

D2.2

Wearable Technologies Program and Training Module

Leading the Way in Wearable Technologies for Sports Coaching

Facilitator slide deck · 5 modules · 90 minutes each · Companion to the D2.2 manual



Co-funded by
the European Union

How to use this deck

Instructor-led

One 90-minute session per module. Timing, discussion prompts and small-group activities are in the Facilitator Guide (Annex B).

Blended

Coaches read the manual chapter and take the quiz asynchronously, then meet for a 60-minute live session built on these slides.

Self-study

The deck also works as a visual summary of each chapter. Speaker notes carry the facilitator script for solo review.



Every slide carries speaker notes: the talking points, the timing, and the question to put to the room. Open the Notes pane before you present.

Session shape

15 min concept · 30 min worked example · 30 min applied activity · 15 min debrief.

Cohort size

12–24 coaches. Below 12, merge the small-group tasks into one plenary discussion.

Interactive units

Each module has a matching interactive e-learning unit and video tutorial for practice between sessions.

Five modules, one competency arc

1 Fundamentals

Sensors, the device market, validity and reliability, the GDPR consent baseline.
Bloom level: remember / understand.

2 Real-Time Data Tracking

Internal vs external load, dashboards, sRPE, TRIMP and ACWR, data quality.
Bloom level: apply.

3 Performance Optimization

Individual baselines, periodisation, recovery metrics, taper confirmation.
Bloom level: analyse.

4 Injury Prevention

Load management and its critics, asymmetry triage, early-warning systems, five worked cases.
Bloom level: evaluate.

5 Integration into Practice

PDCA, data governance, athlete communication, delivery pathways, the 90-day plan.
Bloom level: create.

Assessment

Per-module quizzes calibrated to the stated objectives, an interactive e-learning unit per module, and one capstone artefact: the coach's own 90-day integration plan.

Terminology defined in Module 1 is reused throughout; formulas from Module 2 reappear in Modules 3 and 4; the GDPR baseline from Module 1 is deepened in Module 5.

Four coaches who appear in every module

Mehmet

Grassroots youth football, Türkiye.
Twenty players aged 12–16.
Budget of €1,200 for the whole season.

Anna

University strength-and-conditioning, athletics, Northern Europe. Individual endurance athletes, some lab access.

Kjell

Professional league head coach, Norway. Full performance staff, GPS vests, integrated medical team.

Zeynep

Wheelchair basketball, Türkiye.
Twelve senior athletes; the propulsive joint is also the playing joint.



Each module draws on at least two personas, so the examples cover grassroots and elite, individual and team, ambulatory and para-sport.

Ask the room

Which persona is closest to your own setting?
Keep that answer for the capstone plan.

No brand ranking

Comparisons are by category and feature. The programme endorses no commercial device.

Accessibility

Slides follow WCAG 2.1 AA contrast; the interactive units are keyboard-navigable.

MODULE

Fundamentals of Wearable Technology

What each sensor physically measures, what the device derives from it, and what you are entitled to conclude.

- Sensor families and the device market
- Validity, reliability, ecological validity
- The GDPR consent baseline

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1

What you will be able to do

1 Classify

Name the main families of wearable technology and distinguish sensors by the quantity they measure.

2 Trace the data

Explain the journey from athlete to sensor to platform to coaching decision.

3 Evaluate

Apply validity, reliability and ecological validity to a vendor claim.

4 Select

Apply a multi-criteria selection matrix to a realistic device-choice scenario.

5 Comply

Recognise the baseline ethical and GDPR obligations before a device is switched on.



Opening question for the room: name one wearable you already use, and say out loud what physical quantity it actually measures. Most rooms discover the gap within two minutes.

Seventy years from clinic to touchline

1950s • Holter monitor

A portable ECG recorder proves physiological signals can be captured during free-living activity.

1960s • Pedometers

Mechanical step counting does the same for ambulatory activity volume.

1980s • Chest straps

Polar's Sport Tester opens structured heart-rate training to non-elite athletes.

2000s • GPS units

Backpack-worn tracking arrives in rugby and Australian football, then across team sport.

2010s • IMUs

Accelerometer, gyroscope and magnetometer in one small package move from research to practice.

Now • Textiles & optics

Sensors woven into garments, continuous biochemical monitoring, consumer rings and watches.



The pattern is not technology pushed at coaches. It is coaches and researchers asking questions that needed instrumentation to answer. So ask first: what coaching question is this device trying to answer?

What each sensor physically measures

Accelerometer

Linear acceleration on 1–3 axes. Robust but ambiguous — at low sampling rates a footstrike and a bus ride can look alike.

Gyroscope

Angular velocity around an axis. With accelerometers it enables orientation and movement-pattern recognition.

Magnetometer

The local magnetic field, used as a compass reference. Sensitive to ferrous metal — limited reliability indoors.

Optical PPG

Variation in reflected light caused by pulsatile blood flow. Sensitive to motion, skin tone and strap tightness.

ECG electrodes

Electrical activity of the heart directly. More accurate than PPG in dynamic exercise; requires skin contact.

GPS / GNSS • sEMG

Position from satellites — robust outdoors, degrades or fails indoors. sEMG reads muscle activity through the skin.



Coaches often hear a sensor named and conclude they understand it. The deeper competence is knowing what is measured and what is merely derived.

Measured quantity, derived metric, inferred construct

Measured quantity

The raw physical signal a sensor captures.

Example: acceleration on three axes (m/s²).



Derived metric

A processed output computed from measured quantities.

Example: PlayerLoad, total distance, sprint count.



Inferred construct

A coaching concept the metric is taken to represent.

Example: "external load", "neuromuscular fatigue".



The further you travel from measured quantity toward inferred construct, the more layers of assumption you accumulate.

When two devices report different PlayerLoad values for the same drill, the answer is usually that they use different proprietary derivation formulas — not that one is wrong and one is right. Ask the vendor which layer their number lives on.

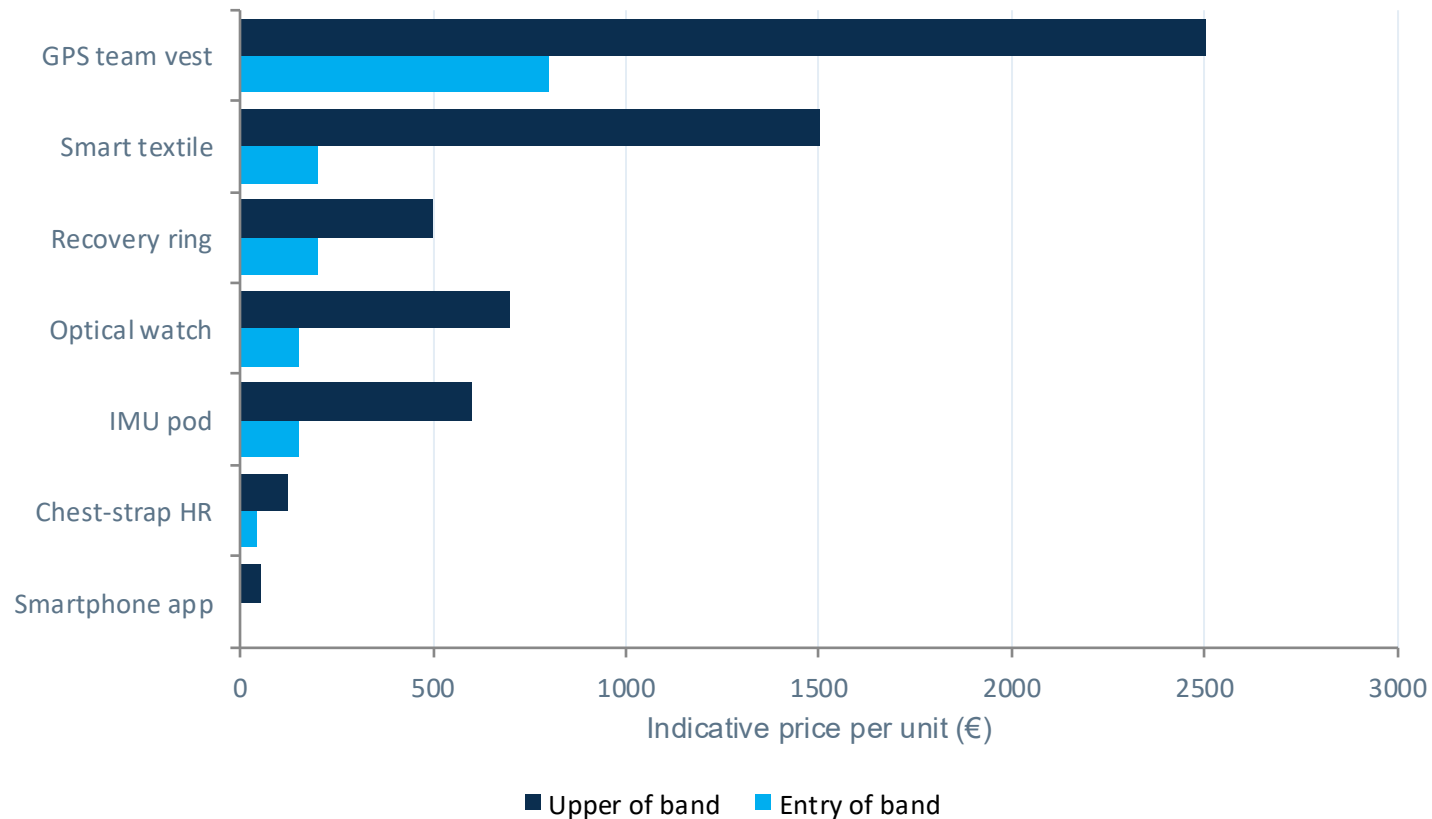
The device market, read by category rather than brand

Category	Typical use	Price band	Strengths	Limitations
Chest-strap HR (ECG)	Endurance, group HR	€40–120	Accurate in dynamic exercise; affordable	Comfort; direct contact needed
Optical wrist / multi-sport watch	Endurance, sleep, daily monitoring	€150–700	Comfort; integrated GPS, sleep, HRV	Accuracy varies in high-motion work
GPS team vest	Outdoor team sport	€800–2,500 + platform	High-quality GNSS; dashboards	Cost; platform lock-in
IMU patch / pod	Asymmetry, jump, gait	€150–600	Targeted biomechanics; portable	Narrow use case; software dependent
Smart textile	HR + EMG in dynamic sport	€200–1,500	Garment-integrated; comfortable	Durability; washing; variable sensors
Recovery ring or band	Continuous HRV, sleep	€200–500 + subscription	Continuous wear; HRV trends	Sleep-stage accuracy vs PSG is partial
Smartphone-based	Grassroots, low budget	€0–50 (apps)	No additional hardware	Depends on phone sensors



Specific models change every season. The categories, and the questions they invite, are stable — which is why this table is not a buyer's guide.

Cost is a design constraint, not a quality ranking



Mehmet's constraint

A €1,200 season budget buys 20 chest straps and one shared GPS pod — enough for structured sRPE and ACWR monitoring.

Kjell's constraint

GPS vests carry recurring platform fees and export limits. Ask about data portability before you sign.

The real question

Not "what can we afford?" but "what will we actually use every week?" Unused capacity is the most expensive line item.

Validity and reliability for coaches who are not researchers

Validity

Does the device measure what it claims to measure? A GPS unit reporting total distance is valid if it agrees with a measured track within an acceptable margin.

Reliability

Does it give consistent results when conditions are stable? Different distances for the same athlete on the same route on two days means unreliable.

Ecological validity

Does lab performance survive real conditions — wind, sweat, contact, indoors, gripped objects, weather?

S

Sperlich & Holmberg (2017) warned that the gap between marketed and validated performance is often large. Düking et al. (2016) found systematic accuracy problems across commercial wearables assessed against criterion measures. Akenhead & Nassis (2016) documented that coaches choose monitoring tools under significant uncertainty about validation status.

1 Sample

Who was tested, in what sport, at what intensity?

2 Gold standard

What was the device compared against?

3 Statistic

Mean bias and limits of agreement — not correlation alone.

4 Ecological match

Were the conditions anything like yours?

Before you switch anything on: the consent baseline

Lawful basis

Article 6 for the processing, and an explicit Article 9 basis for health data — usually explicit consent in a non-medical coaching setting.

Informed and free

The athlete understands what, why, with whom, for how long — and consents without selection pressure.

Minors

Parental or guardian consent, plus explanations adapted to the young athlete's age.

Data minimisation

Collect only what you need. Every extra field is a liability you must justify, secure and eventually delete.

Retention

Define and communicate how long the data is kept, and delete on schedule.

Breach plan

Know the escalation chain. Certain breaches must be reported within 72 hours.



The operational rule for Module 1: do not deploy a device without an informed consent process already in place. Module 5 builds the full governance policy on top of it.

Module wrap-up

Reflective prompt

Write down one device you use or are considering, the sensors it contains, one coaching question it should answer, and one limitation for your sport. Keep this note — Module 5 needs it.

Self-check

Which of these is a measured quantity rather than a derived metric: total distance, linear acceleration, PlayerLoad, sprint count? Full item bank in Annex C.

Bridge to D2.3

Rate your confidence with sensor terminology and device selection in the Self-Assessment Toolkit. Anything below 3/5 is worth a re-read before Module 2.



Interactive unit 1 + video tutorial 1: sensor matching, a device-selection matrix for your own budget, and a GDPR consent checklist — roughly 25 minutes.

Close the session with the reflective prompt. Coaches who write nothing down complete the course; coaches who write something down change their practice.

MODULE

Real-Time Data Tracking

Reading a dashboard, computing the three core load metrics by hand, and deciding what the athlete should hear during a session.

- Internal versus external load
- sRPE, TRIMP, ACWR on a real session
- Data quality and the discipline of scepticism

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2

What you will be able to do

1 Distinguish

Separate internal from external load and pick appropriate metrics for a given sport.

2 Compute

Calculate sRPE, TRIMP and ACWR from raw session data using the formulas given.

3 Interpret

Read the five canonical visualisations used in monitoring dashboards.

4 Diagnose

Spot common data-quality problems and apply basic filtering rules.

5 Decide

Judge what to share with athletes in real time and what to defer to a debrief.



Bring one real session file to this module — your own, from last week. Every calculation on the following slides is meant to be repeated on your own numbers before you leave.

Internal load versus external load

External load

What the athlete did — the dose you prescribed

- Kilometres covered, sprints, accelerations
- Weight lifted, repetitions, jumps
- High-speed running distance, PlayerLoad
- Measured in physical terms, independent of the athlete
- Comparable between athletes only as prescription

Internal load

What the athlete experienced — the biological cost

- Heart rate and HR-derived TRIMP
- Rating of perceived exertion and sRPE
- Hormonal and autonomic response
- Depends on fitness, fatigue, sleep, environment, motivation
- The only view of the individual response



Impellizzeri, Marcora & Coutts (2019) revisited their framework fifteen years on and emphasised that monitoring built only on external load misses the individual variability that determines adaptation and injury risk. Two athletes given the same session experience different internal loads.

The coach who tracks only external metrics is tracking only half the picture.

The internal–external comparison is itself diagnostic

Same dose

Unchanged external load — the same prescribed session

Higher cost

Rising internal load — higher HR, higher sRPE

Early signal

One of the clearest early signs of accumulated fatigue

1 Do not compare prescriptions

Comparing two athletes on external metrics alone compares what you asked for, not what they gave.

2 Track internal over time

sRPE and TRIMP show when a previously well-tolerated dose has become a strain.

3 Pair the two

Always read external and internal side by side. Either alone is an incomplete sentence.



External load is the dose prescribed by the coach. Internal load is the body's response to that dose.

What live dashboards actually offer

Live per-athlete metrics

HR zones, total distance, high-speed running, accelerations and decelerations, a PlayerLoad-type composite.

Customisable thresholds

Colour change or audible alert when an athlete crosses a value you set in advance.

Drill segmentation

Period markers so post-session analysis aligns with the session plan you actually ran.

Data export

Raw and processed data out of the platform for your own analysis and archive.



The honest reality: not every "live" metric is reliable enough to act on within seconds. Heart rate, distance and impacts update with sufficient stability. Composite metrics with smoothing windows are more meaningful as session totals than as live readouts.

In real time

Trust simple metrics: heart rate, distance covered, impact counts.

At session debrief

Trust composites: PlayerLoad variants, asymmetry indices, session totals.

Dashboard literacy: five visualisation families

Time series

Time on the horizontal axis, a metric on the vertical.

Shows: trends, peaks, recoveries.

Watch for: y-axis scaling that exaggerates or suppresses variation.

Heat map

Spatial intensity across a pitch or court.

Shows: coverage, tactical insight.

Watch for: running with and without the ball are merged — intent is not shown.

Radar (spider) chart

Multi-axis profile of one athlete or session.

Shows: a multidimensional view at a glance.

Watch for: arbitrary axis scaling that visually distorts strengths.

Box plot

Distribution across the squad with median, quartiles and outliers.

Shows: outliers immediately.

Watch for: instability below $n = 10$ — treat small squads with caution.

Scatter plot

Two metrics against each other, e.g. weekly sRPE vs session HR.

Shows: correlation and outliers.

Watch for: correlation is not causation — never act on a pattern alone.

The one question

Across all five families the coach asks the same thing: what is this picture telling me, and what would change my mind?

That is dashboard literacy.

Data quality, anomalies, and the discipline of scepticism

1 GPS dropout

Indoor halls and heavy steel structures give intermittent satellite signal. A player covering 50 m in 10 minutes was indoors — treat the metric as missing, not as low load.

2 Optical HR artefact

Wrist PPG reads erratically during gripping, vibration and short bursts. A 20-bpm jump and drop within five seconds is an artefact, not a physiological event.

3 Sensor drift

Long sessions, heat and sweat-saturated straps distort readings gradually. Compare end-of-session HR with start-of-session HR at similar effort.

4 Time-sync errors

Small clock offsets between devices confuse any derived metric that aligns two data streams.

5 Missing or partial files

A 73-minute file labelled "90 minutes" quietly corrupts the weekly load total for that athlete.

6 The filter rule

Check the file before you check the athlete. Flag, do not delete — a missing value and a zero are different facts.



A metric that looks too good, or too bad, to be true probably is.

Practical lab — Stat Pack #1

The session

A 60-minute training session for one athlete

- Total distance: 6,800 m
- High-speed running (>19.8 km/h): 720 m
- Average HR 152 bpm · Max 188 bpm · Rest 56 bpm
- RPE (Borg CR-10): 7
- Chronic load (28-day rolling weekly sRPE): 2,400 AU
- This week's acute load (7-day sRPE): 3,300 AU

The arithmetic

Do it by hand once, then let Template A4 do it

- $\text{sRPE} = \text{RPE} \times \text{duration} = 7 \times 60 = 420 \text{ AU}$
- $\text{HR fraction} = (152 - 56) / (188 - 56) = 0.727$
- $\text{TRIMP} \approx \text{duration} \times \text{HR fraction} \times \text{weighting} \approx 94 \text{ AU}$
- $\text{ACWR} = \text{acute} / \text{chronic} = 3,300 / 2,400 = 1.375$
- Commercial implementations vary in the exponential factor (Banister, 1991)

420 AU

sRPE — session internal load

≈ 94 AU

TRIMP — HR-weighted internal load

1.375

ACWR — upper edge of the cited sweet spot

Reading the ACWR you just calculated

Below ≈ 0.8

Acute load well under chronic. Detraining or an under-prepared athlete relative to what the schedule will demand next.

$\approx 0.8 - 1.3$

The often-cited "sweet spot". Progressive and broadly tolerated — but it is a population heuristic, not an individual guarantee.

Above ≈ 1.5

A spike worth investigating. Sustained values here warrant caution and a conversation, not an automatic rest day.



Our worked value of 1.375 sits at the upper edge of the sweet spot. It warrants attention. Whether it warrants intervention depends on the athlete's history and the surrounding context — Module 4 takes this apart, including the critiques.

What ACWR cannot do

It cannot tell you why the week was heavy, and it cannot separate load from schedule.

What it does well

It converts a vague sense that "this week feels big" into a number you can bring to a staff meeting.

Real-time feedback to athletes: the timing question

What?

Some metrics are actionable live — HR for pacing, distance covered for substitution decisions.

Others are not: HRV and sleep are pre-session inputs. Share what is actionable.

When?

During a drill the athlete is executing; metric talk is a distraction.

Between drills or at the end of a block, brief metric-anchored feedback lands well. Trend feedback belongs in a one-to-one.

How?

Frame metrics as information, not verdicts.

The factual content can be identical; the framing changes whether the athlete collaborates or resists.

Lands as collaboration

- "Your sprint count was high today — let's protect tomorrow."
- "Your HR didn't come down between reps; rest longer next time."

Lands as a verdict

- "You overworked."
- "The watch says you're not ready."

Module wrap-up

Reflective prompt

Take last week's heaviest session and compute sRPE, TRIMP and ACWR by hand. Then ask what decision, if any, those three numbers would have changed.

Self-check

Which live metric would you refuse to act on within seconds, and why? Full item bank in Annex C.

Practical activity

Screenshot one dashboard view from your own platform and label it: which of the five visualisation families is it, and what is it hiding?



Interactive unit 2 + video tutorial 2: a live sRPE / TRIMP / ACWR calculator, a dashboard-reading exercise, and a data-quality anomaly hunt — roughly 30 minutes.

Close the session with the reflective prompt. Coaches who write nothing down complete the course; coaches who write something down change their practice.

MODULE

Performance Optimization

Individual baselines, periodisation, recovery judgment, and confirming a taper with data instead of hope.

- A baseline is a distribution, not a number
- Micro, meso and macrocycle integration
- Triangulating HRV, sleep and wellness

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3

What you will be able to do

1 Baseline

Establish an individualised athlete baseline and define personalised reference ranges.

2 Integrate

Place wearable metrics inside linear, block and undulating periodisation.

3 Synthesise

Combine HRV, sleep, wellness and CMJ into a single recovery judgment.

4 Taper

Design a wearable-informed tapering plan for a competition peak.

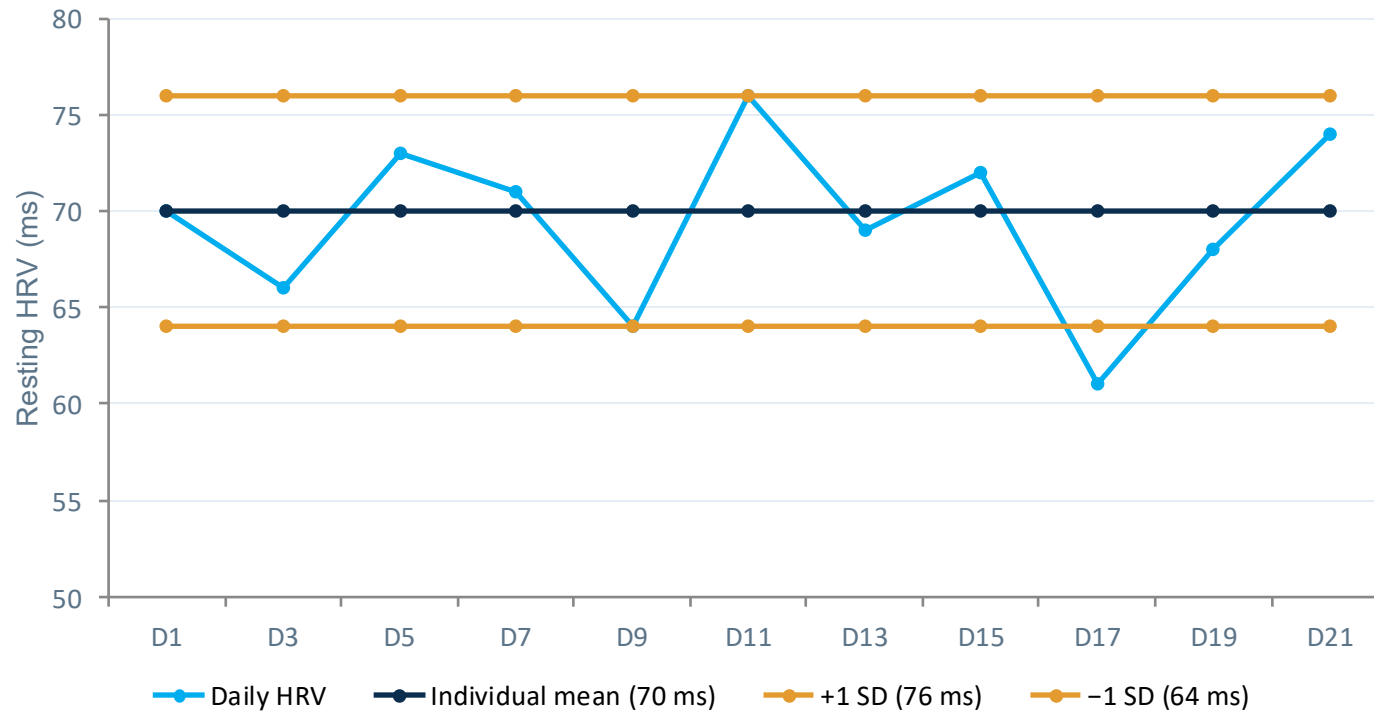
5 Prune

Weigh the marginal value of a new metric against its measurement burden.

?

The organising idea of this module: data does not write the plan. Data tells you whether the plan you wrote is doing what you intended.

A baseline is a distribution, not a number



1 Collect 4–6 weeks

Before drawing any inference at all.

2 Standardise conditions

HRV on waking, supine, before caffeine; same wearable each night.

3 Compute mean and SD

Per athlete, per metric — never squad averages.

4 Set the bands

± 1 SD = normal range. ± 2 SD = anomaly worth investigating.

S

Plews et al. (2013): HRV interpretation must be rooted in the individual, because between-athlete variability dwarfs within-athlete day-to-day variability. The principle generalises across metrics — compare athletes to themselves, not to the squad.

Where wearables enter the periodisation plan

Microcycle • one week

Entry point: daily readiness.

Each morning read HRV, sleep and wellness; classify green, amber or red; adjust the day's session. Decision rules are pre-defined in Template A8, so the call is not improvised under pressure.

Mesocycle • 3–6 weeks

Entry point: progressive overload management.

Plan weekly increases (typically 5–10% within a block). Weekly reports compare planned versus actual external load against the observed internal response.

Macrocycle • one season

Entry point: long-arc adaptation tracking.

Falling resting HR at the same training load suggests cardiorespiratory adaptation; stable CMJ height across a heavy block suggests neuromuscular preservation under load.



Classic periodisation models were designed before continuous monitoring. They are not replaced by wearables — they are augmented.

Ask the room: at which of the three levels does your own club already have a working routine, and at which is the data collected but never read?

Recovery metrics: what they show and what they do not

Heart rate variability

Reflects autonomic status — the balance of sympathetic and parasympathetic input.

Higher resting HRV over time is consistent with recovery; a sustained downward trend indicates accumulated stress.

Caveat: sensitive to alcohol, illness and life stress. A single day never triggers action — the 5–7 day trend does.

Sleep

Total sleep time and sleep efficiency validate reasonably well against polysomnography.

Stage classification (deep, REM, light) is far less accurate on consumer devices.

Actionable rule: track total time and efficiency; treat stage data as suggestive. Walsh et al. (2021): 7–9 hours nightly as a baseline.

Subjective wellness

Five morning items rated 1–5: sleep quality, fatigue, soreness, mood, stress.

Costs nothing and adds the athlete's own experience. Saw, Main & Gatin (2016) showed subjective measures often outperform objective ones for acute training response.

Coaches who never ask the athlete miss the most informative signal.

3

Triangulation: never act on one metric alone.

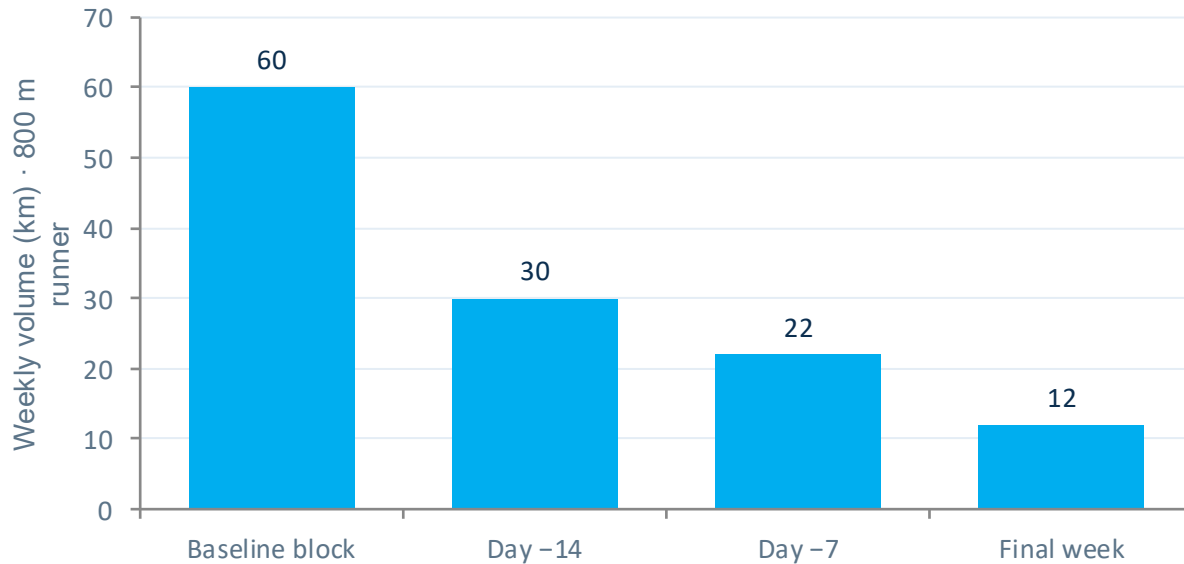
Monitor

HRV down, sleep fine, wellness fine — probably a single life-stress event.

Intervene

HRV down, sleep declining, wellness declining — a coherent picture, act on it.

Tapering with wearable confirmation



During a well-executed taper, expect:

- **HRV rises** — parasympathetic recovery exceeds training-induced sympathetic load.

Subjective wellness improves — mood up, fatigue down, soreness down.

CMJ height rises modestly — neuromuscular freshness returns.

Resting HR drifts down — slightly, and only alongside the others.

Wearable data confirms — it does not redesign. Volume comes down, intensity is preserved.

65 → 71 ms

HRV, baseline mean to day -5

38 → 40 cm

Countermovement jump height

3.6 → 4.2 / 5

Subjective wellness composite

41–60%

Volume reduction over 8–14 days
(Mujika & Padilla, 2003)

If the data shows the opposite — HRV declining, wellness worsening — the plan is not working. Investigate residual fatigue, sleep and life stress. The intervention is not "ignore the plan"; it is "diagnose and adjust".

The measurement-burden trade-off

Athlete time

A morning HRV measurement adds five minutes per athlete per day. Across a squad and a season this is real money.

Equipment

Purchase, charging, cleaning, replacement, and the subscription that renews whether you use it or not.

Staff analysis time

Data nobody has time to read is not monitoring; it is storage.

Number anxiety

Athletes becoming preoccupied with their own metrics. Non-trivial among adolescents and athletes prone to perfectionism.



Before adding any metric, ask honestly: what decision will this change?

If the answer is "none", the metric should not be in the system. A small set of well-used metrics outperforms a large set of unused ones — and protects the goodwill you will need when a difficult conversation depends on the data.

Module wrap-up

Reflective prompt

Name one metric you currently collect that has never changed a decision. What would it take to either use it properly or remove it this month?

Self-check

An athlete's HRV is 8 ms below their individual mean, SD is 6 ms. Yellow, orange or red — and what do you do about it?

Practical activity

Build a one-page individual athlete profile (Template A3) for one athlete: mean, SD and current value per metric, with traffic lights.



Interactive unit 3 + video tutorial 3: a baseline and reference-range builder, a taper simulator, and a triangulation decision exercise — roughly 30 minutes.

Close the session with the reflective prompt. Coaches who write nothing down complete the course; coaches who write something down change their practice.

MODULE

Injury Prevention

Load management and its critics, asymmetry triage, and an early-warning system that removes improvisation from the moment of pressure.

- ACWR, monotony and strain — with the current debate
- Asymmetry: identify, document, refer
- Five worked cases across five contexts

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4

What you will be able to do

1 Identify

Link modifiable injury risk factors detectable in wearable data to their evidence base.

2 Compute

Calculate ACWR, training monotony and training strain, and apply defensible thresholds.

3 Triage

Detect biomechanical asymmetries from IMU data and decide whether to correct or refer.

4 Construct

Build an early-warning system for your sport with clear escalation protocols.

5 Progress

Manage return-to-play using wearable confirmation alongside clinical judgment.



Set expectations at the start of this module: monitoring reduces risk. It does not eliminate it. A coach who promises otherwise will lose the squad's trust the first time someone gets hurt anyway.

Injury epidemiology and the role of monitoring

6–9

Time-loss injuries per 1,000 hours of exposure in professional football

>20%

Annual lower-limb overuse incidence among recreational runners

#1

Hamstring strain — the largest single category in most football studies

Non-modifiable

Monitoring does not change these

- Age
- Prior injury history
- Anatomical features
- Genetic predisposition

Modifiable

Where wearable monitoring earns its place

- Training load progression
- Sleep quantity and quality
- Side-to-side asymmetry
- Recovery practices and conditioning level



A coach who understands this distinction sets realistic expectations — with athletes, with parents, and with the board.

Load management and the injury–training paradox

What supports the framework

- Gabbett (2016): under-prepared athletes are at risk and over-loaded athletes are at risk — the relationship is U-shaped.
- ACWR proposed as a practical tool with a sweet spot of roughly 0.8–1.3.
- Bowen et al. (2020): ACWR spikes associated with a 5–7-fold injury risk across three Premier League seasons.
- Drew & Finch (2016): systematic review of the broader load–injury literature, broadly consistent.

What challenges it

- Impellizzeri et al. (2020): ACWR is a ratio with overlapping numerator and denominator — it can produce spurious associations.
- Schedule confounding: heavy weeks tend to follow heavy weeks for non-load reasons.
- Bornn, Ward & Norman (2019): a causal analysis making a similar argument.
- A single ratio cannot carry the weight of a yes/no injury prediction.



The honest synthesis for a practising coach: ACWR is a useful prompt, not a verdict.

Spikes are worth investigating. Sustained ACWR above 1.5 warrants caution. Use it alongside the athlete's history, the wellness picture, and your own knowledge of the training context.

Monotony, strain, and movement-quality red flags

Training monotony (Foster, 1998)

Mean daily load $\div$ standard deviation of daily load, over a week.

High monotony = a uniform load pattern. Sustained high monotony at high mean load has been associated with elevated illness and overreaching risk.

Training strain (Foster, 1998)

Weekly load $\times$ monotony.

Combines volume and uniformity in one index. Useful as a tracking metric across weeks; less useful as a single-week decision input.

Jump-landing asymmetry

A CMJ on dual force plates or two unilateral IMUs gives the percentage difference between limbs. Above $\approx 10\text{--}15\%$ is commonly flagged.

Sprint asymmetry

Step length, contact time or impulse differences between legs during sprinting, captured by IMUs.

Deceleration mechanics

Asymmetric braking force at change of direction — particularly relevant in ACL injury research.

3

The coach's role with asymmetry data is triage: identify, document, refer. Coaches without specific biomechanics training should not prescribe correctives from asymmetry data alone.

Designing an early-warning system in five steps

1 Choose 3–4 inputs

Outdoor team sport: ACWR, sRPE-based weekly strain, sleep duration, wellness.
Endurance individual: ACWR, HRV trend, sleep, wellness.
Indoor without GPS: sRPE load and sRPE-derived ACWR, sleep, wellness.

2 Set personalised thresholds

Use the individual baseline from Module 3. One SD drop in HRV is a yellow flag; two SD is orange; three is red. Set thresholds for every chosen input.

3 Define escalation tiers

A single yellow may warrant observation only. Yellow flags across multiple inputs warrant intervention. Orange or red on any single input warrants immediate review.

4 Pre-decide the actions

Agree in advance what happens at each tier. The point of pre-deciding is that you remove improvisation from the moment of pressure — when the match is Saturday and the player is your captain.

5 Brief everyone

Athletes and staff are told the system before it is used. When an orange flag fires, the athlete already knows the response is "modify, not punish".



A working early-warning checklist is provided in Annex A, Template A9. Build yours in the session — do not leave with a blank one.

A useful system is sport-specific, has few high-signal inputs, defines thresholds in advance, and assigns pre-decided actions to each threshold.

Escalation tiers: decide the response before you need it

Tier	Trigger	Action	Who is involved
Yellow	One input drops one SD below the individual baseline	Monitor. Ask the athlete how they feel. No change to the session.	Coach and athlete
Orange	Two SD on one input, or yellow flags across multiple inputs	Modify the session: reduce intensity or volume by a predetermined amount. Discuss with the athlete.	Coach, S&C, athlete
Red	Three SD on any single input, or symptoms reported	Substitute the session. Escalate to medical staff for review before the next exposure.	Coach, S&C, medical staff



The tiers are worthless if they are negotiated in the moment. Write them down, sign them off with the medical staff, and brief the squad — then the system survives contact with a cup final.

Five worked cases, five contexts

1 Professional football

A second-division club, 28 players, 10 Hz GPS. Individualised high-speed running caps at 1.5× each player's 28-day chronic exposure.

Hamstring time-loss fell — but the staff were honest that squad turnover and schedule density changed too.

2 University basketball

A Division-I point guard, nightly HRV. A 25% drop across three weeks, confirmed by sleep, wellness and CMJ.

Conditioning volume cut 40% for one week; HRV back within one SD in ten days.

3 Endurance • triathlon

A national age-group athlete in a 16-week build. Sleep efficiency 91% → 82%, HRV 56 → 47 ms, sRPE drifting up on the same sessions.

Unplanned 7-day deload at week 12; race performance a personal best.

4 Para-sport

Wheelchair basketball, twelve athletes. In wheelchair sport the propulsive joint is the playing joint.

IMU stroke counts plus weekly shoulder-pain scales caught three cases; one was subacromial impingement.

5 Grassroots youth

Twenty players aged 12–16 on a €1,200 budget. Paper sRPE logs, 20 chest straps, one shared GPS pod.

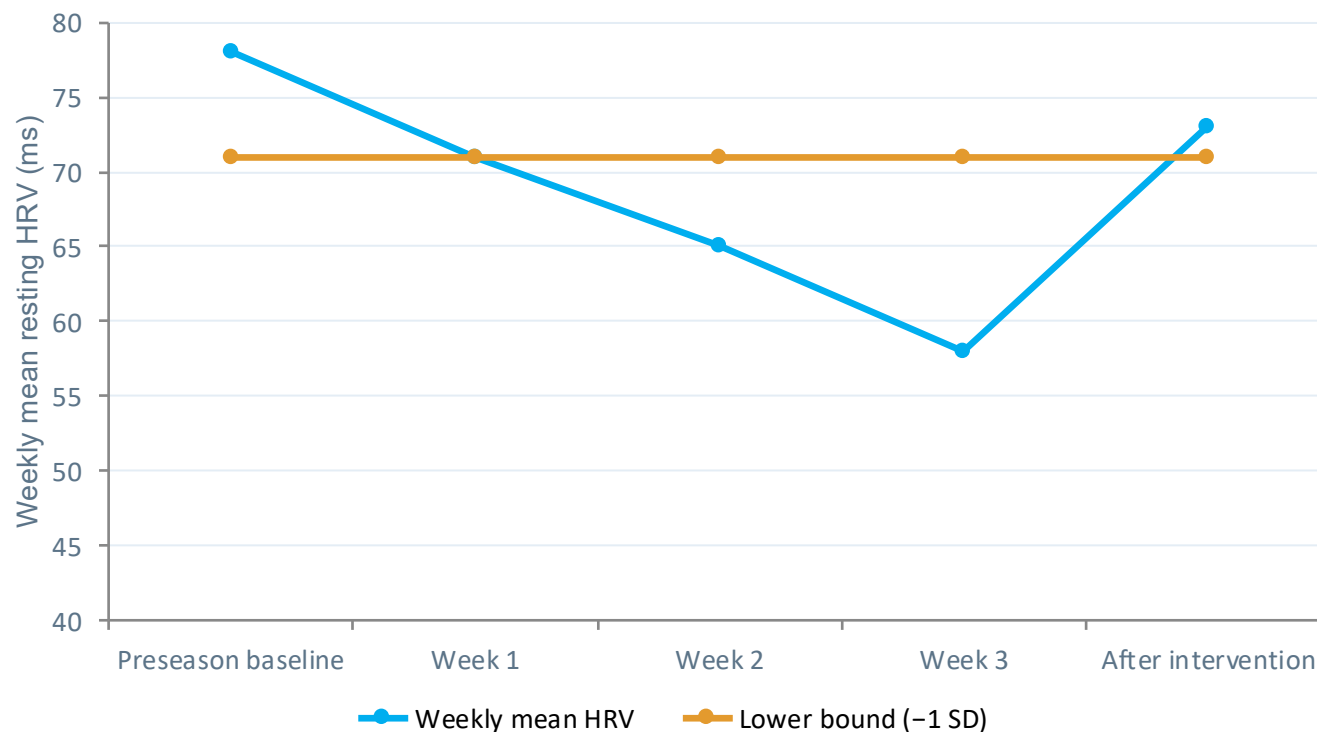
Two players flagged and load-reduced in the first half of the season.

What the cases share

Individual thresholds. Pre-decided actions. Staff buy-in across coaching and medical functions.

And intellectual honesty about what an internal, single-season evaluation can and cannot establish.

Case spotlight — HRV early-warns overtraining



Concurrent inputs

Wellness 4.2 → 3.4 · sleep efficiency 92% → 84% · CMJ 42 → 38 cm.

The decision

Conditioning volume cut ≈40% for one week, active recovery added, travel adjusted to protect the sleep window. Match minutes untouched.

The outcome

HRV back to 73 ms within ten days; season completed without symptomatic overreaching.

3

HRV alone might have been dismissed as noise. HRV plus sleep plus wellness plus CMJ formed a coherent picture — that is triangulation doing its job.

Case spotlight — effective load management on €1,200

€1,200

Total season monitoring budget

20

Players aged 12–16 covered

€60

Per chest-strap HR monitor

2

Players flagged and load-reduced in the first half of the season

What they measured

Weekly sRPE for every session and match, on paper. Weekly load, monotony and ACWR computed from sRPE.

The rule they wrote

ACWR > 1.5, or two consecutive weeks of declining wellness, means modified training the following week.

The honest caveat

Injury time-loss was lower than the prior season, but the comparison is informal — not a controlled result.



Monitoring is a discipline, not a budget. The cheapest system that is used outperforms the most expensive system that is not.

Module wrap-up

Reflective prompt

Write the three inputs your early-warning system will use, and the exact action attached to each tier. If you cannot name the action, the tier does not exist yet.

Self-check

An athlete shows ACWR 1.6 with stable wellness and sleep. What do you do first — and what would change your mind?

Practical activity

Complete Template A9 for one squad, then walk it past your medical or physiotherapy contact before the next module.



Interactive unit 4 + video tutorial 4: an early-warning system builder with threshold logic, a branching case simulation, and an asymmetry triage exercise — roughly 35 minutes.

Close the session with the reflective prompt. Coaches who write nothing down complete the course; coaches who write something down change their practice.

MODULE

Integration into Coaching Practice

Governance, communication, change management, delivery pathways — and the artefact that makes the whole programme count.

- Plan-Do-Check-Act on one specific question
- A written data-governance policy
- The 90-day integration plan

A large, light blue circle containing a smaller, darker blue circle. Inside the smaller circle is the number "5" in a white, bold, sans-serif font.

5

What you will be able to do

1 Design

Build a 90-day wearable-integration plan for your own context using PDCA.

2 Govern

Write a data-governance policy covering consent, access, retention, sharing and breach response.

3 Communicate

Deliver wearable data to athletes and parents with framing that supports rather than judges.

4 Lead change

Manage staff and stakeholders who resist data-driven practice.

5 Disseminate

Choose and operationalise the right delivery pathway for your organisation.



This module produces the single most important artefact of the programme. A coach who completes the manual without writing the plan has learned the content; a coach who writes and implements it has changed practice.

Plan-Do-Check-Act, applied to wearable integration

Plan

Define one specific question wearables will help you answer this season. "Will player-individualised load caps reduce hamstring incidence?" Specify the metrics, the population, the timeline and the success criterion.

Do

Implement at small scale first. One cohort, one season. Resist rolling out across the whole organisation in week one — the governance, training and cultural work has not been done yet.

Check

Evaluate against the success criterion. Did the question get answered? Did the metrics behave as expected? Were there unintended consequences — athlete anxiety, staff workload, inter-staff friction?

Act

Scale, adjust, or stop. The most important option is the last one: a coach willing to stop a monitoring effort that delivered no value earns credibility and resources for the next attempt.

Eight components of a defensible governance policy

Lawful basis

Article 6 — consent or legitimate interests. For wearable data, consent is usually cleanest.

Special-category basis

Article 9 — explicit consent for health data, plus organisational safeguards.

Informed consent

Plain language: what, why, who sees it, how long, how to withdraw. Template A1.

Minors

Guardian consent under 16, plus age-appropriate explanation to the athlete.

Access controls

Coach, S&C, analyst and medical staff have different legitimate access. Scouts, agents and sponsors do not.

Retention

Affiliation plus a defined post-affiliation period, e.g. 24 months. Document it and follow it.

Third-party sharing

Federation, national team or research project — each needs its own consent and agreement.

Breach response

Article 33: certain breaches reported within 72 hours. A lost laptop is a breach.



Athletes have the right to access their data, correct inaccuracies, request erasure and withdraw consent. Building these into the workflow from the start is far easier than retrofitting them later. Template A1 requires local legal review before adoption.

Talking to athletes about their numbers

Information invites collaboration

- "Your HRV suggests your body is still recovering — let's adjust today's session."
- The athlete owns their body; the coach provides expertise; the data supports a shared decision.
- Athletes who feel this engage with their data.

A verdict invites resistance

- "Your HRV says you're not ready."
- The factual content is identical. The framing changes the conversation.
- Athletes who feel judged either game the numbers or withdraw.

1 Acknowledge

The athlete's effort and commitment.

2 Share

The data observation, in plain terms.

3 Connect

The observation to the decision.

4 Invite

The athlete's own perspective.

5 Confirm

The path forward, together.



Watch for number anxiety — particularly in adolescents and athletes prone to perfectionism. Limit athlete-facing metrics where the risk is present, and talk about feelings as well as numbers.

Integrating into a multi-disciplinary staff

Data domain	Head coach	S&C coach	Analyst	Medical
Daily readiness screen	Informed	Responsible	Consulted	Consulted
Weekly load report	Accountable	Responsible	Responsible	Informed
Early-warning flags	Accountable	Responsible	Informed	Consulted
Red flag / referral	Informed	Consulted	Informed	Responsible
Consent and retention	Accountable	Informed	Consulted	Consulted

Failure mode 1

Multiple staff making conflicting decisions because nobody owns the data domain.

Failure mode 2

Data sitting unanalysed because everyone assumed someone else was responsible.



A weekly performance meeting, with a defined agenda anchored to last week's monitoring outputs, is what makes the system stick. Template A10 gives a starting RACI structure.

Five delivery pathways for this programme

Self-paced • ≈6 weeks

One module per week: read, quiz, download templates, apply one activity. ≈4 hours per module including application.

Best for: individual coaches, dispersed audiences.

Instructor-led • 2 days

Day 1: Modules 1–3. Day 2: Modules 4–5 plus the capstone workshop. Cohorts of 12–24.

Best for: federations, NSGBs, club staff training days.

Blended • 4 weeks

3 hours asynchronous plus a 2-hour live session weekly. Modules 1–2 combined in week 1.

Best for: university coach education, federation CPD tracks.

Microlearning • 30 days

One 10-minute unit per day in the mobile app: a concept, a question, a micro-exercise.

Best for: time-pressed coaches, mass dissemination at low commitment.

Train-the-trainer • 3 days

Day 1 content mastery, Day 2 adult-learning facilitation, Day 3 practice teaching with feedback.

Best for: scaling across federations and national contexts.

Choosing between them

Individual and dispersed → self-paced or microlearning.

A cohort with facilitator capacity → instructor-led or blended.

Scaling the programme itself → invest in train-the-trainer first.

Capstone — the 90-day integration plan

Context analysis

Sport, level, athlete numbers, current practice, resources, staff structure.

The PDCA question

One specific question wearables will answer this season.

Metric selection

3–5 metrics, with personalised thresholds for one named athlete.

Governance

A short statement covering consent, access and retention.

Communication plan

How athletes — and parents, where applicable — will be briefed.

Success criteria

What success looks like at day 30, day 60 and day 90.

Review checkpoints

Calendar dates for honest review, booked in advance.

Stop conditions

What would cause you to stop or substantially modify the plan.



In instructor-led settings the plans are peer-reviewed within the cohort. In self-paced settings the rubric in Annex C supports honest self-review.

Module wrap-up

Reflective prompt

Return to the note you wrote in Module 1. Does the device you named still answer the coaching question you wrote beside it? If not, say so in your plan.

Self-check

Which single stop condition would you be most reluctant to write down — and what does that reluctance tell you?

Capstone

Complete Template A5. Bring it to the next cohort session, or self-review it against the Annex C rubric within two weeks.



Interactive unit 5 + video tutorial 5: a guided 90-day plan builder with an exportable summary, a governance self-audit, and a negative-news conversation simulation — roughly 40 minutes.

Close the session with the reflective prompt. Coaches who write nothing down complete the course; coaches who write something down change their practice.



WearCoach

Where this goes next

The programme is designed to outlast the devices on the market today. Sensors will improve, dashboards will be redesigned, algorithms will be revised. The durable competence is the coach's.

- 1 Complete the Wearable Technologies Self-Assessment Toolkit (D2.3).
- 2 Use the interactive e-learning units and video tutorials between sessions; the mobile app (D2.4) follows.
- 3 Write and implement your 90-day integration plan — the artefact that changes practice.
- 4 Send feedback to the consortium; the pilot phase (D2.5) refines these materials.



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