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Title: Can off-field 'brains' provide a competitive advantage in professional football?

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Introduction

'Working-fast and working-slow' in sport describes the concept that practice and research can be integrated to improve high-performance outcomes and improve professional practice.[1] 'Working-fast' is the task of the fast-thinking, intuitive practitioner operating on 'the ground' at a frenetic pace, interacting with coaches, athletes and delivering the daily preparation programme. 'Working-slow' is key for the team's deliberate, focused researcher acting as the resident sceptic, operating behind the scenes on tasks that the 'fast-practitioner' may not have time and/or skills to undertake. Such hidden, but important tasks include determining measurement noise/error in performance tests, establishing proof of concept for new ideas and ensuring validity of methods. Embedding research into the fast environment of high-performance football may provide a competitive advantage using ethical and evidence-based methods.[1]

Football teams can learn from many of the world's largest technology companies.[2] who embed research within their organisations to improve efficiency and enhance productivity. Such a strategy is coined, 'Research and Development' (R&D) and defined as: 'work directed toward the innovation, introduction and improvement of processes',[3] However, to the current authors' knowledge, R&D is not widely adopted in high-level football teams.

Here we argue for professional football teams to embed R&D in their daily activity to improve' their processes relating to reducing injury-risk and optimising performance.

Innovation, introduction and improvement of processes using R&D

In the fast-moving environment, practitioners combine data (e.g. training load, recovery, screening) with their expert opinion to inform decisions on individual players. We suspect these data are often not interrogated to the level that a researcher might aim for.[1] Nevertheless, practitioners are expected to be innovative and often become early adopters of new technology and techniques to gain competitive advantage (e.g. altitude training).[1] In-house R&D can inform judgements and decisions taken in the fast-working environment. Remember that innovation is a sword with two-edges – it can also lead to impaired performance.

Example 1 – what do repeated player measurements really mean?

High-performance practitioners undertake a multitude of measurements in their players (e.g. injury-screening, recovery/monitoring). However, it is impossible to know if changes are meaningful without knowing what noise (typical variation) surrounds the signal (actual change in measurements).[4] A R&D programme can apply statistical methods to determine what is a real change for practitioners to act on.[6]

Considering week-to-week variation (CV) and smallest-worthwhile change (SWC), we can determine 'real and meaningful' changes.[6,7] For example (Table 1), player 1 demonstrates a high week-to-week variation in recovery of isometric hamstring flexion and therefore requires greater change to detect anything meaningful. Player 2 with low week-to-week CV requires a smaller reduction to be real (and thus, potentially at risk of injury). This concept applies to various monitoring, medical and performance measurement tools typically used in the professional football team setting.

Table 1: Separating the signal from the noise: A comparison of players with higher versus lower week-to-week variation for recovery of isometric hamstring flexion.

Isometric hamstring flexion force at 90° (dominant limb)	**Player 1**	**Player 2**
Typical week-to-week variation (CV%)	13.8% (11.0-18.7)	5.6% (4.5-7.7)
Smallest Worthwhile Change (%)	2.8%	1.1%
Change in performance required to be real (%)	16.6%	6.7%

CV% - between match variation, with 90% Confidence Interval
SWC% - smallest worthwhile change (0.5 x Individual CV%)
Real Change in performance - minimum criterion change required to produce a probable significant change in performance (75% confidence)

While such confidence in data is imperative, the information must be translated so that it influences practice (e.g. does the injury-screening tool detect injury risk, does the change in recovery-marker relate to real changes in performance?). Such analyses require specialised knowledge in analysing large datasets, which are time-consuming, and are not within the natural scope of practice for 'fast' practitioners, clinicians and strength and conditioning coaches.

Example 2 –is this technological aid valuable or just voodoo?

Teams are constantly faced with offers of new technologies and methods/procedures that claim to accelerate recovery, reduce injuries and enhance performance. A teams' 'slow worker' would investigate the legitimacy of such technologies. Using an adapted method originally created to prescribe medication,[8] it is possible to assign graded-recommendations (Figure 1) for new products or procedures in practice, based on scientific level and quality of evidence from research literature combined with expert opinion. This ensures that products or

processes introduced are based on solid evidence[1] and cost-effectiveness (which is not always at the forefront in professional football).

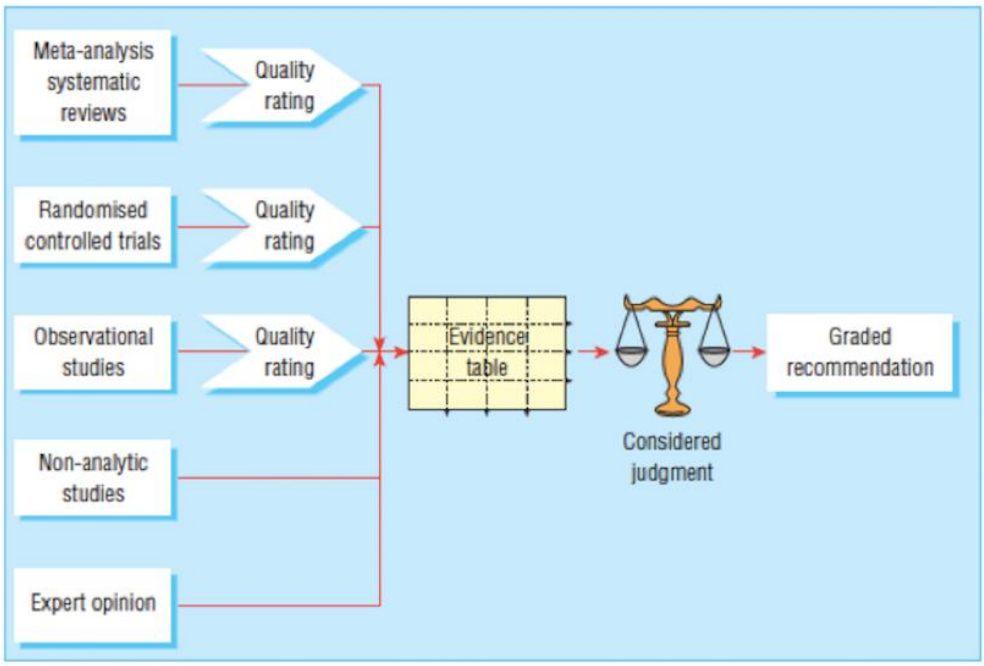

Figure 1: Proposed method to establish level of evidence and provide an overall graded recommendation for the introduction of a new product or process (reprinted with permission from Harbour and Miller, 2001[8]) (reprinted with permission, BMJ)

In the example (table 2), consider Whole-body Cryotherapy (WBC) as a recovery strategy. According to the sources, quality of evidence, general consensus and considered judgment (practitioners and researcher) the graded-recommendation for WBC is D (insufficient evidence to recommend).

Table 2: Assigning a graded recommendation: Consideration of Whole-Body Cryotherapy as a recovery modality using adapted evidence based medical guidelines[8]

Source of Evidence	Quality of Evidence	General consensus	Considered Judgement	Graded Recommendation
3 x Systematic Reviews & Meta-analyses 2 x expert opinion	One study 1++ Two studies 1+ 4	Overall, insufficient and inconclusive evidence that WBC improves markers of recovery (subjective, inflammatory, performance related) CWI more effective than WBC Insufficient evidence for use in elite athletes or football players **Expert 1** does not use WBC – insufficient evidence, high cost, lack of practicality e.g. limited number of athletes can enter at any one time **Expert 2** does use WBC and suggests that they have preliminary results that suggest it may ↑ functional recovery	High monetary cost Need to construct a new building to house the chamber Maintenance costs and time associated Not yet proven to be more effective than cold-water immersion (which is less expensive and already installed) Anecdotally more tolerable than cold-water immersion (higher compliance?) Are there any implications for 'future proofing', If evidence emerges regarding ↑ recovery	**D** **(insufficient evidence**

Quality of evidence ratings:
1 (Meta-analysis, systematic review of randomised control trials (RCT) or RCT)
2 (Systematic review of case control studies or cohort studies, case control, cohort studies)
3 (Non-analytic studies e.g. case reports, case series)
4 (Expert opinion)
++ (High quality, very low risk of bias)
+ (Well conducted, low risk of bias)
- (Low quality, high risk of bias)
Graded recommendations: A (High), B (Acceptable), C (Weak), D (insufficient evidence)
WBC – Whole-body cryotherapy
CWI – Cold-water immersion

The challenge: ensuring the slow-work impacts practice/performance

Successful preparation and acting on player-related recommendations in professional football are highly dependent on 'buy in' from key-decision makers (coaches, players, CEOs). In the fast-moving environment, these key-decision makers are concerned with simple 'yes/no' answers (can the player train/play? will he/she suffer recurrent injury?) whereas the researcher is concerned with 'what, why and how' of these issues. The ability to communicate relevant

data with practical meaning is paramount. The R&D role should provide translation of data from complex analyses into clear messages to inform decision-making.

In summary, an effective way to optimise decision-making of the fast-intuitive practitioner can be through embedding R&D within the team, ensuring an ethical, valid and financially prudent approach to the innovation, introduction and improvement of processes. Appropriate delivery of information to team management is essential.

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Figure Legend

Figure 1: Proposed method to establish level of evidence and provide an overall graded recommendation for the introduction of a new product or process (reprinted with permission from Harbour and Miller, 2001[7]) (reprinted with permission, BMJ)