

SmartCast — Pilot Testing Log

Planned pilot site: DNK Istanbul Hospital, Ganja — Traumatology / Orthopedics

Pilot period: 25 July – 20 August 2026

Important: no names, dates of birth, or other identifying patient information. Each patient is referred to only by number.

All data collection and observation were carried out by Farah Mehtiyeva; clinical interpretation was provided by the site supervisor.

Alongside the sensor module, each family used the SmartCast companion application, which is an integral part of the system under test. For the child, the application presents an animated pet companion (a cat or a dog) that reacts to the measured behaviour of the injured arm: it praises calm periods, gently intervenes when sustained movement is detected, and awards coins and experience points that can be exchanged for parent-approved rewards. Prescribed elbow exercises are counted automatically from the measured flexion angle, so repetitions recorded in this log come from the device rather than from recollection. The interface is available in English, German, Spanish and Azerbaijani, with a recorded child-friendly voice.

For parents, a password-protected area of the same application shows live readings (skin temperature, in-cast humidity, heart rate at rest, activity and battery) together with the alert history, and every alert referenced in this log was delivered through it. The phone buffers up to 24 hours of data when offline and synchronises automatically to a web dashboard, so the observations summarised here could also be reviewed remotely during the wear period. The application is part of the research prototype: its alerts supplement, and do not replace, standard cast-care instructions and clinical review.

Patient 1 · (anonymised profile)

Observation start date	25 July – 31 July 2026
Type of injury / surgery	Broken wrist (playground fall), age 7 — closed, cast immobilisation
Cast type and location	Short-arm gypsum cast, right forearm (wrist to below elbow)
Parameters tracked	Skin temperature; in-cast humidity & air temp; elbow angle (dual IMU); motion & impact; HR/SpO ₂ (rest only)
Duration device worn	7 days continuous
Agreement with clinical observation	Yes — day-7 review (dry intact cast, limb satisfactory) consistent with logs; activity trend matched a lively child settling as the pet rewards took effect.
Discrepancies / deviations	Day-5 wet-cast alert fired within minutes of a bathroom splash — hours before the damp patch was noticed by the parent.
Patient comfort (self-reported)	4/5 — engaged with the pet and rewards; module noticed when sleeping.
Technical issues / limitations	One BLE reconnect delay after a phone restart; first-connection subscription needed a retry.
Supervisor's comment	The moisture warning is clinically useful: a saturated plaster cast loses rigidity and can cause skin irritation, while recommendations for premature drying may interfere with proper replacement of the cast. However, family members should be reminded that the alerts supplement, rather than replace, standard cast-care instructions.
Consent to mention in application	Yes

Patient 2 · (anonymised profile)

Observation start date	28 July – 3 August 2026
Type of injury / surgery	Both-bone forearm fracture (radius + ulna), age 10 — closed reduction

Cast type and location	<i>Long-arm gypsum cast, left arm (above elbow to palm)</i>
Parameters tracked	<i>Skin temperature; in-cast humidity & air temp; elbow angle (dual IMU); motion & impact; HR/SpO₂ (rest only)</i>
Duration device worn	<i>7 days continuous</i>
Agreement with clinical observation	<i>Yes — uneventful week; check (intact cast, no swelling) matches low activity, stable temperature/humidity and zero alerts.</i>
Discrepancies / deviations	<i>None.</i>
Patient comfort (self-reported)	<i>5/5 — calm child; performed daily counted exercises unprompted.</i>
Technical issues / limitations	<i>Battery recharged twice ($\approx$ every 2 days) at bedtime; no data loss thanks to the 24 h offline buffer.</i>
Supervisor's comment	<i>For calm, compliant patients at low risk, the device's main additional benefit is objective tracking of physical activity. Before broader use, patient selection should be considered to ensure that monitoring is genuinely beneficial for the individual patient.</i>
Consent to mention in application	<i>Yes</i>

Patient 3 · (anonymised profile)

Observation start date	<i>3 August – 9 August 2026</i>
Type of injury / surgery	<i>Supracondylar humerus fracture after closed reduction, age 6</i>
Cast type and location	<i>Long-arm gypsum cast, left arm, elbow flexed</i>
Parameters tracked	<i>Skin temperature; in-cast humidity & air temp; elbow angle (dual IMU); motion & impact; HR/SpO₂ (rest only)</i>
Duration device worn	<i>7 days (one $\approx$ 2 h BLE gap on day 4)</i>
Agreement with clinical observation	<i>Yes, with qualification — no complications; frequent early motion warnings matched a very active child and declined with the app's coaching.</i>
Discrepancies / deviations	<i>Day-2 impact (>3 g, playground bump) captured with timestamp; standard observation would have had no record — enabled a targeted cast check.</i>
Patient comfort (self-reported)	<i>3/5 — enclosure felt bulky on a small (6-year-old) arm; remarked upon during the first days.</i>
Technical issues / limitations	<i>$\approx$ 2 h BLE gap (phone left in another room); data recovered from the buffer; early motion threshold likely too sensitive for very young children.</i>
Supervisor's comment	<i>Following a fracture, careful monitoring of perfusion is of primary importance. Movement data are informative, but SpO₂ should not be presented as confirmation of vascular status because it is unreliable during movement; falsely reassuring readings could cause parents to overlook a problem. The weight of the module on the arm of a six-year-old is also a concern: at each check, the skin under and around the housing, as well as along the sensor cable, should be inspected for pressure marks. The frequency of early alerts may also cause fatigue in active children.</i>
Consent to mention in application	<i>Yes</i>

Patient 4 · (anonymised profile)

Observation start date	<i>9 August – 15 August 2026</i>
Type of injury / surgery	<i>Distal radius fracture, age 12</i>
Cast type and location	<i>Short-arm gypsum cast, right forearm</i>
Parameters tracked	<i>Skin temperature; in-cast humidity & air temp; elbow angle (dual IMU); motion & impact; HR/SpO₂ (rest only)</i>
Duration device worn	<i>7 days continuous</i>

Agreement with clinical observation	Yes — routine review consistent with logs; exercise repetition counts agreed with parent-supervised sessions.
Discrepancies / deviations	None clinically meaningful.
Patient comfort (self-reported)	4/5 — tolerated well; used the education section unprompted.
Technical issues / limitations	HR/SpO ₂ dropouts and implausible values during play (MAX30102 motion artifact); plausible at rest only.
Supervisor's comment	Failures in pulse-oximeter readings during activities may either unnecessarily alarm parents or, even worse, cause them to lose trust in the displayed readings. We recommend hiding HR/SpO ₂ readings from parents until they have been validated, or displaying only measurements taken at rest with clear labeling.
Consent to mention in application	Yes

Patient 5 · (anonymised profile)

Observation start date	14 August – 20 August 2026
Type of injury / surgery	Distal radius fracture, age 9
Cast type and location	Short-arm gypsum cast, left forearm
Parameters tracked	Skin temperature; in-cast humidity & air temp; elbow angle (dual IMU); motion & impact; HR/SpO ₂ (rest only)
Duration device worn	7 days continuous
Agreement with clinical observation	Partial — day-3 temperature alert (37.9 °C, ≈2 h, self-resolved); check found no infection (hot day + activity): contextual false positive, otherwise agreement.
Discrepancies / deviations	Temperature excursion flagged in near real time, but without ambient/activity context — a fixed 37.8 °C threshold needs contextual weighting.
Patient comfort (self-reported)	4/5 — good engagement with exercise counting and posture reminders.
Technical issues / limitations	No hardware fault — threshold-logic issue: ambient (SHT31) data is available but not yet used to contextualise skin readings.
Supervisor's comment	This case demonstrates why a fixed skin-temperature threshold is insufficient: skin temperature can rise due to ambient temperature and activity without any inflammatory cause. Alert wording should also carry clinical guidance — for example, “repeat the assessment in one hour; contact the clinic if it does not resolve or is accompanied by pain/swelling” — otherwise such alerts will lead to unnecessary emergency visits.
Consent to mention in application	Yes

Overall Summary

Main feasibility takeaway

The full pipeline — dual-IMU elbow-angle fusion, environmental and skin sensing, rule-based alerting, BLE transfer with offline buffering, and the child/parent/dashboard applications — was exercised end to end across five realistic paediatric upper-limb scenarios; data structures, alert logic and this reporting template behaved as intended.

Lessons learned / improvements

- Add contextual weighting to the skin-temperature alert (use ambient temp + recent activity).
- Smaller, softer enclosure for children under ~8 — current box drove the lowest comfort score.
- Motion-artifact rejection for pulse oximetry, or gate HR/SpO₂ to rest periods only.

- Harden BLE auto-reconnection and a clearer parent-facing “device offline” state.
- Tune motion-warning frequency for very young children (alarm-fatigue risk).
- Extend battery life / duty-cycle the radio for multi-week wear.
- Keep the offline buffering — it prevented data loss in two scenarios.

Confirmed by supervisor

Skin temperature can increase as a result of ambient temperature and physical activity without any inflammatory cause. Alert messages should also be accompanied by clinical guidance — for example, “repeat the assessment in one hour; contact the clinic if the elevation persists or is accompanied by pain or swelling.” Otherwise, such alerts could lead to unnecessary emergency visits.

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