Cough Detection Performance of the CoughCheck™ Algorithm in Subjects with Subacute Cough

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RATIONALE

- Progress in deep neural network algorithms presents an opportunity to expand the application of objective cough monitoring by supplementing manual human annotation
- Cough annotation by algorithm from sound recordings would expand the scope and lower the cost of objective cough monitoring, particularly in studies with larger populations
- We report here the performance of the CoughCheck™ signal processing algorithm to identify cough events in continuous, real-world respiratory recordings in a population with subacute cough

METHODS

CoughCheck was trained to identify cough events in a set of respiratory sound recordings

- Collected using a dedicated biosensor (**Fig. 1**)
- Collected during ordinary daily conditions (including sleep, sedentary time, and activity) with **no specific restrictions** on environment (e.g., avoiding high-noise environments)
- 249 subjects with cough (chronic (≥8 weeks) and subacute cough (3-8 weeks))
- 3,099 hours (233,626 human-annotated coughs)
- CoughCheck agreement with cough identification with human-annotation was assessed in a separate benchmark set

Figure 1: The RESP Biosensor

LEXICON

- **Precision**
  Ratio of True Positive cough predictions over the sum of coughs identified by the algorithm
- **Sensitivity**
  Ratio of True Positive cough predictions over the sum of human-annotated coughs
- **Absolute cough count**
  Number of algorithm-predicted coughs vs. the number of human-annotated coughs, independent of timing
- **Temporal detection of cough events**
  The timing-dependent assessment of algorithm-predicted cough events vs. human-annotated cough events

RESULTS

Performance Benchmark Set

Data Collection
- Dedicated biosensor (**Fig. 1**)
- Continuous & ambulatory
- Ordinary daily conditions

N = 36

Condition
Subacute Cough (3-8 weeks)

Average Duration
23.5 hours

Total
845 total hours
14,486 human-annotated coughs

Mean Cough frequency
17.11 ± 23.24 **coughs/h** (arithmetic)
8.53 ± 3.34 **coughs/h** (geometric)

24-hour Cough Frequency Determination

- Correlation with human annotation (**Fig. 2**): R^2=0.993
- Mean absolute error (**Fig. 2**): 1.16 coughs/h
- Bland Altman analysis (**Fig. 3**):
  - Mean difference (bias): -0.285 coughs/h
  - Standard deviation of differences: 1.77 coughs/h

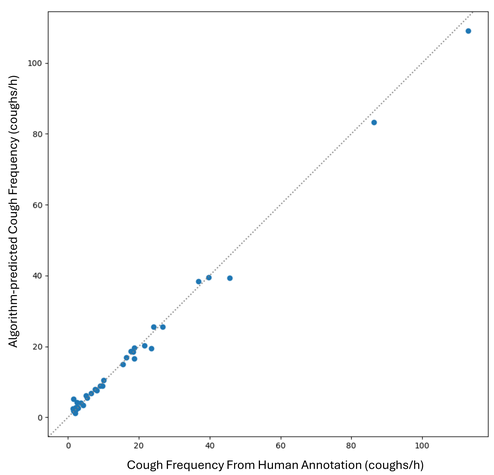

Figure 2. Algorithm-predicted vs human-annotation derived hourly cough frequency

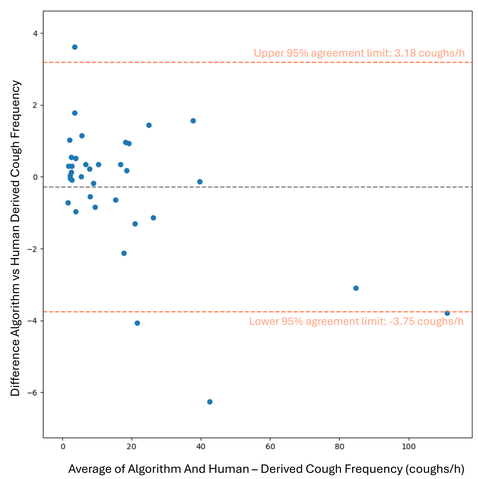

Figure 3. Bland Altman Plot of Algorithm vs. Human – Derived Cough Frequency

Precision & Sensitivity

Absolute cough count
- Precision 97.4%
- Sensitivity 95.7%
- Mean overcounting rate: 0.433 coughs/h

Temporal cough events count (**Fig. 4**)
- Precision: 91.5%
- Precision at 80% sensitivity: 90.4%
- Precision at 90% sensitivity: 78.8 %

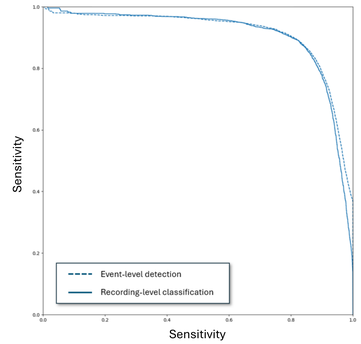

Figure 4: Precision/Sensitivity Curve for Cough Detection (temporal events)

CONCLUSIONS

- CoughCheck was able to derive 24-hour cough frequencies with satisfactory agreement with human annotation and a low mean overcounting rate in a population with subacute cough
- These results warrant the continuing development and validation of CoughCheck for objective cough monitoring purposes
- Future work will evaluate the performance of CoughCheck in other cough categories (e.g. chronic cough), etiologies and applications