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Research on a monitoring and evaluation platform for mountain sickness of grid construction workers based on disease information entropy

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ABSTRACT

The inaccuracy of acute altitude sickness screening has brought great challenges to power grid construction workers in high-altitude areas. Human vital signs monitoring technology is an effective technical means to prevent people from developing altitude sickness. This paper proposes a monitoring and evaluation platform for high altitude sickness in power grid operations based on information entropy of the causes of the illness. First, the vital characteristics data of workers are collected through sensors such as blood pressure and blood oxygen. Secondly, the collected data is transmitted back to the platform by using the Internet of Things technology. The information entropy establishes an analysis model of altitude sickness and generates personnel evaluation reports and treatment recommendations. Finally, the application results of the platform verified that the preventive effect of the platform is much higher than that of the pre-existing physical examination method.

Keywords: power grid field operation; monitoring and evaluation of altitude sickness; illness cause information entropy

1. Introduction

The average altitude of the Qinghai-Tibet Plateau is above 4,000 m. Affected by factors such as high altitude, thin air, low atmospheric pressure, low partial pressure of oxygen, and strong ultraviolet rays in the region, acute altitude sickness has become a major threat to the construction personnel of the power grid in Tibet[1,2]. According to severity, acute mountain sickness is divided into two types: Mild (reactive or acute altitude sickness) and severe (high altitude cerebral edema, high altitude pulmonary edema)[3]. The onset time of acute mountain sickness is short, occurring within hours to days. If it is not treated in time, it will be life-threatening[4].

Surveys and studies performed by High Altitude Sickness Prevention and Control Center of State Grid Corporation of China have shown that when the power grid construction workers, whose original permanent residences were from low altitude areas just entered the Qinghai-Tibet Plateau, were likely to induce acute altitude sickness, with the total incidence of acute altitude sickness of 18.97%, of which the incidence rate of mild and...
severe altitude sickness was 18.19% and 0.78%, respectively. It can be seen that among those who have just entered the Qinghai-Tibet region to perform power grids operations, experience high and harmful incidence of acute altitude sickness, which further poses a serious threat to their health[5].

Many scholars have done a lot of research on the prevention and treatment of altitude sickness among power grid construction workers. Literature[6] proposed the establishment of altitude sickness analysis software, using ultrasound examination, electrocardiogram and other methods to conduct pre-physical examinations for personnel entering the construction sites in the Qinghai-Tibet area. In literature[7], it was proposed that the method of establishing bone marrow nucleated red blood cell examination and analysis software be used to carry out the pre-analysis of construction workers in the Qinghai-Tibet area.

However, the above-mentioned altitude sickness prevention and control software have no effective method for predicting and screening acute altitude sickness. The only way to prevent and treat altitude sickness is to perform physical examinations on power grid construction workers in advance or to send them to the hospital for treatment after the power grid construction workers developed altitude sickness. Doing so often misses the critical period for the prevention and treatment of altitude sickness and causes permanent damage to the body of power grid construction workers[8]. At the same time, power grid infrastructure construction is often performed in remote areas. When the power grid construction personnel fall ill, power grid companies will not only have to spend a lot of manpower and material resources for treatment but also, the life safety of the patients cannot be guaranteed[9]. Meanwhile, the progress of power grid construction will also be delayed to varying degrees. In recent years, the state has attached great importance to the economic construction of the Qinghai-Tibet region, and the scale of power grid construction has continued to expand. According to statistics, more than 60,000 power grid construction workers enter Tibet and Qinghai regions every year to participate in power grid construction projects. As a result, the number of power grid construction workers suffering from acute altitude sickness is huge. If it cannot be effectively prevented and disposed of, altitude sickness will cause significant economic losses to power grid companies.

The Internet of Things technology has the characteristics of comprehensive perception, efficient information processing, convenient and flexible application, and can realize intelligent supervision and management of power grid operations[10–12]. The Internet of Things technology, especially with the use of mobile internet technology, allows the realization of mobile communication between the grid construction personnel and the back-end systems[13,14]. The use of the technology can provide vital sign data transmission support for the prevention and treatment of altitude sickness for power grid construction workers in the Qinghai-Tibet region.

Given the above background, this paper proposes a monitoring and evaluation platform for high altitude sickness for power grid construction workers based on the data of human vital signs collected and transmitted by the Internet of Things and mobile internet technologies. The platform can collect real-time data of the life characteristics of power grid construction workers and timely analyze the warning risks and provide treatment plans of the said workers in the Qinghai-Tibet region through the information entropy modeling of the causes of altitude sickness to prevent the occurrence of altitude sickness among power grid construction workers in advance. The application results of the high altitude sickness monitoring and evaluation platform for power grid construction workers verify that the prevention effect attained from this platform is much higher than that of the pre-physical examination method, and it can effectively reduce the incidence of high altitude sickness among power grid construction workers.
2. Analysis on the characteristics of altitude sickness among power grid construction workers

Based on the survey of altitude sickness among power grid construction workers of the High Altitude Disease Prevention and Control Center of State Grid Corporation of China, Suzhou High-tech Zone People’s Hospital analyzed 452 patients on the illness causes characteristics among power grid construction workers suffering from altitude sickness. From the results, it was summarized that there were 7 types of causes for altitude sickness with characteristic data that can be categorized into 4 categories and 16 subcategories.

| Cause of illness                         | Metric           | Number of patients | Proportion of patients/% |
|----------------------------------------|------------------|--------------------|--------------------------|
| Original altitude                      | ≤ 1,000 m        | 415                | 91.81                    |
| Time of construction workers to enter  | ≤ 5 days         | 291                | 64.38                    |
| The high altitude area                 |                  |                    |                          |
| Acclimation time at mid-altitude areas | ≤ 2 days         | 391                | 86.50                    |
| Psychological factors                  | ≤ Class III      | 215                | 47.57                    |
| Construction labor intensity           | ≥ Class II       | 442                | 97.79                    |
| Age                                    | ≥ 50 years old   | 87                 | 19.25                    |
| Respiratory infection                  | ≥ mild           | 142                | 31.42                    |

From Table 1, it can be seen that the causes of altitude sickness among power grid construction workers from high to low include construction labor intensity, original altitude, acclimatization time in mid-altitude areas, time of construction workers entering the high altitude area, psychological factors, respiratory infection and age. Based on this, in the early stage of the grid construction workers entering the high altitude area, the cause of the construction workers becoming altitude sickness patients should be included in the information entropy analysis of the causes of illness and focus on observing the people whose original altitude, acclimatization time in mid-altitude areas and construction labor intensity that exceeded the threshold.

The characteristic data of power grid construction workers suffering from altitude sickness are listed in Table 2.

It can be seen from Table 2 that after the power grid construction workers suffer from altitude sickness, the physical characteristics are mainly composed of 4 major categories and 16 subcategories including respiratory, cardiovascular, digestive and urinary system abnormalities. In this, it is necessary to combine the causes of altitude sickness and the characteristics of altitude sickness data as a joint source for information entropy modeling. When the power grid construction workers have abnormal physical characteristics, effective treatment and rescue are then able to be carried out to prevent such personnel from developing altitude sickness.

3. High altitude sickness monitoring and evaluation platform process

Figure 1 shows the overall process of the monitoring and evaluation platform for altitude sickness among power grid construction workers. The architecture mainly includes three links: data collection and transmission of construction personnel’s vital signs, information entropy modeling of the causes of altitude sickness, and evaluation and treatment of the power grid construction personnel.
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Table 2. Data sheet of altitude sickness characteristics of construction workers

| Category           | Name of illness characteristic data                      | Eigenvalues |
|--------------------|-----------------------------------------------------------|-------------|
| Respiratory system | BMI index/(kg·m⁻¹)                                        | ≥28.3       |
|                    | Lung function-FVL/L                                       | ≥3.47       |
|                    | Lung function-FEV1/L                                      | ≥3.23       |
|                    | Lung function-FEE25/(L·sec⁻¹)                             | ≥4.51       |
|                    | Lung function-SaO₂ Decrease/%                            | ≥83.9       |
|                    | Number of breaths/(times h⁻¹)                             | ≥35         |
|                    | Breathing pause time/s                                    | ≥10         |
|                    | ECG ST-segment/%                                          | ≥40.1       |
|                    | Diastolic blood pressure/mmHg                             | ≤65         |
| Cardiovascular system | Systolic blood pressure/mmHg                          | ≥135        |
|                    | Heart rate ≥ 100 times/min                                | ≥30         |
|                    | Red blood cells/(pcs L⁻¹)                                 | ≥10         |
|                    | Hemoglobin/pg                                              | ≥35         |
| Digestive system   | Abdominal muscletone/(number of spasms h⁻¹)               | ≥2          |
|                    | Urine red blood cells/(μL)                                | ≥50         |
| Urinary system     | Urine protein/(mg L⁻¹)                                    | ≥150        |

Figure 1. Overall process of altitude sickness monitoring and evaluation platform.

The human vital sign data collection module monitors the personnel’s blood pressure, blood oxygen, electrocardiogram and other characteristic data in real-time through the vital sign sensors wearable by the grid construction workers. The data aggregation module uses the data-centric self-organizing algorithm based on the information negotiation sensor network protocol (Sensor Protocols for Information Via Negotiation, SPIN) to realize local aggregation of vital signs data of multiple construction workers. In the mobile interconnection transmission module of the power Internet of Things, the local data is transmitted back to the altitude sickness prevention and control platform of the power grid construction personnel of the power supply company through the 5G network. In the information entropy modeling and analysis of the causes of altitude sickness, experience data of the expert knowledge base can be combined with the collected characteristic data for modeling analysis to generate the risk assessment report of altitude sickness for power grid construction workers. Finally, the wearable video transmission model is used to provide remote treatment guidance for altitude sickness prevention and treatment.

4. Data collection and transmission model of construction workers’ vital signs

The power grid infrastructure construction in the Qinghai-Tibet region is mostly in remote areas.
Hence, the collection and transmission of vital signs data of power grid construction personnel mainly consider the reliability and cost of the collection and transmission. In this, the collection model includes two parts: wearable life feature data collection, wireless networking and aggregation transmission of data collected by multiple people in the construction team.

4.1. Wearable vital signs data collection

The vital sign data of power grid construction personnel is collected by wearable vital sign sensors. The sensors are mainly divided into heartbeat, cardiogram, blood pressure, blood oxygen, body temperature, respiratory rate and altitude. Additionally, several life feature collection points are also configured according to the conditions of the construction workers. This multi-sensors data fusion is carried out through neural network, wavelet transform and Kalman filtering technology[15,16] to obtain accurate measurement signals.

In this paper, the multi-sensor data-adaptive weighted fusion estimation algorithm is used to collect vital sign data.

There are n sensors to measure a grid construction worker where the variance of the sensor is $\mathbb{E} \{ \sum_{\sigma=1}^{n} y_{\sigma} x_{\sigma} \}$. From the first measurement, the number of measurements is $\sigma$, while the estimated true value of the sensor measurement is $x_{fa}$, and the measurement value of each sensor is $x_1, x_2, \ldots, x_n$ and the weighting factor of each sensor is $y_1, y_2, \ldots, y_n$. After multi-sensor fusion, the weighting factor of $x_{fa}$ is:

$$x_{fa} = \sum_{\sigma=1}^{n} \left( \frac{n}{\sigma} \right) y_{\sigma} x_{\sigma}$$

(1)

Assuming that the second group is measured $h$ times, the average variance of the sensor is:

$$\hat{\sigma}^2 = E \left[ \sum_{\sigma=1}^{n} y_{\sigma}^2 (x_{fa} x_{\sigma})^2 + 2 \sum_{\sigma=1, h=1}^{n} y_{\sigma} y_{h} (x_{fa} - x_{\sigma})(x_{fa} - x_{h}) \right]$$

(2)

It can be seen from equation (2) that the average variance of the sensor is a multivariate quadratic function about each weighting factor and so has a minimum value. According to the multivariate function theory, to find the extreme value theory, the weighting factor corresponding to the minimum total mean square error can be obtained:

$$y_{\sigma}^h = 1/(\partial^2 \sum_{\sigma=1, h=1}^{n} 1/\partial^2)$$

(3)

At this time, the minimum variance corresponding to the multi-sensor is:

$$\hat{\sigma}_{min}^2 = 1/\sum_{\sigma=1}^{n} 1/\partial^2$$

(4)

The multi-sensor data-adaptive weighted fusion estimate $x_{fb}$ can be calculated from equations above:

$$x_{fb} = \sum_{\sigma=1}^{n} y_{\sigma} x_{\sigma}(\hat{\sigma})$$

(5)

It can be seen from equations that through the data fusion of wearable vital signs multi-sensors, the accurate vital signs data of heartbeat, cardiogram, blood pressure, blood oxygen, body temperature and other types of power grid construction workers can be obtained.

4.2. Multi-person wireless networking and aggregation transmission

In the Qinghai-Tibet Plateau power grid construction site, several people are participating in the power grid construction work. If each construction worker occupies a 5G transmission channel, it will cause a waste of resources and an increase in transmission costs[17-19]. Therefore, the data-centric self-organizing algorithm SPIN can be used to achieve local aggregation of life characteristics data of multiple construction personnel.

In the SPIN multi-person wireless network of
power grid construction personnel, the geographical location of the construction personnel is randomly arranged, and each vital sign monitoring sensor node will first send a command to request the allocation level to the adjacent base point sensor. If the adjacent base point sensor is the convergence point, then the vital sign monitoring sensor node will receive the level assigned by the convergence point, and the sensor node will send the vital sign information datagram to the convergence point. If the adjacent node sensor is another transit vital sign monitoring sensor, the sensor node will send vital sign information data to the transit sensor. Through the SPIN routing algorithm networking, each sensor node hopes to become a transit node and guides its transmission path to the aggregation node. In order to reduce the loss of node transmission, the vital sign sensor nodes of each construction worker negotiate directly during transmission to achieve the best transmission efficiency. The schematic diagram of SPIN multi-person wireless network is shown in Figure 2.

![Figure 2. SPIN multi-person wireless networking.](image)

When the vital sign data of each power grid construction worker reaches the convergence point, the 5G network is used to transmit the data to the monitoring and evaluation platform of high altitude sickness for power grid construction workers of the power supply company through the multi-level security architecture of the Internet of Things[20].

5. Causes of altitude sickness information entropy modeling

The information entropy of the causes of altitude sickness mainly involves the traceability analysis of the causes of altitude sickness to power grid construction workers, respiratory system, cardiovascular system, digestive system, and urinary system. Based on the analysis of the characteristics of altitude sickness among power grid construction workers, a two-layer cause of altitude sickness information entropy modeling was carried out comprising of the independent information entropy of the causal factors and the combined information entropy of altitude sickness.

5.1. Modeling of independent information entropy of the cause factors

Traceability modeling of the causes of altitude sickness

The traceability of the causes of altitude sickness mainly includes seven aspects. The range of values for the traceability characteristics of the causes of high altitude disease is listed in Table 3.
Let \( z \) be the information entropy of tracing the causes of altitude sickness, the altitude of the original location is \( z_a \), the labor intensity of construction is \( z_b \), the acclimatization time in the mid-altitude area is \( z_c \), the time for construction workers to enter the high altitude area is \( z_d \), the psychological factors is \( z_e \), and the respiratory infection is \( z_f \), and the cause entropy for tracing the origin of altitude sickness is:

\[
H(z) = H(z_a) + H(z_b) + H(z_c) + H(z_d) + H(z_e) + H(z_f) + H(z_g) + H(z_a|z_b|z_c|z_d|z_e|z_f|z_g)
\]

(6)

**Respiratory system modeling**

There are 7 main aspects of respiratory system modeling. According to the breathing data monitored by the vital sign sensors, the monitoring data such as pauses of more than 10 s are generated by detecting the rapid breathing of a worker and the continuous 3 or 4 rapid breathing to determine the risk of altitude sickness onset. The value range of respiratory system characteristic value is listed in Table 4.

**Cardiovascular system modeling**

According to the heartbeat data, dynamic electrocardiogram data, and blood pressure data monitored by the vital sign sensors, detection on the whether there are increases in heart rate, blood pressure, red blood cells and hemoglobin as well as whether there are clinical symptoms present such as ectopic arrhythmia, can be used to determine the risk of altitude sickness. The value range of cardiovascular system eigenvalues is listed in Table 5.

| Cause of illness                                | Lower limit | Upper limit |
|------------------------------------------------|-------------|-------------|
| Altitude of the original location/m            | 0           | 4,000       |
| Time of construction Workers to enter the high altitude area/day | 0           | 60          |
| Acclimation time at mid-altitude areas/day     | 0           | 60          |
| Psychological factors/class                    | 1           | VI          |
| Construction labor intensity/class             | 1           | VII         |
| Age/years old                                 | 18          | 65          |
| Respiratory infection                         | No infection| Severe      |

| Name                      | Unit   | Lower limit | Upper limit |
|---------------------------|--------|-------------|-------------|
| BMI Index                 | kg/m   | 10          | 50          |
| Lung function-FVL         | L      | 0.5         | 10          |
| Lung function-FEV1        | L      | 0.5         | 10          |
| Lung function-FEE25       | L/sec  | 0.5         | 10          |
| Lung function-SaO decrease| %      | 0           | 99          |
| Number of breaths         | number/h| 5           | 100         |
| Breathing pause time      | s      | 0           | 100         |

Let the information entropy of the respiratory system be \( x \), the BMI index to be \( x_a \), the lung function-FVL to be \( x_b \), the lung function-FEV1 to be \( x_c \), and the lung function-FEE25 to be \( x_d \), the decrease in lung function-SaO2 is \( x_e \), the number of breaths is \( x_f \), the breathing pause time is \( x_g \) and the entropy of respiratory system pathogenesis is:

\[
H(x) = H(x_a) + H(x_b) + H(x_c) + H(x_d) + H(x_e) + H(x_f) + H(x_g) + H(x_a|x_b|x_c|x_d|x_e|x_f|x_g)
\]

(7)

**Table 3.** The value range of the traceability characteristics of the causes of high altitude sickness

| Cause of illness                                | Lower limit | Upper limit |
|------------------------------------------------|-------------|-------------|
| Altitude of the original location/m            | 0           | 4,000       |
| Time of construction Workers to enter the high altitude area/day | 0           | 60          |
| Acclimation time at mid-altitude areas/day     | 0           | 60          |
| Psychological factors/class                    | 1           | VI          |
| Construction labor intensity/class             | 1           | VII         |
| Age/years old                                 | 18          | 65          |
| Respiratory infection                         | No infection| Severe      |

**Table 4.** Value range of respiratory system characteristics

| Name                      | Unit   | Lower limit | Upper limit |
|---------------------------|--------|-------------|-------------|
| Name                      | Unit   | Lower limit | Upper limit |
|---------------------------|--------|-------------|-------------|
| ECG ST segment            | %      | 0           | 90          |
| Diastolic blood pressure  | mmHg   | 20          | 140         |
| Systolic blood pressure   | mmHg   | 60          | 240         |
| Heart rate ≥100 times     | min    | 0           | 600         |
| Red blood cells           | number/L| 0           | 9,999       |
| Hemoglobin                | pg     | 0           | 9,999       |

Having set the information entropy of the cardiovascular system as \( y \), the ST segment of the
electrocardiogram as \( y_a \), the diastolic blood pressure as \( y_b \), the heart rate \( \geq 100 \) times as \( y_a \), the red blood cells as \( y_c \) and the hemoglobin as \( y_d \), the source entropy of the cardiovascular system is:

\[
H(y) = H(y_a) + H(y_b) + H(y_c) + H(y_d) + H(y_e) + H(y_f) + H(y_a|y_b|y_c|y_d|y_e|y_f)
\]

\( H(\cdot) \) is the source of the digestive system is:

\[
H(p) = H(p_a)
\]

\( H(\cdot) \) is the source of the urinary system is:

\[
H(q) = H(q_a) + H(q_b) + H(q_a|q_b)
\]

5.2 Combined information entropy modeling of altitude sickness

In the information entropy modeling of the causes of altitude sickness, five cause variables of altitude sickness, respiratory system, cardiovascular system, digestive system, and urinary system are independent of each other. The amount of information obtained by observing the five variables should be the same as the amount of information of the five variables observed at the same time is the same. Let the amount of traceability information about the causes of altitude sickness be \( s_i = s\{z=z_i\} \), the amount of information about the respiratory system is \( a_i = a\{x=x_i\} \), and the amount of information about the cardiovascular system is \( b_i = b\{y=y_i\} \), the amount of information in the digestive system is \( c_i = c\{p=p_i\} \), and the amount of information in the urinary system is \( d_i = d\{q=q_i\} \), then the information entropy of the causes of altitude sickness, the respiratory system, the cardiovascular system, the digestive system, and the urinary system are:

\[
H(z) = \sum_{i=1}^{16} s_i \log \frac{1}{s_i}
\]

\[
H(z) = \sum_{i=1}^{26} a_i \log \frac{1}{a_i}
\]

\[
H(z) = \sum_{i=1}^{40} b_i \log \frac{1}{b_i}
\]

\[
H(z) = \sum_{i=1}^{12} c_i \log \frac{1}{c_i}
\]

\[
H(z) = \sum_{i=1}^{18} d_i \log \frac{1}{d_i}
\]

If in equations (11) to (15) the base of the logarithm is 2, then the information entropy of the causes of altitude sickness, respiratory system, cardiovascular system, digestive system, and urinary system are expressed as \( H2(z) \), \( H2(x) \), \( H2(y) \), \( H2(p) \), \( H2(q) \), respectively. At this time, the entropy unit based on 2 is bits. The curve of the entropy function is shown in Figure 3.
It can be seen from Figure 3 that the log₂ value of information entropy can be regarded as the amount of information provided by information entropy.

The joint entropy of altitude sickness is defined as the uncertainty of the simultaneous occurrence of five factors traceability of the causes, respiratory system, cardiovascular system, digestive system, and urinary system of altitude sickness. The joint entropy is:

$$H(z, x, y, p, q) = \sum(z, x, y, p, q) \log s(z, x, y, p, q)$$

$$a(z, x, y, p, q) \log a(z, x, y, p, q)$$  \hspace{1cm} (16)

$$b(z, x, y, p, q) = \log c(z, x, y, p, q)$$  \hspace{1cm} (17)

$$c(z, x, y, p, q) = \log c(z, x, y, p, q)$$  \hspace{1cm} (18)

$$d(z, x, y, p, q) = \log d(z, x, y, p, q)$$  \hspace{1cm} (19)

$$H(z, x, y, p, q) = H(z) + H(x) + H(y) + H(p) + H(q) + H(z | x | y | p | q)$$  \hspace{1cm} (20)

Conditional entropy $H(z | x | y | p | q)$ can be regarded as the average amount of information lost due to interference and noise on the channel, and can also be regarded as channel noise or dispersion.

The joint entropy relationship and mutual information of the causes of altitude sickness are shown in Figure 4.

As shown in Figure 4, the intersection of $H(z)$, $H(x)$, $H(y)$, $H(p)$, and $H(q)$ is the joint entropy of altitude sickness $H(z | x | y | p | q)$, where the greater the value of the joint entropy of altitude sickness, the greater the difference between the five functions, which means the greater the probability of altitude sickness, to determine whether the power grid construction personnel would have the risk of altitude sickness.

6. Evaluation and treatment of power grid construction personnel

The monitoring and evaluation platform for power grid construction workers can accurately assess the risk of high altitude sickness among the workers after analyzing the probability of high altitude sickness among them based on the information entropy modeling of the causes of altitude sickness. At the same time, when combined with the expert diagnosis database of the altitude sickness patients, it is possible to accurately assess the risk of altitude sickness among power grid construction workers, and generate altitude sickness risk assessment reports and treatment recommendations according to the needs of the construction workers. The level of assessment generated is divided into three categories: mild, moderate, and critical risk while treatment recommendations include stopping work, resting on the spot, intake of glucose, oxygen therapy, and immediate sending to the hospital (see Table 7).
Table 7. Risk assessment level and treatment recommendations of altitude sickness

| Serial number | Evaluation level | Treatment recommendation |
|---------------|------------------|--------------------------|
| 1             | Mild risk        | Stop work, rest on site, glucose intake |
| 2             | Moderate risk    | Oxygen therapy           |
| 3             | Critical risk    | Immediately send to hospital |

The altitude sickness monitoring and evaluation platform for power grid construction workers send the evaluation report and treatment recommendations to the medical staff at the power grid construction site through the 5G network. The hospital staff on the site can then conduct on-site treatment to the power grid workers who were assessed to be at risk of altitude sickness or send them immediately to the nearest hospital according to the treatment recommendations.

7. Platform application analyses

On-site construction workers of 185 people working on a 330kV line in the Qinghai-Tibet region was selected to conduct analysis on the prevention and treatment of altitude sickness. Before entering the Qinghai-Tibet area, relevant hospitals were arranged to conduct physical examinations on the 185 construction workers, all of whom met the requirements for high-altitude operation.

Before the application of the altitude sickness monitoring and evaluation platform for power grid construction workers, according to the survey performed by the High Altitude Sickness Prevention and Control Center of State Grid Corporation of China, the total incidence of acute altitude sickness among construction workers who have just entered the Qinghai-Tibet Plateau was 18.97% while the estimated number of people at risk of altitude sickness is 35. During the one month of monitoring, the platform found that 33 people were assessed to be at risk of altitude sickness. After the medical staff accompanying the team took measures such as providing glucose intake and oxygen therapy for treatment, the conditions of 27 patients were improved, thereby avoiding the occurrence of altitude sickness among power grid construction workers, and only 6 workers suffered from altitude sickness. The comparison is shown in Table 8.

Table 8. Comparison of altitude sickness before and after monitoring and evaluation platform application

| Serial number | Construction workers/person | Types                  | Number of patients/person | Prevalence rate/% |
|---------------|-----------------------------|------------------------|---------------------------|-------------------|
| 1             | 185                         | Estimated incidence    | 35                        | 18.97             |
| 2             | 185                         | Actual assessment      | 33                        | 17.84             |
| 3             | 185                         | After application       | 6                         | 3.24              |

From Table 8, it can be seen that before the use of altitude sickness prevention platform for power grid construction workers, among the construction team of 185 people, the estimated incidence of altitude sickness was 35 people, and the estimated prevalence rate was 18.97%. Following actual assessment, there were 33 construction workers with symptoms, and the actual prevalence rate was 17.84%. After using the altitude sickness monitoring and evaluation platform for power grid construction workers, they were evaluated as risky construction workers and treated on-site by medical personnel, with the actual number of patients with altitude sickness to be at 6, and a prevalence rate of 3.24%, signifying a decrease of 14.59% as compared with the method of physical examination beforehand.

8. Conclusions

The altitude sickness monitoring and evalua-
tion platform for power grid construction workers has changed the traditional way of pre-existing physical examination for power grid construction personnel entering Tibet and has realized the transition from altitude sickness treatment of power grid construction personnel to early warning of altitude sickness. The specific implementation of interconnection application reduces the cost of altitude sickness prevention and relief at the construction site, where it not only ensures the health of power grid construction personnel but also improves the efficiency of power grid construction in the Qinghai-Tibet region.

**Conflict of interest**

The authors declare no conflict of interest.

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