Supporting information

Humidity sensing and respiratory monitoring system constructed by quartz crystal microbalance sensors based on chitosan/polypyrrole composite film

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1. The related diseases of the four types of abnormal breathing

2. The diagnostic principle and process of five respiratory types

3. The judgment results of the other three types of respiration

1. The related diseases of the four types of abnormal breathing

The related diseases of the four types of abnormal breathing are as follows. Tachypnea is common in severe exercise, mood swings, fever, asthma, heart failure or respiratory and central nervous system diseases. Bradypnea is often seen in drug poisoning, respiratory failure, intracranial hypertension, renal failure or the end of life. Cheyne-Stokes is common in heatstroke, encephalitis, brain hypoxia or severe heart disease. Biot's respiration is common in intracranial lesions, respiratory center failure or brainstem stroke.

## 2. The diagnostic principle and process of five respiratory types
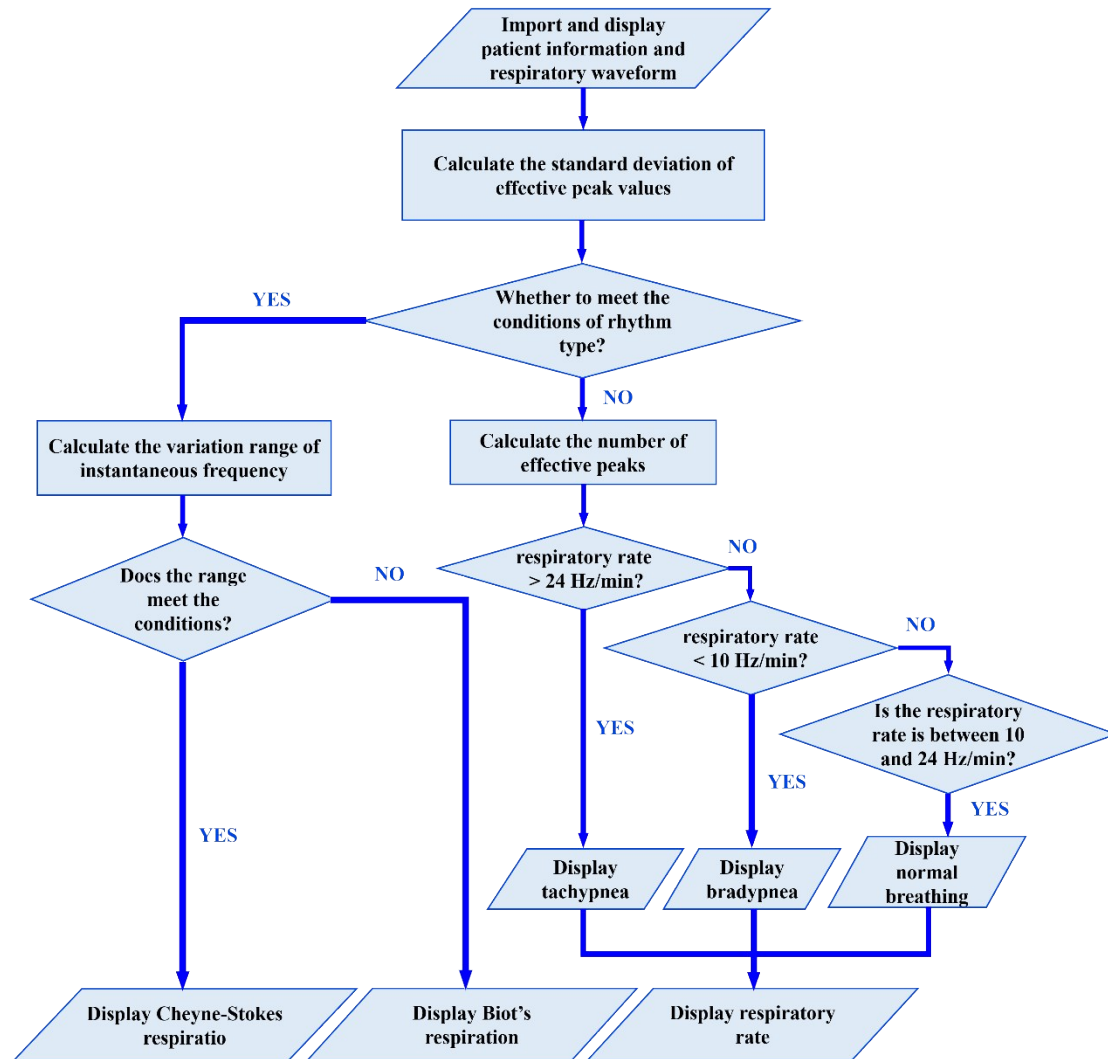
Figure S1. Flow chart of respiratory signal feature extraction and type judgment.

Fig. S1 shows the diagnostic principle and process of five respiratory types. Firstly, the collected respiratory humidity signal is smoothed by moving median method (MAD) to ensure the effectiveness of peak searching. The standard deviation of the effective peak values is calculated, because the rhythm of Cheyne-Stokes respiration and Biot's respiration is unstable, and the standard deviation is larger, the respiration is divided into unstable rhythm type (Cheyne-Stokes respiration and Biot's respiration) and stable frequency type (tachypnea, normal respiration and bradypnea).

Furthermore, the number of effective peak values is calculated, and the number of effective peaks is respiratory rate, so as to distinguish normal respiration, tachypnea and bradypnea. The phase difference method based on Hilbert transform is used to estimate the variation range of instantaneous frequency, and the variation range of instantaneous frequency of Cheyne-Stokes respiration is larger, so as to distinguish Cheyne-Stokes respiration and Biot's respiration.

3. The judgment results of the other three types of respiration

(a)

(b)

(c)
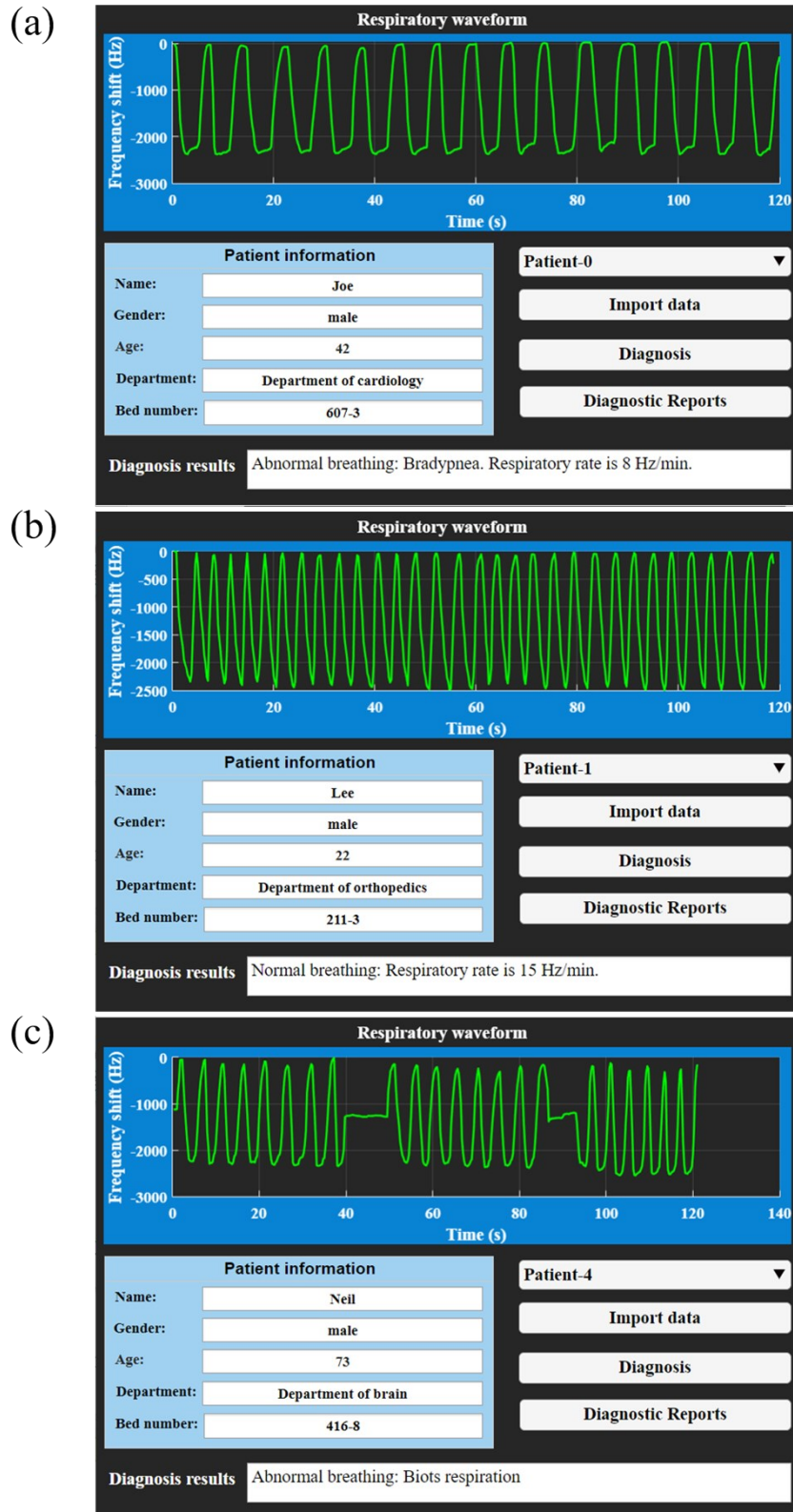
Figure S2. The judgment results of (a) bradypnea, (b) normal breathing and (c) Cheyne-Stokes respiration