9 pH units) can exceed the acidity in the 4th range (3.0 - 3.9 pH units) by 1260 times. Therefore, when assessing the degree of effect of acidic GER on the mucous membrane of the esophagus, it is necessary to take into account daily average concentrations of H^+ ions in the pH ranges: 0.8 - 0.9; 1.0 - 1.9; 2.0 - 2.9; 3.0 - 3.9 units pH and the duration of exposure to acid reflux on the mucous membrane of the esophagus in the indicated pH ranges. When determining % of the total time with pH < 4 and the generalized DeMeester indicator, the average daily concentration of H^+ ions of acid reflux and the duration of its effect on the mucous membrane of the esophagus in each of the pH ranges: 0.8 - 0.9; 1.0 - 1.9; 2.0 - 2.9; 3.0 - 3.9 units pH is not taken into account. It should be noted that previously new parameters were developed for the analysis of daily pH-metry, namely: the average daily pH of the stomach and esophagus, calculated by the average concentration H^+ ions [5,6].

Materials and Methods

In this work, to improve the accuracy of assessing the damaging effect of GER acid reflux on the esophagus mucosa, it is proposed to use the sum of the products of the average daily concentrations of H^+ ions (mmol/L) of acid reflux and duration (in hours) as a new indicator of the daily pH of the esophagus (PCP). Its effects on the mucous membrane of the esophagus in the pH range: 0.8 - 0.9; 1.0 - 1.9; 2.0 - 2.9 and 3.0 - 3.9 units pH.

It is the average daily concentration of H^+ ions (in mmol/l) of acid reflux and the duration of its effect on the mucous membrane of the esophagus in the pH ranges: 0.8 - 0.9; 1.0 - 1.9; 2.0 - 2.9 and 3.0 - 3.9 units pH should be taken into account when analyzing the results of the daily pH of the esophagus in order to assess the effect of GER on the damage to the mucous membrane of the esophagus.

Results

The modern Gastro-Scan software package, supplied as part of the instruments, can convert the pH values of the daily pH of the esophagus to the concentration of hydrogen ions H^+ and calculate the average pH levels from the average concentrations of H^+ ions in the pH ranges: 0.8 - 0,9 (strongly acidic pH levels); 1.0 - 1.9 (strongly acidic pH levels); 2.0 - 2.9 (moderate acidic pH levels) and 3.0 - 3.9 (moderate acidic pH levels).

Clinical examples

Let us consider the acidity indicators used in the diagnosis of acid-dependent diseases using examples. Average pH levels and their duration in the ranges: 0.8 - 0.9; 1.0 - 1.9; 2.0 - 2.9 and 3.0 - 3.9 units pH (Figure 1) are equal respectively: 0.8; 1.3; 2.3; 3.4 units pH and 0.0139; 0.039; 0.136; 0.103h. Patient K.'s esophageal acidity index (PEP) (Figure 1) is 158.49 mmol/L × 0.0139h + 50.119 mmol/L × 0.339h + 5.01 mmol/L × 0.136h + 0.398 mol/L × 0.103h = 2.2 mmol/L × h + 16.99 mmol/L × h + 0.68 mmol/L × h + 0.04 mmol/l × h = 19.91 mmol/l × h.

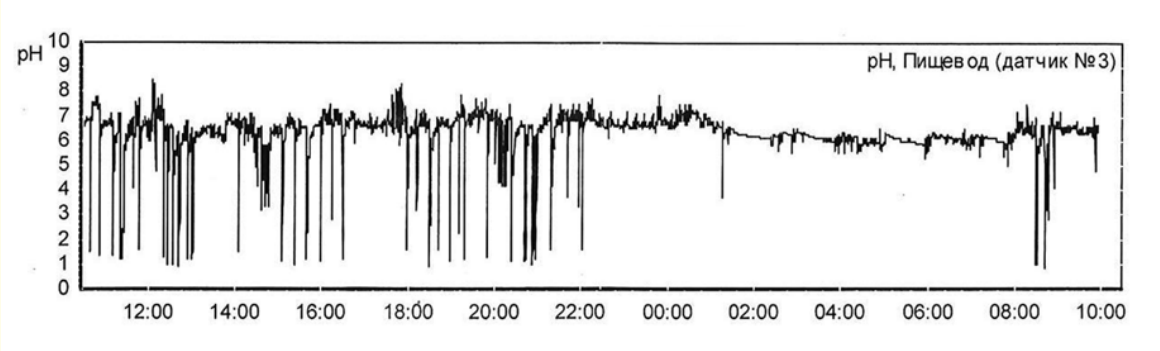

Figure 1: *Daily pH-gram of the esophagus of patient K., 48 years old.*

The proportion of strongly acidic GER in the PCP was 96.4%. From the above data it follows that most of the time (~ 60%), strongly acid reflux (pH 0.8 to 1.3 pH units) contacted the esophageal mucosa. Moreover, the proportion of medium-acid and moderate-acid GER in the PKP of patient K was only 3.6%. The presence of esophageal pathology is also confirmed by the value of 3.1 units calculated by the average concentration of H^+ ions of the esophagus per day, equal to 3.1 units. pH, at a rate of 6.0 - 7.0 units pH Time with pH < 4 in the range from 0.8 to 3.9 is 0.59 hours;% of time with pH in the range from 0.8 to 3.9 is 2.5%; daily average pH = 6.2; the generalized DeMeester indicator equal to 8.82 indicates the absence of pathology of the patient's esophagus K. However, the average pH per day is an incorrect indicator [5,6].

And indicators such as time, It was found that it is the sum of the products of the daily average concentrations of H^+ ions (in mmol/l) and their duration in the pH ranges: 0.8 - 0.9; 1.0 - 1.9; 2.0 - 2.9; 3.0 - 3.9 units pH is a more reliable indicator of assessing the effect of acid reflux on the value of damage to the mucous membrane of the esophagus than% of the total time with pH < 4 and the generalized DeMeester indicator.

With pH < 4 in the range from 0.8 to 3.9;% of time with pH from 0.8 to 3.9 and the generalized DeMeester indicator do not take into account the average daily concentration of H^+ ions (mmol/l) of acid reflux and the duration of its exposure on the esophagus in the pH ranges: 0.8 - 0.9; 1.0 - 1.9; 2.0 - 2.9; 3.0 - 3.9 units pH therefore these indicators may erroneously indicate the absence of pathology of the esophagus.

Analysis of the parameters of the daily pH-metry of patient I. Figure 2 showed that the PKP is 5.2 mmol/h. Average pH levels and their duration in the range of 1.0 - 1.9; 2.0 - 2.9 and 3.0 - 3.9 units pH equal to 1.6; 2.3; 3.3 units pH and 0.125; 0.37; 0.51 hours. It is seen that the majority (> 50%) of the esophageal mucosa was contacted by mild acid refluxate. The daily average pH of 3.7 calculated from the average concentration of H^+ ions also indicates moderate acid reflux. The percentage of time with a pH in the range from 0.8 to 3.9, equal to 4.2 and a generalized DeMeester of 13.55 are also in compliance.

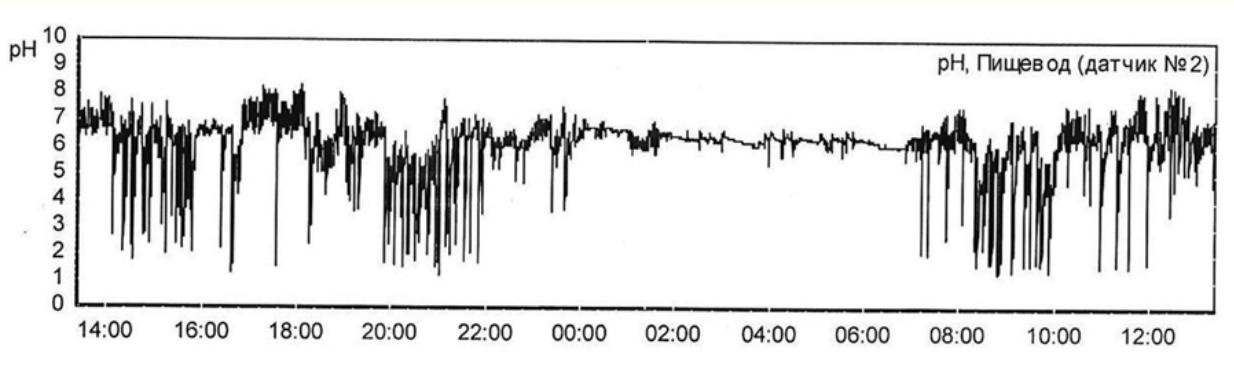

Figure 2: *Daily pH-gram of the esophagus of patient I., 30 years old.*

Analysis of the parameters of the daily pH-gram of patient X. Figure 3 showed that the total time with pH < 4 in the range from 0.8 to 3.9, equal to 0.975 hours, and% of time with pH in the range from 0.8 to 3.9, equal to 4.1%, do not exceed the established norms of pH-metry, and the generalized indicator DeMeester 15.53 exceeds the norm < 14.72. Average pH levels in the pH ranges: 1.0 - 1.9; 2.0 - 2.9 and 3.0 - 3.9 units pH and their duration are equal respectively 1.4; 2.2; 3.5 units pH and 0.236; 0.333; 0.4h. PKP of patient X. is 11.62 mmol/h. The total duration of medium-acid and moderate-acid GER (Figure 3) is ~ 76%. The proportion of strongly acidic GER in the PCP of patient X is 80.8%, which indicates pathological GER.

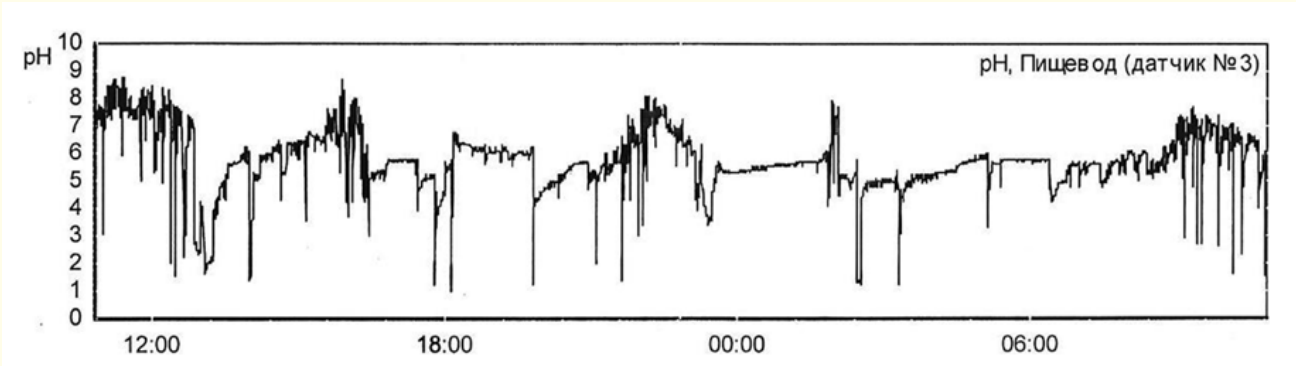

Figure 3: *Daily pH-gram of the esophagus of patient H., 28 years old.*

As a result of the analysis of the parameters of the daily pH-gram of patient B. Figure 4 it was found that the total time with pH < 4 in the range from 0.8 to 3.9, equal to 1.12 hours, and the percentage of time with pH in the range from 0.8 to 3.9, equal to 4.7%, exceed the norms of the generalized DeMeester indicator, and the generalized DeMeester indicator, equal to 12.47, indicates physiological GER.

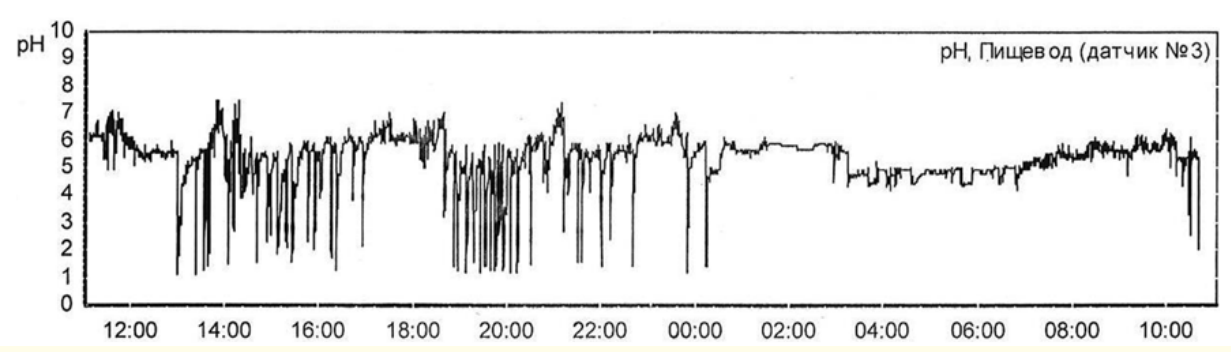

Figure 4: *Daily pH-gram of the esophagus of patient B., 45 years old*

Average pH levels and their duration for ranges: 1.0 - 1.9; 2.0 - 2.9; 3.0 - 3.9 units pH equal to responsible: 1.5; 2.3; 3.4 units pH and 0.328; 0.38; 0.411h PKP is 12.43 mmol/h. Despite the fact that a significant part of the time (70.5%) with the mucous membrane of the esophagus was contacted by medium-acid and moderate-acid GER, the proportion of strongly acidic GER in the PKP of patient B. is 83.4%, which indicates on pathological GER in the esophagus.

When analyzing the parameters of the daily pH-gram of patient D. Figure 5 it was found that the generalized DeMeester indicator, equal to 28.66;% of time with a pH in the range from 0.8 to 3.9 units, equal to 6.7, and time with pH in the range from 0.8 to 3.9, equal to 1.6 hours, indicate pathological GER in the esophagus. Average pH levels and their duration in the ranges: 1.0 - 1.9; 2.0 - 2.9; 3.0 - 3.9 units pH are equal to Naturally: 1.7; 2.4; 3.4 units pH and 0.08h; 0.5h; 1.02 hours. That is, most of the time (95%) with the mucous membrane of the esophagus was contacted by medium acid (31%) and moderate acid (64%) reflux. PKP of patient D., equal to 3.99 mmol/l × h, indicates normal GER, and not pathological GER. When analyzing the parameters of the daily pH-gram of patient K. Figure 6 it was found that the generalized DeMeester indicator, equal to 19.60;% of time with a pH in the range from 0.8 to 3.9 units, equal to 5.2%, and a time with a pH in the range of 0.8 to 3.9, equal to 1.26 hours, indicates abnormal GER in the esophagus. Average pH levels and their duration in pH ranges: 1.0 - 1.9; 2.0 - 2.9; 3.0 - 3.9 units pH equal to responsible: 1.7; 2.4; 3.3 units pH and 0.14h; 0.52h; 0.6 hours. That is, most of the time (89%), the acidity of the refluxate in the esophagus was mildly acidic (41%) and mildly acidic (48%). PKP of patient K. is equal to 5.16 mmol/l × h. The duration of strongly acidic GER does not exceed 11%. We believe that PKP does not indicate a pathology in the esophagus of patient K.

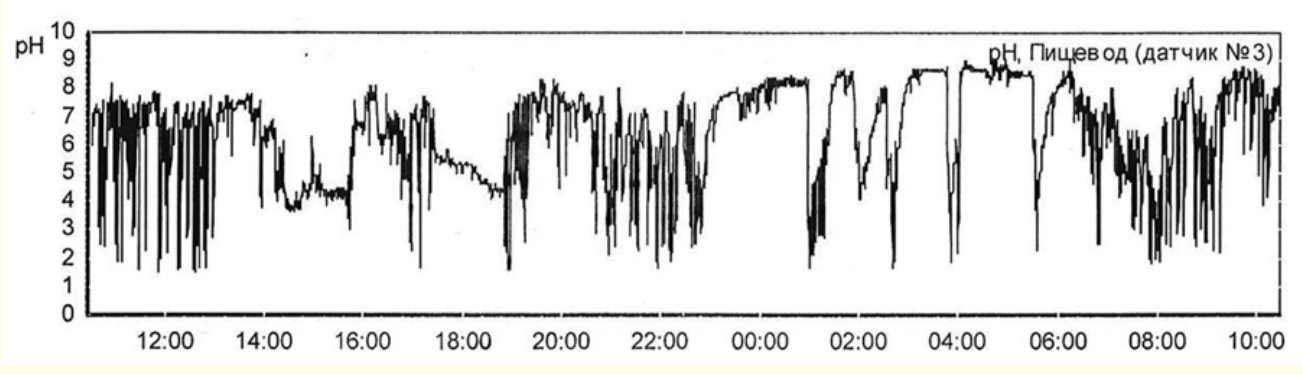

Figure 5: *Daily pH-gram of the esophagus of patient D., 52 years old.*

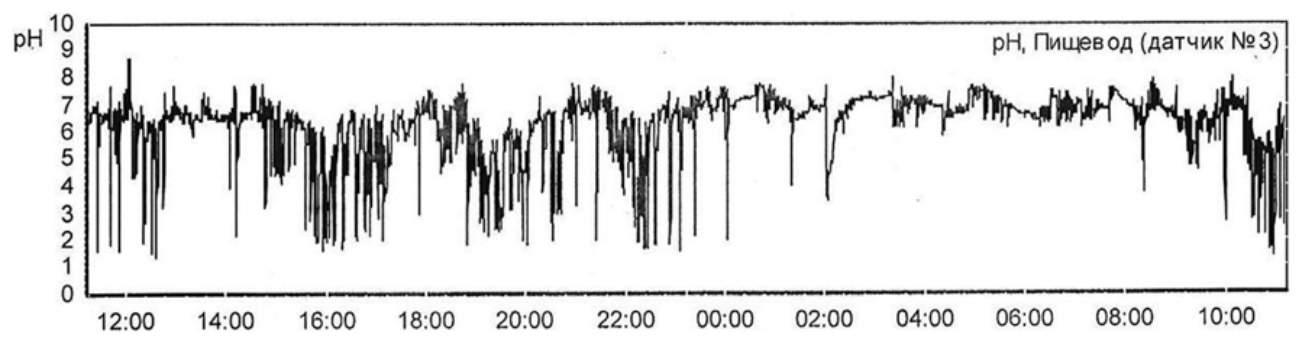

Figure 6: *The daily pH of the esophagus of patient K., 27 years old.*

Discussion

We believe that when assessing the effect of GER on the mucous membrane of the esophagus, it is imperative to take into account the average concentrations of H^+ ions in mmol/l of acid reflux and their duration in the esophagus in the pH ranges: 0.8 - 0.9; 1, -1.9; 2.0 - 2.9; 3, -3.9u. To increase the reliability of the assessment, it is also necessary to determine the proportions (%) in the PNP of strongly acidic, medium-acid, and moderately acidic GER.

Conclusion

The use of the generalized DeMeester indicator and the percentage of time with pH < 4 for assessing the acidity of the intraesophageal pH per day can lead to significant distortion of the results. To determine a new indicator of esophageal acidity (EPP), it is necessary to use the average concentration of H + ions in the esophagus per day in the pH ranges: 0.8 - 0.9; 1.0 - 1.9; 2.0 - 2.9 and 3.0-3.9 units pH and long sti (in hours) of the effect of reflux on the mucous membrane of the esophagus in the indicated pH ranges. It was found that the new PKP indicator, equal to the sum of the products of average concentrations H^+ ions in mmol/L on their duration in the pH ranges: 0.8 - 0.9; 1.0 - 1.9; 2.0 - 2.9 and 3.0 - 3.9 units pH is a more accurate and correct indicator of the assessment of the acidity of GER in the esophagus.

The use of PCPs will significantly reduce the likelihood of errors when using the DeMeester indicator and% of time with pH < 4, the calculation of which does not take into account the average concentrations of H^+ ions of the refluxate and the time of its contact with the esophagus in the pH ranges: 0.8 - 0.9; 1.0 - 1.9; 2.0 - 2.9 and 3.0 - 3.9 units.

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