

Implementing Asthma Monitoring Tools in Your Practice



iSonea

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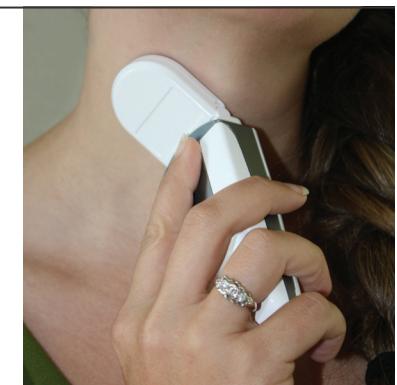


What are AirSonea™ and AsthmaSense®?



AIRSONEA™ DIGITAL WHEEZE MONITOR

Personal monitoring device for patients with asthma



How It Works

- A small sensor is placed on the trachea for 30 seconds
- Sounds are wirelessly transmitted to the patient's smartphone, then uploaded to a cloud-based analytical engine
- Algorithm interprets the sounds
 - Determines if a wheeze is present
 - Provides a quantitative measurement of wheeze
- Wheeze reading and sound file recording are stored in a web database and downloaded to patient's smartphone
- Wheeze recording and results can be emailed to family or healthcare professional
- Wheeze recording and results are also stored on phone



ASTHMASENSE® ASTHMA MANAGEMENT APP

Asthma guardian system

How It Works

- Smartphone app for iPhones or Android phones
- Makes it easy to track symptoms and use of rescue medication
- Reminds the user to take regularly scheduled controller medication
- Allows the phone's GPS function to determine patient location and provide local weather, pollen and air quality information
- Automatic data entry and tracking of AirSonea wheeze monitoring information
- Helps patients manage their action plan – stored on phone for review anytime, anywhere
- Provides objective data for physician review during patient visit



Alerts when asthma risks increase or asthma is not well-controlled

RATIONALE FOR SELF-MONITORING IN ASTHMA

1. Significant percentage of patients can improve the level of asthma control with self-monitoring

- In Australia, two-thirds of people with asthma do not self-monitor their condition¹
- Several studies have demonstrated that mobile phone-based self-care systems can significantly improve expiratory flow rate, episodic exacerbations, emergency visits, and quality of life for asthma patients.^{2,3,4,5}

2. Guidelines⁶ for the care of asthma emphasize

- Engaging patients (and parents) regarding the effective treatment of asthma
- Recognition of asthma triggers
- Adherence to medications
- Frequent monitoring of symptoms — systematically to assess degree of asthma control

3. Many patients under the care of a medical provider still have poor asthma control

- Poor adherence to medications
- Underestimate the severity of their condition
- Do not systematically monitor their condition (symptoms or objective measures)

4. Unmet need for better home monitoring system to increase asthma control

MONITORING IS CONSISTENT WITH MANAGEMENT GOALS

1. The goal of care is to achieve and maintain control and if possible, prevent asthma exacerbations.⁶
2. Every patient should have an Asthma Action Plan designed by his or her doctor.
3. Asthma Action Plans can decrease hospitalizations and deaths from asthma.⁷
4. Typical treatment plans recommend routine doctor visits and ongoing self-monitoring for:⁸
 - Signs and symptoms of asthma, including history of events
 - Breathing function
 - Quality of life
 - Adherence to therapy and potential side effects

ISSUES WITH PEAK FLOW AS ROUTINE MONITORING TOOL

- Recommended in guidelines but seldom used
- > 50% of diagnosed asthmatics are trained on Peak Flow Measurement⁹
- Effort dependent
- Variable results – can give falsely high or low measurements
- Requires manual data entry in diary
- Many people have difficulty using them correctly
- Not appropriate for young children
- In one study (n=296), children 8-16 years old were able to use peak flow correctly only 24% of the time¹⁰



Audio Sonogram of a Wheeze

Recorded with AirSonea

CLICK TO PLAY

WHEEZE

Wheeze is a physiological sign of airflow limitation in asthma.¹¹

The relationship of wheeze to airway obstruction in asthma is well-accepted as an indication of airflow limitation and bronchoconstriction.

- The duration and quality of wheeze depends in part upon the size of the affected airways, the degree of obstruction, and the rate of airflow.
- In very severe obstruction, as flow rates fall toward zero, wheeze may be absent.

Auscultation by a health care professional provides an assessment of wheeze in the practice or clinic, but auscultation is not practical for ongoing patient self-monitoring in the home environment.

Acoustic Respiratory Monitoring (ARM) with AirSonea can provide a surrogate for auscultation outside of the clinical setting.

PHYSICIAN EXAMINATION OF WHEEZE

Physician examination of patients with lung disease typically finds the presence of two categories of abnormal breath sounds:

- Continuous adventitious breath sounds – wheeze
- Discontinuous breath sounds – crackles

The relationship between the degree of airway obstruction and the presence and characteristics of wheeze have been demonstrated in several studies.^{12, 13}

The best correlation is observed when the degree of obstruction is compared with the portion of the respiratory cycle occupied by wheeze:

- Tw/Ttot – time wheezing over time of total breathing cycle, as % or wheeze duration¹²
- Wheezing detected over trachea has been found to correlate closely with methacholine induced 20% fall in forced expiratory volume in one second (FEV₁) in children.¹⁴

THE CHALLENGES OF PATIENT WHEEZE RECOGNITION

In patients with asthma, reported wheeze is a key indicator of recent asthma control.

However, wheeze can be difficult for parents and patients to recognize and quantify:

- Cane, Ranganathan, et al found 55% disagreement between parent and physician assessment of wheeze in children.¹⁵
- Lowe, Murray, et al found that parental reports of wheeze to physicians were unreliable 40% of the time.¹⁶
- Belgrave, Simpson, et al found parental reports of wheezing were unreliable in 33% of cases.¹⁷

“Parents often confuse wheeze with other respiratory sounds, which may lead to the under- or over-estimation of the true prevalence of wheeze.”

Lowe, Murray, et al; *Arch Dis Child* 2004

THE VALUE OF OBJECTIVE WHEEZE MONITORING

Objective measurement and differentiation of wheeze in daily self-monitoring can increase patient or parent awareness of the severity of symptoms, with implications for care.

Joint modeling of parentally reported and physician-confirmed wheeze identifies children with persistent troublesome wheezing

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Background: Previous studies have suggested the presence of different childhood wheeze phenotypes through statistical modeling based on parentally reported wheezing.

Objective: We sought to investigate whether joint modeling of observations from both medical records and parental reports helps to more accurately define wheezing disorders during childhood and whether incorporating information from medical records better characterizes severity.

Methods: In a population-based birth cohort ($n = 1184$), we analyzed data from 2 sources (parentally reported current wheeze at 4 follow-ups and physician-confirmed wheeze from medical records in each year from birth to age 8 years) to determine classes of children who differ in wheeze trajectories. We tested the validity of these classes by examining their relationships with objective outcomes (lung function, airway hyperreactivity, and atopy), asthma medication, and severe exacerbations.

Results: Longitudinal latent class modeling identified a 5-class model that best described the data. We assigned classes as follows: no wheezing (53.3%), transient early wheeze (13.7%),

late-onset wheeze (16.7%), persistent controlled wheeze (13.1%), and persistent troublesome wheeze (PTW; 3.2%). Longitudinal trajectories of atopy and lung function differed significantly between classes. Patients in the PTW class demonstrated the highest rates of hospitalizations and unscheduled visits.

"We observed striking differences in exacerbations, hospitalizations, and unscheduled visits, all of which were markedly higher in patients in the Persistent Troublesome Wheeze class compared with ... the other classes."

¹⁷ Belgrave DM, et al; J Allergy Clin Immuno 2013

ACOUSTIC RESPIRATORY MONITORING OF WHEEZE

The core technology – Acoustic Respiratory Monitoring (ARM™) used in AirSonea has been validated in several studies.*

Studies compared wheeze detected by the sensor and analyzed by algorithms with wheeze ascertained by physicians and nurses examining the patients.

- Several studies were broncho-provocation studies in which wheeze was elicited in patients suspected of asthma
- These studies showed that the ARM technology was capable of recognizing wheeze as well as the medically trained listeners – in some cases, wheeze was detected by ARM prior to becoming audible to the study investigators

Recent analysis compared wheeze detection by an expert panel of pulmonologists with sound files from iSonea's ARM wheeze detection algorithm.

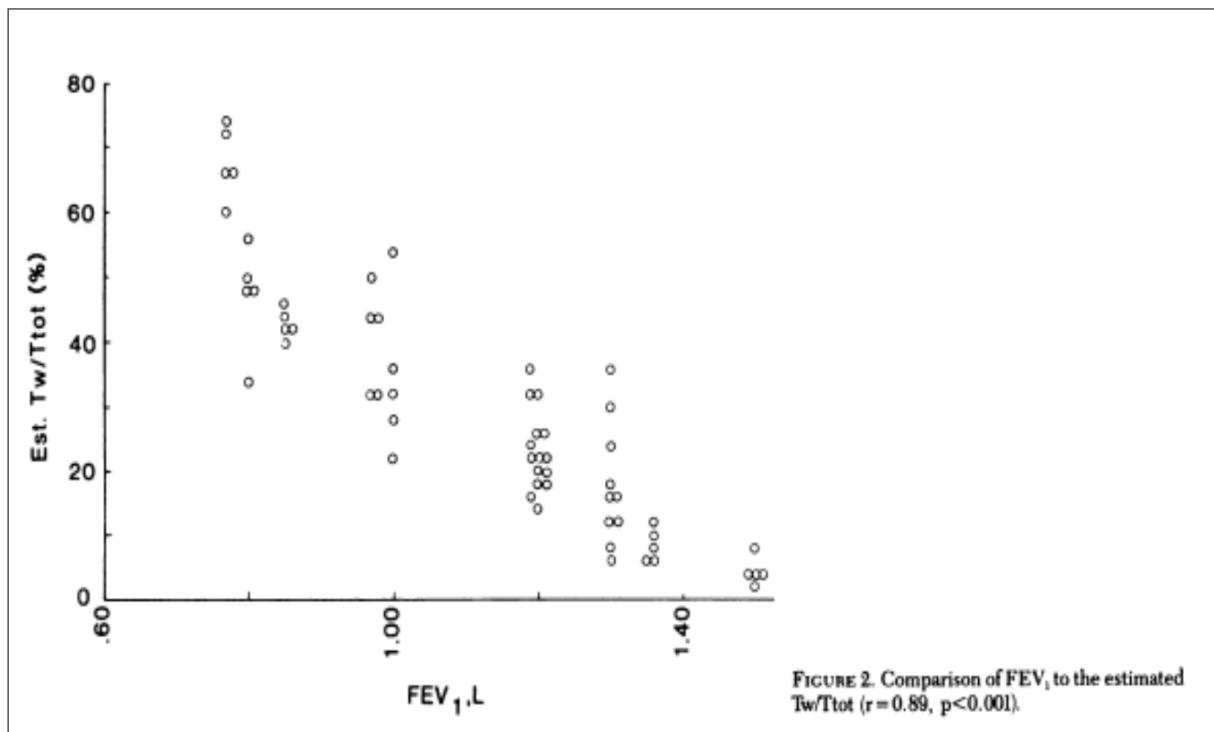
There was 100% positive and 93.3% overall agreement between the AirSonea algorithm and the expert panel for the detection of wheeze.

*See studies on page 18

WHEEZE RATE CORRELATES WITH FEV₁

Peer-reviewed studies by Baughman & Loudon established statistically significant correlation between wheeze rate and FEV₁, using acoustic respiratory monitoring technology.

COMPARISON OF FEV₁ TO WHEEZE RATE



“Analysis of lung sounds for the amount of wheezing in the breath cycle [wheeze rate] correlated with the FEV₁. ”

WHEEZE RATE CORRELATES WITH SYMPTOMS

FIELD STUDY OF ARM TECHNOLOGY:

- Diagnosed asthmatics ranging in age from 11 to 64 years old
- Measured and recorded symptoms, peak flow and wheeze rate pre- and post-bronchodilator administration
- In home for a period of two weeks
- 300 matched data points collected from 21 participants

Change in Wheeze Rate vs. Change in Symptoms

R Square 0.655404791

Weighted R 0.809571

Change in FEV₁ vs. Change in Symptoms

R Square 0.374152765

Weighted R 0.61168

Change in Peak Flow vs. Change in Symptoms

R Square 0.460614552

Weighted R 0.6786859

iSonea sponsored clinical study; data on file

CONCLUSION:

There is a statistically significant and stronger correlation between the Symptoms Scores and Wheeze Rate than seen with Symptoms Scores compared to FEV₁ or Peak Flow.

ARM DETECTED WHEEZE AGREEMENT WITH PHYSICIANS

The ability to successfully record and identify wheeze by the AirSonea sensor and acoustical analysis algorithm has been documented by a comparison study.

- Multiple reader / multiple case clinical study

60 sound files were collected in homes of diagnosed asthmatics.

Seven board-certified pulmonologists reviewed these sound files to determine the presence of wheeze.

Overall agreement between physicians and AirSonea technology for determining the presence or absence of wheeze was 93.3% (intra-observer kappa of 0.71).

PUBLISHED LITERATURE - CORE ARM TECHNOLOGY*

LEAD AUTHOR	PUBLICATION	n	DESCRIPTIONS/CONCLUSIONS
Boner	Jour Asthma 2010	9	Asthmatic patients 9 – 16 yrs old were monitored overnight: symptoms, wheeze rate, AM FEV ₁ ; Pulmotrack detected nocturnal wheezing that would not have been predicted based on reported nocturnal symptoms or FEV ₁ the next AM; nocturnal wheezing correlated with overall symptom score
Visel	Cough 2010	12	Healthy adult volunteers; cough detection; Pulmotrack sensitivity 96%, specificity 87%
Prodhan	Resp Care 2008	11	Neonatal ICU; Pulmotrack more sensitive than auscultation
Beck	BMC Ped 2007	27	RSV bronchiolitis age 2 – 12 mos; feasibility of Pulmotrack CWD (computerized wheeze detection) in assessment of treatment effectiveness
Godfrey	Ped Pulm 2005	80	Pre-schoolers; bronchial challenge; ARM identified wheezing before auscultation
Bentur	BMC Ped 2005	55	Pre-schoolers resp symptoms and bronchial challenge; analysis of PC20-FEV ₁ and wheeze detection methods
Levy	Jour Asthma 2004	31	Age 4 – 62 mos. with asthma symptoms; ambulatory setting; 77% agreement between physician and Pulmotrack wheeze score
Godfrey	Ped Pulm 2004	51	Pre-schoolers with possible asthma/ challenge test; ARM correlation with clinical impressions and electronic stethoscope
Bentur	Chest 2004	28	<24 mos. old; cough; undergoing bronchial provocation test; ARM more sensitive than stethoscope
Bentur	Ped Asthma Allergy 2004	12	Age 7 – 18 with subjective nocturnal wheezing; spirometry and overnight ARM; correlation night-time wheezing and reduced AM FEV ₁ ; ARM comparable to FEV ₁
Bentur	Ped Asthma Allergy 2004	18	Infants with cough overnight esophageal pH and ARM; hyper-reactive airways on ARM correlated with improvement on inhaled steroids and symptoms @ 1yr
Bentur	Eur Resp Journal 2003	12	Age 6-14; mild-mod asthma, studied at home; 7 healthy children also studied; Pulmotrack nocturnal wheeze index correlated with traditional measures

* Pulmotrack ARM system – predecessor of AirSonea device

How AirSonea™ and AsthmaSense® Work



AIRSONEA™ TECHNOLOGY

The ARM technology in Airsonea uses a contact sensor with excellent acoustic properties in conjunction with computerized algorithms to analyze, detect, measure, record and document the presence of wheeze.

The sensor used in AirSonea is superior to standard or electronic stethoscopes in detecting the frequencies that make up the wheeze sound.

- Traditional stethoscopes have a frequency response that attenuates frequency components of lung sounds above 120 Hz¹⁹
- The human ear is not very sensitive to the lower frequency band.²⁰

The higher frequency wheezing sounds are more clearly detected with a sensor placed over the trachea than at the surface of the chest wall.^{20, 21, 22}

The ARM technology produces, records, and automatically documents an objective measurement of wheeze, creating both a sound file for review and a wheeze rate (wheeze duration as % of recorded breathing time).

HOW AIRSONEA AND ASTHMASENSE WORK: RECORDING



Breathing Indicators and Symptoms

- AsthmaSense alerts patient to check his WheezeRate
- AirSonea device activated by app on smartphone
- AirSonea verifies proper sensor placement and audible breath signal
- Records and transmits 30 seconds of breathing to smartphone
- Data entry is automatic

HOW AIRSONEA & ASTHMASENSE WORK: ANALYSIS



Automatic Data Transmission

- Data sent to Cloud
- ARM algorithm interprets
- Detects presence and extent of wheezing
- WheezeRATE downloaded to phone and AsthmaSense database within seconds
- Environmental stimuli assessed by AsthmaSense



Asthma Risk Alerts

HOW AIRSONEA & ASTHMASENSE WORK: NOTIFICATION



Quick Response to Patient/Parent

- Patient receives assessment of WheezeRATE – indication of changing level of asthma control
- Awareness encourages adherence to treatment plan
- Can share wheeze rate data and sound file via email
- One-touch emergency number dialing via AsthmaSense, if needed

HOW AIRSONEA & ASTHMASENSE WORK: IN PRACTICE

Portable monitoring device used by patients with asthma

- Algorithm interprets the sounds
 - Determines if a wheeze is present
 - Provides a quantitative measurement of wheeze
- Stores the WheezeRATE and sound recording on the device and in the Cloud
- Wheeze audio and sonogram files can be reviewed at patient visit

Helps to Align Treatment Goals

- Wheeze files available for MD review
- Trends – asthma events, symptom history, triggers, medication use, breathing indicators
- Medication adherence data
- Response to medication

AIRSONEA DEMO VIDEO

CLICK TO PLAY

Integration of AirSonea & AsthmaSense into clinical practice



WHEEZE MONITORING IN YOUR PRACTICE

Patients with an established diagnosis of asthma can use AirSonea as a home monitoring device.

- Patients should establish a track record of readings at various times such as before and after bronchodilator treatments and exercise
- In the mornings and evenings, when there may be a higher risk of exacerbations
- Readings of a Wz% of 0 – 3% indicate a lack of detectable wheeze
- Readings of Wz% above 3% need to be considered in the context of the patient's symptoms at the time as well as his or her earlier track record of Wz% readings

Wheeze detection sensors and software can be used for long-term monitoring to assess asthma control and the efficacy of treatments.

Wheeze analysis can provide information about the degree of airflow obstruction and asthma control.¹⁸

Patients who are experiencing respiratory distress should seek emergency care regardless of WheezeRATE.

AIRSONEA & ASTHMASENSE – PRACTICE IMPLICATIONS

Easy-to-use, smartphone-based monitoring system can lead to improved patient self-monitoring.

Accurate wheeze measurement and documentation provides objective data for physician review quickly or at a routine visit, with nothing “lost in translation” and no patient guesswork.

Increased monitoring leads to enhanced patient awareness of symptom severity, triggers, and risks that could signal onset of an asthma exacerbation.

Better vigilance by patients and parents can result in better adherence to physician-prescribed treatment plans and greater asthma control.

Routine monitoring outside the doctor's practice can help achieve the treatment goals:

- Gaining and maintaining control of asthma
- Prevention or reduction of serious exacerbations
- Reduction of emergency visits and hospitalizations

AIRSONEA SYSTEM DATA TRANSFER



FREQUENTLY ASKED QUESTIONS

What is a acceptable Wz%?

- Patients should establish a track record of Wz% readings at various times such as before and after bronchodilator treatments and exercise
- A Wz% of 0 – 3% represents a lack of detectable wheeze
- Wz% readings above 3% need to be considered in the context of the patients typical readings at various times

What should a patient do if their Wz% is 0 or within their usual range but they feel poorly or are short of breath?

- Symptoms that are uncomfortable or are potentially worrisome such as dyspnea should be acted on by the patient regardless of the Wz% readings
- Do not rely upon wheeze monitoring to determine medication requirements

Will patients be willing to do all this monitoring and input?

- Many patients find responding to a Smartphone prompt is easier and less burdensome than keeping a paper diary
- Not all patients need to use all of the features of AsthmaSense all the time
- Parents and other family members are often motivated to help engage the patient on use of the system.
- There is a coolness factor to using the SmartPhone in this way that appeals to teenagers

What if I don't want all this data?

- AirSonea can be used as a stand alone measurement device
- Use of AirSonea Cloud is an option – probably best used for more severe patients and in particular if there are staff that can assist
- The journaling function of AsthmaSense is designed to save time and requires that you enter in only the data that you want to track

APPENDIX AND SOURCES



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The AirSonea Digital Wheeze Monitor is currently available for sale in Australia. It can be purchased for **\$169.95** online at www.AirSonea.com.au and soon in pharmacies.

The AsthmaSense Cloud Asthma Management app can also be downloaded at no charge from the iTunes and Google Play app stores.

