

Pragmatic Audio Standards for Remote Digital Auscultation



Pilot blinded clinician comparison for shared lung sound review

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67 of 90 blinded ratings could not tell Bluetooth from wired; in every pair, fewer than half the raters heard a difference.

Aim / Objectives

- Vision: patients under KTPH@Home self-record lung sounds at home, similar to home vitals monitoring, so clinicians can review remotely and track the case over time.
- This pilot asks the first question: are lung sounds sent over Bluetooth at 8 kHz / 16-bit similar to direct wired recordings, and which sounds more realistic, in blinded ratings?
- Identify the next clinical validation study for KTPH@Home shared review.

Background

- Home visit staff and command-centre clinicians need the same interpretation of clinical findings; verbal relay alone limits escalation confidence and follow-up comparison.
- Digital auscultation is useful only if clinicians trust the transmitted sound.
- Commercial stethoscopes fix very different sampling rates - Littmann Electronic 4 kHz, Clinicloud DS 44.1 kHz (CD quality). A higher rate captures more detail but sends more data [3].

Interventions / Implementation

Pilot Listening Study

10 paired samples | 9 raters | 90 blinded ratings

- Lung sounds recorded from study team members, not patients.
- 9 clinicians (doctors and nurses) made 90 blinded A/B judgements, without knowledge of recording mode.
- Primary endpoint: No Difference + Cannot Tell.

Bluetooth 8 kHz / 16-bit against three wired settings

Comparator	What it tests	Expected	Supported?
4 kHz / 16-bit	lower spec audible?	different	partly
8 kHz / 16-bit	consistency check	same	yes
44.1 kHz / 32-bit	vs CD quality	same	yes

Partly: 28/36 could not tell; 6 of 8 chose Bluetooth.

Proposed KTPH@Home Workflow



Value: shared interpretation, asynchronous consultation, and a retrievable record to track over time.

Limitations

- Pilot only: 10 paired samples, 9 raters, 90 ratings.
- Study-team lung sound recordings in a listening task, not patients.
- Perceptual endpoint; diagnostic accuracy not tested.
- Mostly 3 of 9 raters heard differences; intervals approximate.

Refs: [1] KTPH@Home service. [2] Magor et al., Diagnostics 2023;13:3153. [3] Kevat et al., Respir Res 2020;21:253.

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Results & Outcomes/ Discussion

Most comparisons did not separate Bluetooth from wired recordings.

67/90

ratings could not tell Bluetooth from wired

44 (49%)

23 (26%)

23 (26%)

Of 90 ratings: 44 heard no difference, 23 could not tell, 23 heard a difference.

Could not tell them apart: 78% against half rate 4 kHz, 69% against same rate 8 kHz, 78% against CD quality.

Which sounded more realistic?

Asked only of the 23 ratings that heard a difference.

	chose Bluetooth	chose wired
vs half rate 4 kHz	6	2
vs same rate 8 kHz	6	5
vs CD quality 44.1 kHz	2	2

Centre line = an even split. Only half rate 4 kHz lost.

Most cited reason: clarity (11 of 23).

Together: listeners hear the drop below 8 kHz, but not the gain above it.

Expected experience (not yet measured): patients record at home, nurses send sound not words, doctors compare over time.

Conclusion

- Results were similar against all three wired settings (69-78% could not tell them apart).
- When a difference was heard, the lean was against 4 kHz, not against Bluetooth (6/8 votes).
- The 8 kHz Bluetooth setting is a practical hardware tradeoff, not a final diagnostic standard.
- Next study: patient self-recording at home, diagnostic confidence, escalation decisions, and home noise.

Design target: at 8 kHz / 16-bit the sound keeps enough detail for a clinician to act on, and the file stays small enough to send from a home visit.