Relationship between onset of peptic ulcer and meteorological factors

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Abstract
AIM: To discuss the relationship between onset of peptic ulcer (PU) and meteorological factors (MFs).

METHODS: A total of 24,252 patients were found with active PU in 104,121 samples of gastroscopic examination from 17 hospitals in Nanning from 1992 to 1997. The detectable rate of PU (DRPU) was calculated every month, every ten days and every five days. An analysis of DRPU and MFs was made in the same period. A forecast model based on MFs of the previous month was established. The real and forecast values were tested and verified.

RESULTS: During the 6 years, the DRPU from November to April was 24.4% - 28.8%. The peak value (28.8%) was in January. The DRPU from May to October was 20.0% - 22.6%, with its low peak (20.0%) in June. The DRPU decreased from winter and spring to summer and autumn (P < 0.005). The correlated coefficient between DRPU and average temperature value was -0.6470, -0.5167 respectively (P < 0.01). The correlated coefficient between DRPU and average dew point temperature value was -0.8091, -0.6617, -0.5384 respectively (P < 0.01). The correlated coefficient between DRPU and average air pressure value was 0.7320, 0.5777, 0.4579 respectively (P < 0.01). The average temperature, average highest and lowest temperature, average air pressure and average dew point temperature value of the previous month, ten days and five days could forecast the onset of PU, with its real and forecast values corresponding to 71.8%, 67.9% and 66.6% respectively.

CONCLUSION: DRPU is closely related with the average temperature, average highest and lowest temperature, average air pressure and average dew point temperature of each month, every ten days and every five days for the same period. When MFs are changed, the human body produces a series of stress actions. A long-term and median-term based medical meteorological forecast of the onset of PU can be made more accurately according to this.

INTRODUCTION
The onset of peptic ulcer (PU) is characterized by seasons, with a high incidence in winter and spring and a low incidence in summer[1-8]. We made a correlated analysis of the relationship between detectable rate of PU (DRPU) from 1992 to 1997 in Nanning and a regressive analysis of the meteorological factors (MFs) in the same period. We found that DRPU was closely related to the seasons and MFs.
**Table 1 The 7 meteorological factors**

| MF                              | Symbol | Unit |
|---------------------------------|--------|------|
| Average temperature of 1 month, ten days and five days | Tpj    | °C   |
| Average highest temperature of 1 month, ten days and five days | Tmax   | °C   |
| Average lowest temperature of 1 month, ten days and five days | Tmin   | °C   |
| Average air pressure of 1 month, ten days and five days | P      | hPa  |
| Average relative humidity of 1 month, ten days and five days | FF     | %    |
| Average dew point temperature of 1 month, ten days and five days | Td     | °C   |
| Average total amount of precipitation of 1 month, ten days and five days | RR     | mm   |

**MATERIALS AND METHODS**

**Materials**
A total of 24 252 patients with active PU were found from 17 hospitals in Nanning from 1992–1997. We then calculated the detectable rate of peptic ulcer in every season, every month, every ten days and every five days. The average value of the 7 MFs was provided by Guangxi Meteorological Observation Station (Table 1).

**Methods**
We used detectable rate of peptic ulcer (DRPU) to represent the incidence. The detectable rate of a disease was higher than the incidence of its natural multitude, but the variation of both was similar as previously described\(^9\). (DRPU = number of persons of PU at the same period of time / total number of persons of gastroscopic examination at the same period of time × 100%).

**Statistical analysis**
We made a correlated analysis of the DRPU of 1 month, ten days and five days and the 7 MFs in the same period in Nanning. On the basis of it, we carefully chose the meteorological factors. A regressive effect F value test was made for all the independent variables and factors. A multiple linear regressive mathematical model was established for DRPU forecast equation\(^9\).

**RESULTS**

**Relationship between DRPU and seasons**
From 1992 to 1997, the average DRPU in Nanning was 23.29%. The average DRPU from November to April was 24.2–28.8%, with its peak value being 28.8% in January. The average DRPU from May to October was 20.0–22.6%, with its low peak value being 20.0% in June. The DRPU in winter was 26.48%, 24.98% in spring, 21.10% in summer, and 20.91% in autumn. The seasonal DRPU values showed that the onset of PU was as follows: winter >spring>summer and autumn, winter >spring>summer and autumn. The difference was significant.

**Relationship between DRPU AND MFs**
We made a further correlated analysis of the DRPU and the 7 MFs in the same period. The results showed that the DRPU was not evidently related to the relative air humidity, but had a negative relation with the average temperature, average highest and lowest temperature, average dew point temperature (\(P < 0.01\)) and a positive relation with the AAP (\(P < 0.01\), Table 2). We found that when the monthly average temperature \(\leq 21^\circ C\), the monthly average highest temperature \(\leq 26^\circ C\), the monthly average lowest temperature \(\leq 18^\circ C\), the monthly average air pressure \(\geq 1007\) hPa, the monthly average dew point temperature \(\leq 15^\circ C\), the average ten-day temperature \(\leq 19^\circ C\), the average ten-day highest temperature \(\leq 24^\circ C\), the average ten-day lowest temperature \(\leq 17^\circ C\), the average ten-day air pressure \(\geq 1008\) hPa, the average ten-day dew point temperature \(\leq 14^\circ C\), the average five-day temperature \(\leq 17^\circ C\), the average five-day highest temperature \(\leq 20^\circ C\), the average five-day lowest temperature \(\leq 14^\circ C\), the average five-day air pressure \(\geq 1008\) hPa, the average five-day dew point temperature \(\leq 12^\circ C\). The correlated analysis of the high onset of DRPU of 1 month, ten days, five days and the above single factors corresponded to 75%-78%. The statistical relation between the factors, can be described by the multivariate linear regression equation:

\[
\hat{y} = b_0 + b_1x_0 + b_2x_2 + \ldots + bĄx_A + bbx_b + \ldots + \ldots (A = 1, 2, 3, 4) \]

where \(b_0\), \(b_1\), \(b_2\), \(b_3\), and \(b_4\) stand for regression coefficients; \(n\) is sample size; \(x_0, x_2, \ldots, x_B\) are predictors; \(\hat{y}\) is the predicted value. The multiple linear regressive equation was established as follows:

\[
Y_{monthDRPU} = 127.89366 + 0.95687Tpj - 0.46658Tmax - 0.97166Tmin - 0.9299P - 0.0788Td, \text{average error} = 2.0051, \text{complex relative coefficient} = 0.8129, \text{F month test value} = 25.7068, F_{0.01} = 3.60, \text{F month} > F_{0.01}, \text{thus} P < 0.01.
\]

\[
Y_{ten-dayDRPU} = 62.93681 - 0.34811Tpj + 0.06056Tmax - 0.18958Tmin - 0.02957P + 0.0004Td, \text{average error} = 2.981, \text{complex relative coefficient} = 0.664, \text{Ften-day test value} = 33.1117, F_{0.01} = 3.40, \text{F ten-day} > F_a, \text{thus} P < 0.01.
\]

\[
Y_{five-dayDRPU} = 63.49121 - 0.76259Tpj + 0.27832Tmax - 0.18958Tmin - 0.02957P + 0.0004Td, \text{average error} = 2.981, \text{complex relative coefficient} = 0.664, \text{Ffive-day test value} = 33.1117, F_{0.01} = 3.40, \text{F five-day} > F_a, \text{thus} P < 0.01.
\]
0.06448Tmin - 0.03043P + 0.0764Td, average error = 4.0499, complex relative coefficient = 0.5434, Five - day test value = 35.6956, F0.01 = 3.07, F five - day > Fa, thus P <0.01.

Establishment of DRPU forecast equation and test of its significance

The correlated analysis of DRPU of 1 month, ten days, five days and 7 MFs of the previous month, ten days and five days indicated that the average temperature, average highest and lowest temperature, average air pressure and average dew point temperature of the previous month were also closely related to the DRPU of the present month, ten days and five days (Table 3). Thus if we made the 5 MFs of the previous month, ten days and five days and the DRPU of the present month , ten days and five days, the factors of three DRPU forecast equations could be established as follows:

YmonthDRPU=-358.09409-4.75833Tpj+2.08101Tmax+2.97619Tmin+0.37869P-0.29906Td, average error=2.1138, complex relative coefficient=0.7230, test value = 21.8878, F0.01 =3.07, F month > Fa, thus P<0.01.

Yten-dayDRPU=-45.84159-0.26677Tpj+0.05189Tmax-0.9075Tmin+0.07605P-0.04132Td, average error=3.0625, complex relative coefficient=0.6383, Ten-day test value = 28.7387, F0.01=3.40, F ten- day > Fa, thus P<0.01.

Yfive-dayDRPU=-0.826-0.13995Tpj-0.00568Tmax-0.24365Tmin+0.04104P+0.00342Td, average error=4.0629, complex relative coefficient=0.5362, Ffive-day test value=34.2292, F0.01=3.07, F five - day> Fa, thus P<0.01.

DISCUSSION

It is generally believed that the occurrence of PU is due to the effect of unbalance between the attacking factors such as hydrochloric acid in gastric juice and the defending factors of the mucosa. Helicobacter pylori (H pylori) infection is also an important cause of PU. Treatment of hydrochloric acid in gastric juice and anti- pylorus bacteria can protect stomach duodenum mucosa, yet the occurrence of PU still has remarkable seasonal variations. Therefore the influence of variations of meteorological factors on PU must be considered. Research has shown that the occurrence of PU in winter is related to the higher air pressure and temperature. The high occurrence of PU

Table 2 Correlated analysis of DRPU and 7 MFs

| Related DRPU | Group | Related coefficient | P value |
|-------------|-------|---------------------|---------|
| Monthly average temperature | 72 | -0.8704 | <0.01 |
| Average ten-day temperature | 216 | -0.6624 | <0.01 |
| Average five-day temperature | 432 | -0.5384 | <0.01 |
| Average monthly highest temperature | 72 | -0.8000 | <0.01 |
| Average ten-day highest temperature | 216 | -0.6470 | <0.01 |
| Average five-day highest temperature | 432 | -0.5167 | <0.01 |
| Average monthly lowest temperature | 72 | -0.8091 | <0.01 |
| Average ten-day lowest temperature | 216 | -0.6617 | <0.01 |
| Average five-day lowest temperature | 432 | -0.5384 | <0.01 |
| Average monthly air pressure | 72 | 0.7230 | <0.01 |
| Average ten-day air pressure | 216 | 0.5777 | <0.01 |
| Average five-day air pressure | 432 | 0.4579 | <0.01 |
| Average monthly relative humidity | 72 | -0.2334 | >0.05 |
| Average ten-day relative humidity | 216 | -0.1364 | >0.05 |
| Average five-day relative humidity | 432 | -0.0657 | >0.05 |
| Average monthly dew point temperature | 72 | -0.7812 | <0.01 |
| Average ten-day dew point temperature | 216 | -0.6246 | <0.01 |
| Average five-day dew point temperature | 432 | -0.4936 | <0.01 |
| Monthly precipitation | 72 | -0.2013 | >0.05 |
| Ten-day precipitation | 216 | -0.0916 | >0.05 |
| Five-day precipitation | 432 | -0.0418 | >0.05 |

The results of regressive effect analysis indicated that the 3 multiple regressive equations based on DRPU and variation of the 5 MFs had remarkable effects.
in summer is likely to be related to the lower air pressure. Our study also confirmed the seasonal onset of PU. Analysis of MFs has shown that special attention should be paid to PU patients in winter and spring [26]. Since increased air pressure and dry air result from the cold air, temperature plays a more important role [27]. When these meteorological factors are changed violently, a series of stress action take place, causing endocrinopathy. It was reported that severe cold and changing temperature result in acute stress actions in human body, causing excitation of sympathetic nerve and adrenal gland marrow and rapid secretion of adrenaline and noradrenaline [28]. Animal tests also showed that mouse hypertensin II is much higher compared with acute stress action, sub-acute stress action and other chronic stress action [28]. When human body is stimulated by acute or slow stress action, hypertensin II in plasma increases remarkably. Cold stimulation and oxygen shortage stimulation may accelerate secretion of hydrochloric acid in gastric juice. It has been verified that when endothelin is injected, plasma progastrin increases progressively [32]. When blood supply is insufficient in the duodenal mucosa and the protection barrier is damaged due to insufficient oxygen, the increase of hydrochloric acid in gastric juice accelerates the occurrence of PU. Moreover, cold weather decreases human body's immunity function [28]. Some Japanese experts pointed out that from December to March, the number of human body outer lymph cells and B lymph cells is small [36], indicating lower body cell immunity and body fluid immunity function. Therefore when the temperature stimulates human body, adrenocorticotropin increases its secretion and hypertensin II rises, restraining the body immunity function and causing immunity functional disorder, and making it easy for the duodenal mucosa to be attacked by \textit{H pylori} [37], which destroys the stomach mucosa protection barrier, impairs the stomach mucosa and then restrains secretion of inhibitable growth factors and stimulates secretion of progastrin [12-25].

In conclusion, acute, sub-acute and slow stresses on the human body are likely the cause of PU in winter and spring.

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**Table 3** Correlated analysis of DRPU and 5 MFs of the previous month, ten days, and five days

| Related DRPU                          | Group | Related coefficient | \( P \) value |
|---------------------------------------|-------|--------------------|---------------|
| Average monthly temperature           | 71    | -0.6621            | <0.01         |
| Average ten-day temperature           | 215   | -0.6302            | <0.01         |
| Average five-day temperature          | 431   | -0.5324            | <0.01         |
| Average monthly highest temperature   | 71    | -0.6291            | <0.01         |
| Average ten-day highest temperature   | 215   | -0.6097            | <0.01         |
| Average five-day highest temperature  | 431   | -0.5123            | <0.01         |
| Average monthly lowest temperature    | 71    | -0.6781            | <0.01         |
| Average ten-day lowest temperature    | 215   | -0.6350            | <0.01         |
| Average five-day lowest temperature   | 431   | -0.5348            | <0.01         |
| Average monthly air pressure          | 71    | 0.7628             | <0.01         |
| Average ten-day air pressure          | 215   | 0.5942             | <0.01         |
| Average five-day air pressure         | 431   | 0.4840             | <0.01         |
| Average monthly dew point temperature | 71    | -0.7220            | <0.01         |
| Average ten-day dew point temperature | 215   | -0.6171            | <0.01         |
| Average five-day dew point temperature | 431  | -0.5077            | <0.01         |

The above analysis showed that the 3 forecast equations had good regressive effect. The real test values of the three forecast equations were 71.8%, 67.9% and 66.6%, respectively.
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