LLUI
Prof. Dr. Christoph Bauer
Group Lead
Therapy Science Lab
Lake Lucerne Institute
www.linkedin.com/in/christoph-bauer

APP/INTERNET-BASED FOLLOW-UP AND COACHING OF POST-STROKE PATIENTS

POST STROKE FOLLOW UP – WHY?

Therapy Science Lab
Ubiquous Adaptive Rehabilitation Pathways

~2 in 3 stroke survivors live with unmet needs after stroke —
and those needs grow, not fade, with time. [1-3]

Prevalence

~2 in 3 report ≥1 unmet need[1] — not just motor: information, fatigue, cognition, mood.

Trajectory

Unmet needs don't fade with time: 62% at 6 months → 81% at 2 years.[2]

Care Gap

Structured follow-up in primary and community care remains inconsistent.[3]

Questions

How can we meet these needs within the resources of our system?
What evidence do we have? What do we have available?

[1-3]

DEMOGRAPHIE, FACHKRÄFTE UND REHABEDARF

Demografie (41-43)

- Anteil 65+ steigt 19.9% → 25.5% (2025→2055), absolut 1.81 → 2.67 Mio
- Bevölkerung wächst auf 10.5 Mio. bis 2055 (Referenzszenario)
- Wachstum ab ~2035 überwiegend migrationsgetrieben.

Fachkräfte (44-45)

- Nachwuchsdeckung bis 2029: Tertiär 67% (28’900 vs 43’400), Sek II 80% (21’600 vs 27’100).
- Folge: struktureller Mangel in allen Versorgungssettings

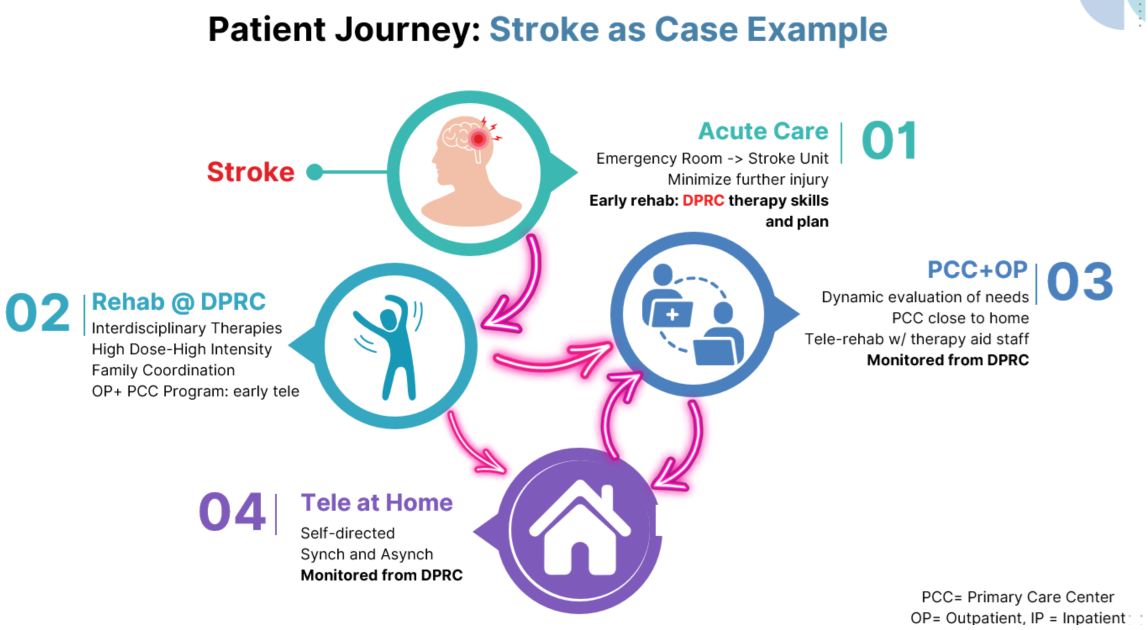
Reha-Bedarf(6-7)

- Stationäre Rehabilitation (Kanton Luzern als CH-Referenz, 2012→2021): Fälle +37%, Rate +25.9% (5.9→7.4/1’000).
- Mittlere Aufenthaltsdauer (MAHD): 25.6 Tage (LU) vs 24.1 Tage (CH) → mehr & längere Reha-Episoden.
- Schlaganfall 2022: ~21’800 Hospitalisierungen → direkte Reha-Nachfrage.

CONTINUOUS CARE – FROM ACUTE TO HOME

From Acute Care to Rehab:

- Acute → rehab → community, with decision checkpoints (restitution → compensation)
- Delivery spectrum: in-person → telerehab (asynchronous, remote review)



[4-5]

FOLLOW UP AND COACHING

"Follow-up" has different dimensions

Clinical follow-up

Monitoring recovery, adjusting medication, catching complications or recurrence.

Follow Up Treatment

Follow-up treatment: continued, dose-bearing rehabilitation after discharge.

Weeks 1–2

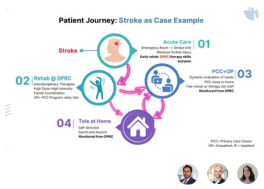
Therapist-led training

Week 3 onward

Semi-asynchronous self-training, with 2–3×/week check-ins

Monitoring: cloud-logged reps, HR, arm-use (asynchronous) + short video check-ins (synchronous)

Training itself adapts: adaptive in-app difficulty pushes the patient to progress, not just repeat.



[6]

COACHING AND SECONDARY PREVENTION

Evidence for coaching and secondary prevention — Targets: blood pressure and adherence.

Systolic blood pressure reduction vs. usual care (mmHg)

Munir 2024 (21,904 patients reviewed): also found a significant SBP reduction with telemedicine follow-up (p=0.003).

Nurse-led telecare (Wong 2025, 9 RCTs, n=2524)

More than doubles the odds of hitting BP targets: **OR 2.33 (95% CI 1.83–2.98, p<.001).**

But its pooled continuous SBP reduction was **not statistically significant** (MD −4.83, 95% CI −12.51 to 2.85) amid very high heterogeneity (I^2=92%)

COACHING AND SECONDARY PREVENTION

Long term follow up

SINEMA (rural China, n=1299) — effects over years

12 months

SBP −2.8 mmHg (95% CI −4.8 to −0.9, p=.005) vs. usual care

5.5 years

SBP −2.8 mmHg (p=.03); recurrence RR 0.77 (0.61–0.99)

6 years

All-cause mortality HR 0.73 (.59–.90); CV-mortality HR 0.73 (sig.); stroke-specific HR 0.71 (NS, p=.16)

Cost-effectiveness: $8.4 per 1 mmHg SBP reduction; $837.9 per QALY within-trial, $727.9 post-trial (Yang et al. 2025).

NAILED (Sweden, n=871, telephone-only follow-up)

At 36 months: SBP 6.1 mmHg lower (95% CI 3.6–8.6, p<.001); LDL-C 0.3 mmol/L lower (p<.001).
More patients at target: **79.4% vs. 55.3% for BP; 69.3% vs. 48.9% for LDL-C (both p<.001).**

[11-15]

FACTORS DRIVING SUCCESS IN COACHING

SINEMA — village-doctor model

Trained village doctor
Performance-paid; monthly in-person visits

App decision-support
Android app structuring each visit

Automated reminders
Daily voice messages: meds + activity

NAILED — nurse case-manager model

Nurse-led telephone follow-up
Structured calls, no app

Treat-to-target protocol
BP <140/90, LDL-C <2.5 mmol/L, checked yearly

Medication titration
Escalated only for patients off target

NULL RESULT IN COACHING STUDY

SPRINT INDIA — one-way messaging model

Automated SMS

One-way prompts — no dialogue

Videos + workbook

Self-directed, 12 languages

No case manager

Standard care only — no escalation rule

SPRINT INDIA (India, n=4298, 31 centres) — stopped early

Primary outcome at 1 year (composite: recurrent stroke, high-risk TIA, ACS, death): *5.5% vs. 4.9%, adjusted OR 1.12 (95% CI 0.85–1.47), p=.37 — not significant.*

Secondary: smoking/alcohol cessation and medication compliance improved (all p<.05); BP, LDL-C, glucose, BMI, mRS and physical activity unchanged.

Engagement: *only 17% acknowledged receipt of messages/videos; ~15% lost to follow-up before 1 year — authors flag possible reduced power (type II error).*

[18]

POSSIBLE INFLUENCING FACTORS

Comparing SPRINT INDIA to SINEMA and NAILED points to four recurring factors.

Human in the loop

SINEMA/NAILED: village doctor or nurse case-manager acts on the data.
SPRINT INDIA: one-way automated messages only.

Escalation protocol

SINEMA/NAILED: treat-to-target — meds titrated when off-target.
SPRINT INDIA: no escalation rule.

Patient engagement

SINEMA: ~90% visit fidelity.
SPRINT INDIA: only 17% acknowledged messages.

Outcome & power

SINEMA/NAILED: continuous BP/LDL, sensitive to change.
SPRINT INDIA: rare hard events + 15% lost to follow-up → underpowered.

Possible influencing factors

Low burden monitoring channel, with bilateral interactions, combined with a human in the loop.

[11,15,16,17,18]

FOLLOW UP TREATMENT

Current evidence suggests: telerehab performs like usual or in-person care — not better, not worse.

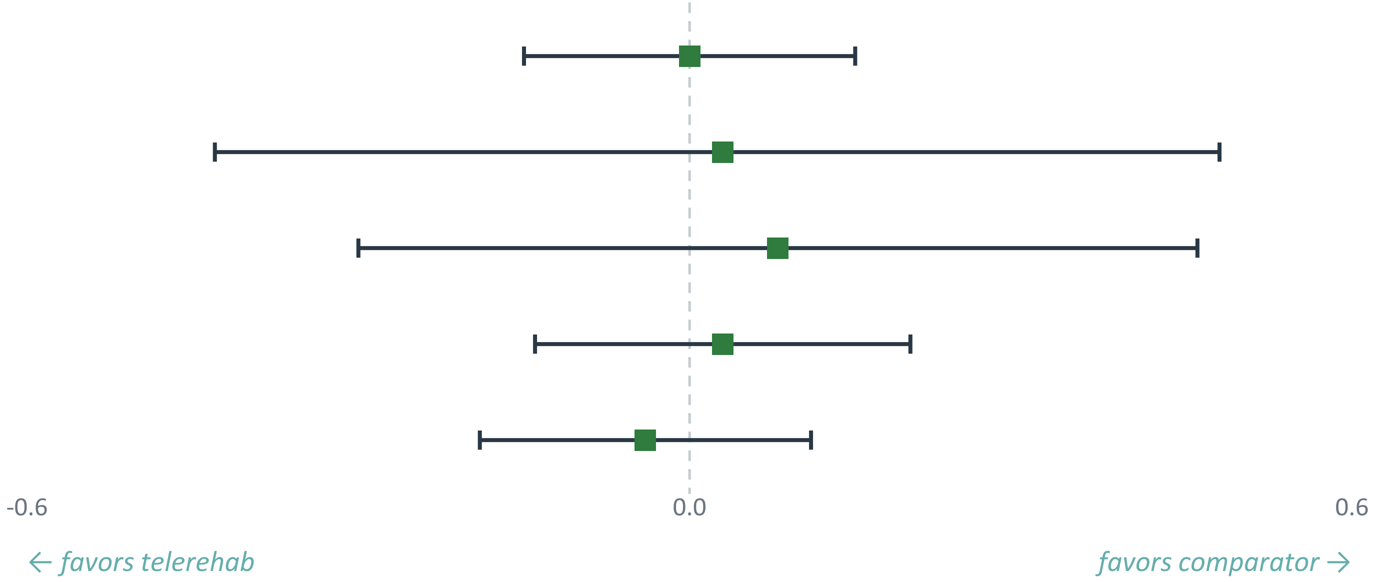
ADL vs. usual care
2 studies, n=661 · moderate-quality evidence

ADL vs. in-person therapy
2 studies, n=75 · low-quality evidence

Balance vs. in-person therapy
3 studies, n=106 · low-quality evidence

Quality of life vs. usual care
3 studies, n=569 · moderate-quality evidence

Depression vs. usual care
6 studies, n=1145 · moderate-quality evidence



Other data: Upper limb function vs. in-person therapy : 3 studies, n=170, mean difference 1.23 (95% CI −2.17 to 4.64), low-quality evidence — also crosses the line of no effect.

BaniHani 2026 — 28 studies, ~1237 patients

Narrative synthesis (too heterogeneous to pool): functional gains "comparable to in-person care" but "not consistently superior to standard rehabilitation across all studies."

Gallinaro 2026 — RCT, n=39

Cognitive telerehab vs. face-to-face training: comparable gains in visual attention and long-term memory at treatment end and 2-month follow-up; working memory/dual-task, mood and QoL unchanged in both arms.

FOLLOW UP THERAPY – MOTOR REHABILITATION

The gap between evidence-based recommendations and clinical practice.

Usual-care active upper-limb practice

Newton 2023: 8–44 min/day, increasing vs. a previously reported ~21 min/day average

Hayward & Brauer 2015: 4–17 min/session depending on discipline and setting

What's recommended and what's achievable

ESO 2025 guideline: +20h upper-limb practice recommended (weak recommendation, very-low-quality evi

Queen Square protocol: 90h delivered over 3 weeks, gains sustained to 6 months

DOSE trial: doubling to quadrupling usual walking-therapy intensity over 4 weeks improved endurance by 58–61m vs. control (sustained at 1 year)

Synthesis:

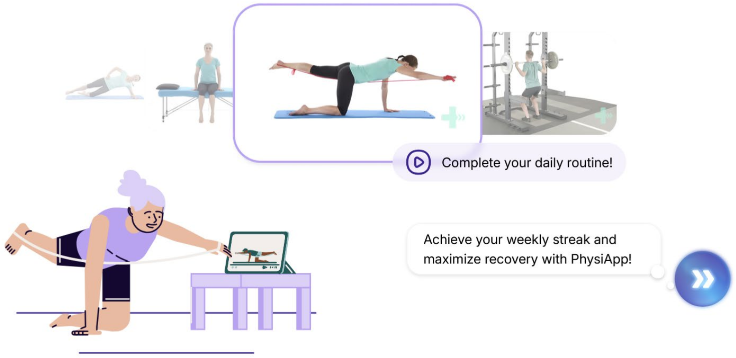
20 to 90 hours of extra practice is achievable and effective — the challenge is delivering it within the health care system.

[22-26]

MOVEMENT REHAB COACHING AND FOLLOW-UP

PhysiApp / Physitrack

Home-exercise prescription + adherence tracking and video check-ins (telerehab + coaching, combined). Class I CE-marked



Home exercise

Video-guided, prescribed exercise programme

Monitoring & outcomes

Adherence tracking + patient-reported progress

Video consultation

Remote check-ins with the treating clinician

Coaching & reminders

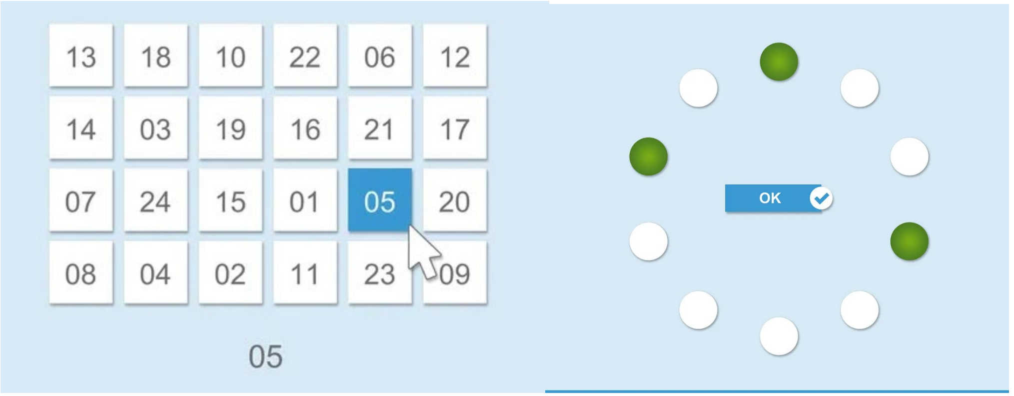
Messaging to reinforce adherence

T
[29-31]

COGNITIVE TELEREHABILITAITON

RehaCom®

Cognitive telerehabilitation (attention, memory, executive function, neglect). Class I CE-marked under MDR 2017/745. Sold in Switzerland via Testzentrale der Schweizer Psychologen (Hogrefe AG, Bern).



Attention

Sustained & selective attention training

Memory

Working & episodic memory exercises

Executive function

Planning, sequencing, problem-solving

Visual neglect

Cancellation-style spatial-attention tasks

[32-33]

MOVEMENT (TELE)-REHABILITATION & COACHING

MindMotion Go®

82.2% of training was asynchronous (no therapist present); 39.7h mean active training. [25]

Cost per patient

~$338 telerehab

vs.

~$1,903 in-person

for an equivalent training dose.

Upper-limb function

Fugl-Meyer UE: +6.4 pts, $p<.001$

Gait

Functional Gait Assessment: +3.1 pts, $p<.001$

Balance

Berg Balance Scale: +6.1 pts, $p<.001$

Monitoring & outcomes

82.2% asynchronous; weekly therapist review via web app

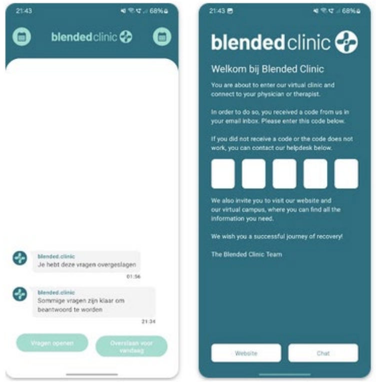
[28,34]

INVESTIGATIVE TRAINING AND COACHING APP

Start®

Swissmedic-notified clinical investigation (device 10001354); feasibility study, n=40 — not yet CE-marked

Reha Rheinfelden, University Hospital Basel, University of Basel, Bern University of Applied Sciences



Training

Structured home exercise delivery

Coaching

Behaviour-change support

Patient education

Condition- and self-management information

Monitoring & outcomes

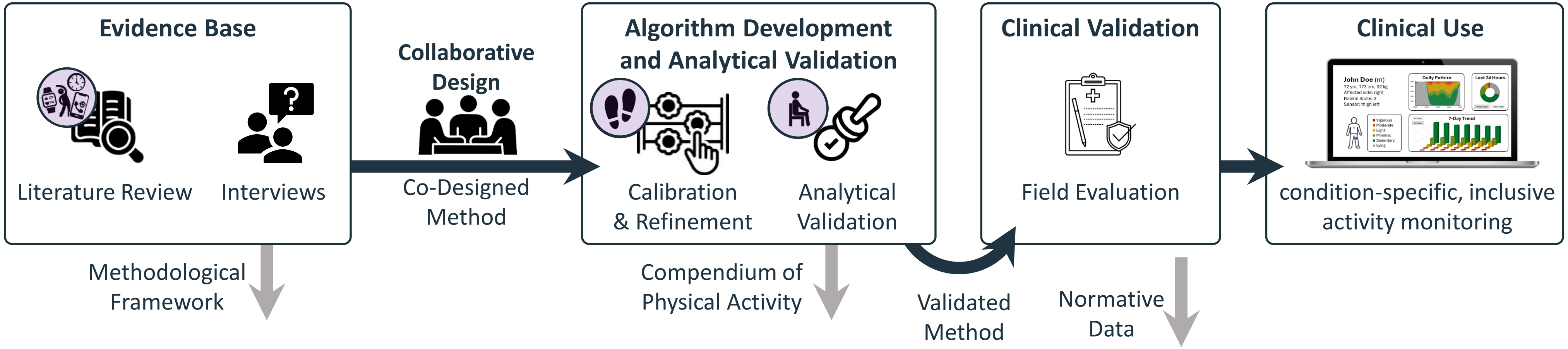
Usage/adherence data + PROMs, combined here

REMOTE ACTIVITY MONITORING

Physical activity is a significant predictor of long-term disability in most clinical populations

Monitoring physical activity typically relies on self-reports, little is known about sensor-based monitoring

Primary aim – quantify real-world physical activity patterns in clinical populations to inform and personalize rehabilitation



[38]

ISPEAK TELE

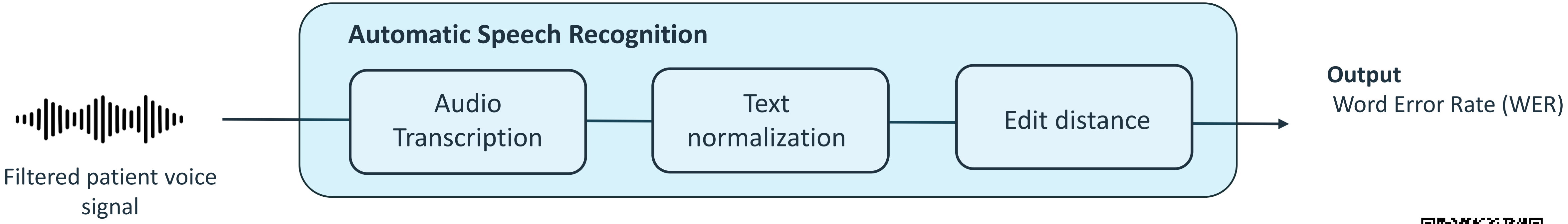
AI-supported dysarthria assessment tool that automatically analyzes **dysarthric speech; the motor speech disorder** affecting up to 42% of stroke survivors.

Motivation:

- Current clinical practice relies on handwritten assessments and perceptual listening.
- No clinician-friendly web tool integrates automatic speech recognition with acoustic analysis in tele-rehabilitation.

Goal: To replace subjective, paper-based FDA-2 scoring with objective, quantitative, and shareable digital measurements.

Next step: Pilot validation with existing database and target population



TAKE-HOME MESSAGE

- **Why coaching and telerehab:** ~2 in 3 stroke survivors carry unmet needs that grow, not fade, over time (62%→81% from 6 months to 2 years) — while an aging population and a widening rehab workforce gap make scaling in-person follow-up harder but also more pressing. Hence solutions to reach patients within the available resources are thought after – Telerehab / coaching and follow-up solutions are among the options being explored
- **Follow-up is not one thing:** clinical follow-up monitors recovery; follow-up treatment includes dose-enhancing rehab; coaching adds behaviour-change support — therapist-led at first, then semi-asynchronous with regular check-ins.

INFLUENCING FACTORS

Human in the loop

SINEMA/NAILED: a person acts on the data. SPRINT INDIA: one-way messages only.

Dose actually delivered

Queen Square 90h, MindMotion GO 39.7h vs. ACTIV's unreported, low-touch dose.

Patient engagement

SINEMA: ~90% visit fidelity.
SPRINT INDIA: only 17% acknowledged messages.

11,15,18,25,27,28]

THANK YOU

REFERENCES

1. Tan K, Thayabaranathan T, Purvis T, Wang Y, Kilkenny MF, Nelson MR, et al. Unmet needs poststroke and associated factors: a systematic review and meta-analysis. Rehabil Psychol. 2026. PMID: 42258252. https://doi.org/10.1037/rep0000675
2. Lin BL, Mei YX, Wang WN, Wang SS, Li YS, Xu MY, et al. Unmet care needs of community-dwelling stroke survivors: a systematic review of quantitative studies. BMJ Open. 2021;11(4):e045560. PMID: 33879490. https://doi.org/10.1136/bmjopen-2020-045560
3. Ravenhall H, Sabatini S, De Ivey R, Errington L, Mohammed K, Raw R, et al. Primary care-based interventions for post-stroke follow-up for long-term care: a systematic review. Fam Pract. 2026;43(4). PMID: 42517595. https://doi.org/10.1093/fampra/cmag058
4. Powers WJ, Rabinstein AA, Ackerson T, Adeoye OM, Bambakidis NC, Becker K, et al. Guidelines for the early management of patients with acute ischemic stroke: 2019 update to the 2018 guidelines. Stroke. 2019;50. (Carried from workshop_final.pdf; PMID/DOI not independently re-verified this session.)
5. Levin MF, Kleim JA, Wolf SL. What do motor "recovery" and "compensation" mean in patients following stroke? Neurorehabil Neural Repair. 2009;23:313-319. (Carried from workshop_final.pdf; PMID/DOI not independently re-verified this session.)
6. Mokni M, et al. Interactive and adaptive mixed reality system for enhancing trunk control rehabilitation. Rehabweek25, Chicago (IL/USA). 2025. (Conference abstract, carried from workshop_final.pdf; not independently re-verified this session.)
7. Yang Y, Xu H, Chang W, Li C, Cao P. Effectiveness and compliance of telemedicine on blood pressure management in poststroke patients: a systematic review and meta-analysis of RCTs. BMJ Open. 2024;14(12):e083461. PMID: 39719284. https://doi.org/10.1136/bmjopen-2023-083461
8. Munir A, Farooqi HA, Nabi R, Hasnain U, Khan M. Telemedical strategies for improving systolic blood pressure control in secondary prevention of cerebrovascular events: a systematic review and meta-analysis. J Stroke Cerebrovasc Dis. 2024;33(12):108046. PMID: 39357612. https://doi.org/10.1016/j.jstrokecerebrovasdis.2024.108046
9. Lv M, Wu T, Jiang S, Chen W, Zhang J. Effects of telemedicine and mHealth on systolic blood pressure management in stroke patients: systematic review and meta-analysis of RCTs. JMIR Mhealth Uhealth. 2021;9(6):e24116. PMID: 34114961. https://doi.org/10.2196/24116
10. Wong AKC, Zhou SY, Tao X, Tsui NY, Kwok VWY, Wang RM, et al. The effectiveness of nurse-led telecare consultations among patients who have experienced a stroke: systematic review and meta-analysis. J Med Internet Res. 2025;27:e74149. PMID: 41307946. https://doi.org/10.2196/74149
11. Yan LL, Gong E, Gu W, Turner EL, Gallis JA, Zhou Y, et al. Effectiveness of a primary care-based integrated mobile health intervention for stroke management in rural China (SINEMA): a cluster-randomized controlled trial. PLoS Med. 2021;18(4):e1003582. PMID: 33909607. https://doi.org/10.1371/journal.pmed.1003582

Therapy Science Lab
Ubiquous Adaptive Rehabilitation Pathways
LLUI

REFERENCES

12. Tan J, Gong E, Gallis JA, Sun S, Chen X, Turner EL, et al. Primary care-based digital health-enabled stroke management intervention: long-term follow-up of a cluster randomized clinical trial. JAMA Netw Open. 2024;7(12):e2449561. PMID: 39671199. https://doi.org/10.1001/jamanetworkopen.2024.49561
13. Chen X, Gong E, Tan J, Turner EL, Gallis JA, Sun S, et al. Long-term mortality outcome of a primary care-based mobile health intervention for stroke management: six-year follow-up of a cluster-randomized controlled trial. PLoS Med. 2025;22(3):e1004564. PMID: 40146698. https://doi.org/10.1371/journal.pmed.1004564
14. Yang B, Gong E, Chen X, Tan J, Peoples N, Li Y, et al. Economic evaluation of a multicomponent mHealth intervention for stroke management in rural China: cluster-randomized trial with 6-year follow-up. JMIR Mhealth Uhealth. 2025;13:e75326. PMID: 40934495. https://doi.org/10.2196/75326
15. Ögren J, Irewall AL, Söderström L, Mooe T. Long-term, telephone-based follow-up after stroke and TIA improves risk factors: 36-month results from the randomized controlled NAILED stroke risk factor trial. BMC Neurol. 2018;18(1):153. PMID: 30241499. https://doi.org/10.1186/s12883-018-1158-5
16. Gong E, Sun L, Long Q, Xu H, Gu W, Bettger JP, et al. The implementation of a primary care-based integrated mobile health intervention for stroke management in rural China: mixed-methods process evaluation. Front Public Health. 2021;9:774907. PMID: 34869187. https://doi.org/10.3389/fpubh.2021.774907
17. Ogedegbe G, Teresi JA, Williams SK, Ogunlade A, Izeogu C, Eimicke JP, et al. Home blood pressure telemonitoring and nurse case management in Black and Hispanic patients with stroke: a randomized clinical trial. JAMA. 2024;332(1):41-50. PMID: 38842799. https://doi.org/10.1001/jama.2024.6609
18. [Author list not returned by PubMed API — verify byline against publisher page before quoting]. Secondary prevention with a structured semi-interactive stroke prevention package in India (SPRINT INDIA): a multicentre, randomised controlled trial. Lancet Glob Health. 2023;11(3):e425-e435. PMID: 36796986. https://doi.org/10.1016/S2214-109X(22)00544-7
19. Laver KE, Adey-Wakeling Z, Crotty M, Lannin NA, George S, Sherrington C. Telerehabilitation services for stroke. Cochrane Database Syst Rev. 2020;1(1):CD010255. PMID: 32002991. https://doi.org/10.1002/14651858.CD010255.pub3
20. BaniHani HA, Esmail MM, Ibrahim SM, Ghozy S, Keser Z, Esterov D, et al. Effectiveness of telemedicine-based rehabilitation after stroke: a systematic review. J Neurol. 2026;273(6). PMID: 42171799. https://doi.org/10.1007/s00415-026-13871-5
21. Gallinaro Y, Boarini R, Evangelista E, Fonte C, Waldner A, Waldner JM, et al. Telerehabilitation vs face-to-face computer-based cognitive training in stroke patients: a randomized controlled trial. J Stroke Cerebrovasc Dis. 2026;35(6):108640. PMID: 42019641. https://doi.org/10.1016/j.jstrokecerebrovasdis.2026.108640

REFERENCES

24. Newton SP, Dalton EJ, Ang JY, Klaic M, Thijs V, Hayward KS. Dose, content, and context of usual care in stroke upper limb motor interventions: a systematic review. Clin Rehabil. 2023;37(11):1437-1450. PMID: 37151039. https://doi.org/10.1177/02692155231172295

25. Hayward KS, Brauer SG. Dose of arm activity training during acute and subacute rehabilitation post stroke: a systematic review of the literature. Clin Rehabil. 2015;29(12):1234-1243. PMID: 25568073. https://doi.org/10.1177/0269215514565395

26. Alt Murphy M, Munoz-Novoa M, Heremans C, Branscheidt M, Cabanas-Valdés R, Engelter ST, et al. European Stroke Organisation (ESO) guideline on motor rehabilitation. Eur Stroke J. 2025;10(4):1160-1188. PMID: 40401760. https://doi.org/10.1177/23969873251338142

27. Ward NS, Brander F, Kelly K. Intensive upper limb neurorehabilitation in chronic stroke: outcomes from the Queen Square programme. J Neurol Neurosurg Psychiatry. 2019;90(5):498-506. PMID: 30770457. https://doi.org/10.1136/jnnp-2018-319954

28. Klassen TD, Dukelow SP, Bayley MT, Benavente O, Hill MD, Krassioukov A, et al. Higher doses improve walking recovery during stroke inpatient rehabilitation. Stroke. 2020;51(9):2639-2648. PMID: 32811378. https://doi.org/10.1161/STROKEAHA.120.029245

29. Saywell NL, Vandal AC, Mudge S, Hale L, Brown P, Feigin V, et al. Telerehabilitation after stroke using readily available technology: a randomized controlled trial. Neurorehabil Neural Repair. 2020;35(1):88-97. PMID: 33190615. https://doi.org/10.1177/1545968320971765

30. Arbuckle SA, Knill AS, Chan-Cortés MH, Rozanski G, Ford AE, Derungs LT, et al. A resource-efficient, high-dose, gamified neurorehabilitation program for chronic stroke at home: retrospective real-world analysis. JMIR Serious Games. 2025;13:e69335. PMID: 40638834. https://doi.org/10.2196/69335

31. Physitrack's patient engagement solution achieves CE marking as medical device [press release]. Business Wire; 2020. https://www.businesswire.com/news/home/20200527005783/en/Physitracks-Patient-Engagement-Solution-Achieves-CE-Marking-as-Medical-Device

32. aarReha Schinznach — digitale Physiotherapie [internet]. https://aarreha.ch/2024/05/03/digitale-physiotherapie/

33. Schulthess Klinik — Schulthess Coach [internet]. https://www.schulthess-klinik.ch/de/schulthesscoach

34. RehaCom® official regulatory information. HASOMED GmbH [internet]. https://www.rehacom.com/

35. RehaCom via Testzentrale der Schweizer Psychologen (Hogrefe AG, Bern) [internet]. https://www.testzentrale.ch/shop/rehacom.html

36. MindMotion GO at Clinique Valmont, Swiss Medical Network [internet]. https://www.swissmedical.net/en/hospitals/valmont/specialties/occupational-therapy/mindmotion-go

37. Gäumann S, et al. START — the Swiss tele-assisted rehabilitation and training program to support transition from inpatient to outpatient care in the subacute phase after a stroke: feasibility, safety and performance evaluation. Front Digit Health. 2025;7:1496170. PMID: 39959919. https://doi.org/10.3389/fdgth.2024.1496170

REFERENCES

38. Crozat et al, 2025, Sensors

39. Selvanayakam et al 2025, Nature-Scioentific Reports

40. Vinet et al, 2026, JMR Formative Reports

41. Bundesamt für Statistik (BFS). Szenarien zur Bevölkerungsentwicklung der Schweiz und der Kantone 2025–2055. Medienmitteilung; 15.04.2025. Verfügbar unter: https://dam-api.bfs.admin.ch/hub/api/dam/assets/34687089/master

42. Bundesamt für Statistik (BFS). Szenarien 2025–2055 (Ref-Szenario, Kurzbericht / Faktenblatt). 2025. Verfügbar unter: https://dam-api.bfs.admin.ch/hub/api/dam/assets/34687099/master

43. Bundesamt für Statistik (BFS). Schweiz-Szenarien (Übersichtsseite). 2025. Verfügbar unter: https://www.bfs.admin.ch/bfs/de/home/statistiken/bevoelkerung/zukuenftige-entwicklung/schweiz-szenarien.html

44. Merçay C, Grünig A, Dolder P. Gesundheitspersonal in der Schweiz – Nationaler Versorgungsbericht 2021. Neuchâtel: Obsan; 2021. Verfügbar unter: https://www.obsan.admin.ch/sites/default/files/2021-10/Obsan_03_2021_BERICHT_0.pdf

45. Obsan. Gesundheitsfachkräfte in der Schweiz: Absicht, im Beruf zu bleiben (SCOHPICA). Bulletin 09/2024; 23.09.2024. Verfügbar unter: https://www.obsan.admin.ch/sites/default/files/2024-09/obsan_bulletin_2024_09_d.pdf