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Case Report

A novel therapeutic strategy: remote dielectric sensing-guided management of pulmonary congestion

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ABSTRACT

Management of pulmonary congestion is a key to improve mortality and morbidity in patients with congestive heart failure, but it is often challenging due to a lack of gold standard to accurately assess the lung fluid level. We had an 86-year-old man who was admitted to our institute due to worsening congestive heart failure. His pulmonary congestion was quantified repeatedly by the novel noninvasive device, remote dielectric sensing, and was optimally managed by the medication adjustment. Remote dielectric sensing might be a promising device to quantify pulmonary congestion and guide clinicians to optimize medications in addition to the conventional multi-modalities.

Learning objective: : Remote dielectric sensing might be a promising device to quantify pulmonary congestion and guide clinicians to optimize medications in patients with congestive heart failure.

Introduction

Despite improvement in medical and non-medical therapy, mortality and morbidity of heart failure patients remain high [1]. In addition to guideline-directed neurohormonal blockers including beta-blockers and renin-angiotensin-aldosterone system inhibitors, appropriate dose titration of diuretics to manage pulmonary congestion is a key to successful heart failure management [2]. However, given the lack of gold standard to accurately quantify lung fluid level, optimal management of pulmonary congestion remains challenging thus far.

The remote dielectric sensing (ReDS™, Sensible Medical Innovations Ltd., Netanya, Israel) system, which is a non-invasive wearable device to quickly quantify the lung fluid level as a percentage, has been introduced and become clinically available outside Japan [3]. Our institute has initiated to utilize this device for the first time in Japan.

We had a patient with congestive heart failure whose pulmonary congestion was successfully managed by ReDS-guided medication titration.

Case report

Before admission

An 86-year-old man with a history of percutaneous coronary intervention was admitted to our institute due to worsening heart failure, which was improved using intravenous furosemide. Following the discharge, he had increases in body weight (from 60 kg to 63 kg) and plasma B-type natriuretic peptide (from 91 to 608 pg/mL) as well as worsening bilateral leg edema for the previous 1 month. He was readmitted to our institute complaining of dyspnea and orthopnea.

On admission

His body height was 164 cm. We could not measure his body weight. Blood pressure was 160/70 mmHg, heart rate was 100 bpm, and saturation was 70% without oxygen support. He was taking bisoprolol 2.5 mg/day, valsartan 80 mg/day, amlodipine 5 mg/day, and furosemide 10 mg/day.

Chest X-ray showed cardiomegaly and butterfly shadow (Fig. 1A). Electrocardiogram showed 83 bpm of heart rate with normal sinus rhythm. Transthoracic echocardiography displayed left ventricular end-diastolic diameter 63 mm, left ventricular ejection fraction 42%, and mild to moderate mitral regurgitation. Plasma B-type natriuretic peptide was 908 pg/mL. We performed ReDS measurement to noninvasively quantify the lung fluid level (Fig. 2A,B)

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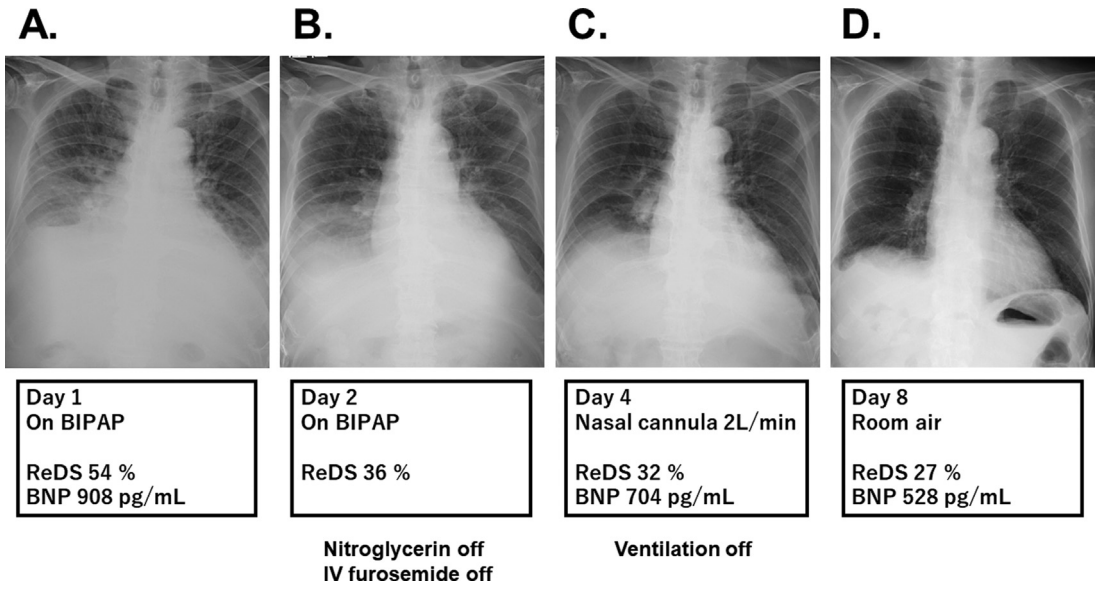

Fig. 1. Trend in chest X-ray, ReDS value, and BNP levels.
BIPAP, bi-level positive airway pressure; ReDS, remote dielectric sensing; BNP, B-type natriuretic peptide.

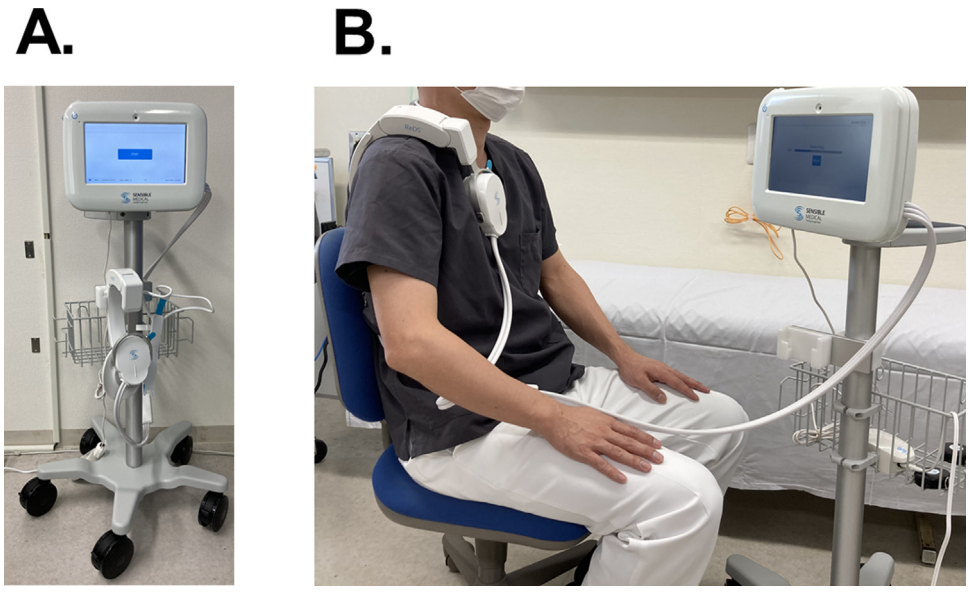

Fig. 2. Remote dielectric sensing monitor (A) and sensor unit application and measurement (B).

[3]. ReDS value on admission was 54% (normal range between 20% and 35%) (Fig. 1A) [4].

In-hospital course

Given elevated blood pressure and pulmonary congestion, we assigned him to clinical scenario 1. Bi-level positive airway pressure therapy (inspiratory/expiratory pressure 8/4 cmH_2O and fraction of inspiratory oxygen 100%) improved his saturation up to 93%. Continuous intravenous administration of nitroglycerin 4 mL/hr was initiated. Furosemide 20 mg was intravenously administered. During the first day, urine volume was 2000 mL/day.

On day 2, blood pressure was 128/64 mmHg, saturation improved up to 100% with a fraction of inspiratory oxygen 80%. Pulmonary congestion relatively seemed to improve in chest X-ray and ReDS value decreased considerably down to 36% (Fig. 1B). Given the improvement in ReDS value, nitroglycerin was terminated. IV furosemide was converted to oral administration of azosemide 30 mg/day. Valsartan was upgraded to sacubitril/valsartan 100 mg/day.

On day 4, pulmonary congestion further seemed to improve in chest X-ray (Fig. 1C). ReDS value decreased to 32%. We weaned off ventilation therapy maintaining his saturation level.

On day 8, the lung field seemed to become clear in chest X-ray (Fig. 1D). ReDS value decreased to 27%, which indicated sufficient decongestion. The patient was discharged on day 11 on foot. Plasma B-type natriuretic peptide was 469 pg/mL and ReDS value was 21% at discharge.

Discussion

Assessment of pulmonary congestion

There is no gold standard to accurately assess the degree of pulmonary congestion thus far. Physical examination, signs, and chest X-rays are often referenced to estimate the existence of pulmonary congestion in daily practice, but these are often ambiguous. Plasma B-type natriuretic peptide is also practical to estimate pulmonary congestion. However, intra-cardiac pressure and lung fluid level do not always work together. Right heart catheterization is a useful procedure to assess intra-cardiac pressure. However, we should be careful of the difference between pressure and volume [5]. Furthermore, we cannot repeat this given its invasiveness.

ReDS is a novel device that measures lung fluid levels noninvasively and easily just for 45 seconds (Fig. 2A,B) [3]. ReDS value had a strong correlation with the degree of pulmonary congestion quantified by computed tomography using a specific dedicated commercial software [4]. Our institute initiated to use this device from August 2021 before commercial use in Japan.

ReDS-guided management of pulmonary congestion

Chest X-ray is a useful modality to assess pulmonary congestion in daily practice, but this assessment is qualitative and requires expert interpretation. In this patient, considerable pulmonary congestion was obvious in the chest X-ray on admission (Fig. 1A). On the contrary, mild to moderate improvement in pulmonary congestion is sometimes challenging to appropriately assess. Change in chest X-ray was relatively small between Fig. 1B and Fig. 1C, whereas ReDS value obviously distinguished them (36% versus 32%).

In this patient, nitroglycerin and IV furosemide were terminated given a decrease in ReDS value. Ventilation was weaned off given the further decrease in ReDS value. We decided to discharge him given a sufficiently decreased ReDS value, indicating complete decongestion. Of note, complete decongestion at discharge is essential to avoid heart failure recurrences [6]. Thus, we can repeat the assessment of pulmonary congestion noninvasively using ReDS device and decide medical management.

Nevertheless, we should state that the ReDS device measures just the lung fluid level alone. The device cannot clarify etiology including pulmonary pneumonia and assess pulmonary function. In the real world practice, we should utilize combination of multi-modalities considering unique features of each modality, as we did in this case. Other multi-modalities are essential for the clinical decision. ReDS system is rather expected to support the decision. Further studies are warranted to validate our proposed strategy: ReDS-guided management of pulmonary congestion.

Another scenario to use ReDS system is out-patient clinic. Given the high sensitivity to detect lung fluid, ReDS system will be useful to rule out any lung abnormalities including pulmonary congestion. The implication of ReDS system beyond this case is the next concern.

Disclosure

All authors have no statements.

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