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

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7 **Introduction**

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

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

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

28

29 *Innovation, introduction and improvement of processes using R&D*

30

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

39

40 *Example 1 – what do repeated player measurements really mean?*

41

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

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

54

55 Table 1: Separating the signal from the noise: A comparison of players with higher versus
 56 lower week-to-week variation for recovery of isometric hamstring flexion.
 57

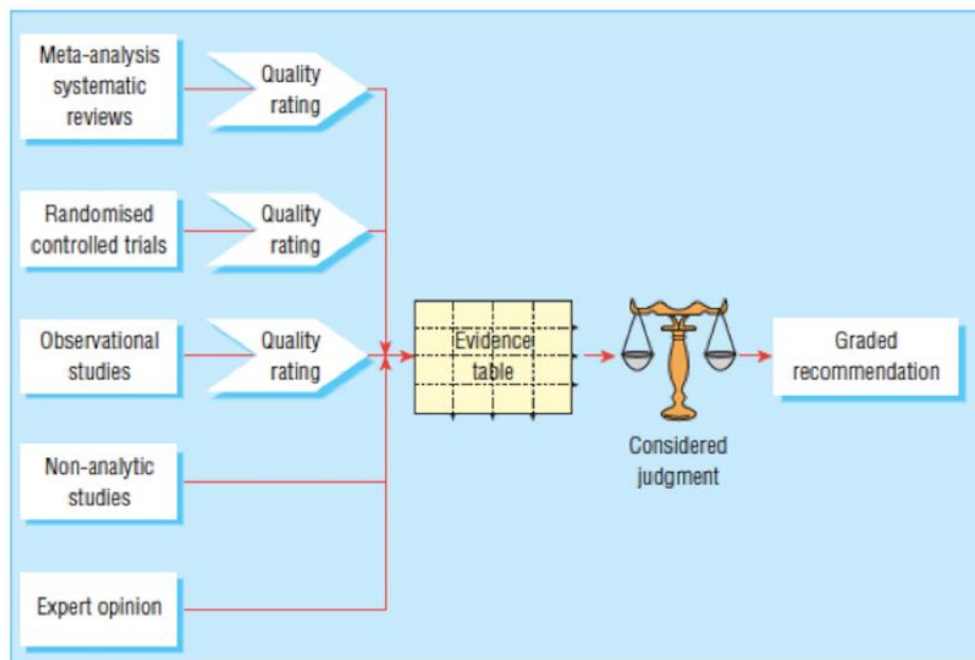
Isometric hamstring flexion force at 90° (dominant limb)	Player 1	Player 2
Typical week-to-week variation (CV%)	13.8% (11.0-18.7)	5.6% (4.5-7.7)
Smallest Worthwhile Change (%)	2.8%	1.1%
Change in performance required to be real (%)	16.6%	6.7%

58 CV% - between match variation, with 90% Confidence Interval
 59 SWC% - smallest worthwhile change (0.5 x Individual CV%)
 60 **Real Change in performance** - minimum criterion change required to produce a probable significant change in performance (75%
 61 confidence)
 62

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

69
 70 *Example 2 –is this technological aid valuable or just voodoo?*
 71 Teams are constantly faced with offers of new technologies and methods/procedures that
 72 claim to accelerate recovery, reduce injuries and enhance performance. A teams’ ‘slow
 73 worker’ would investigate the legitimacy of such technologies. Using an adapted method
 74 originally created to prescribe medication,[8] it is possible to assign graded-recommendations
 75 (Figure 1) for new products or procedures in practice, based on scientific level and quality of
 76 evidence from research literature combined with expert opinion. This ensures that products or

77 processes introduced are based on solid evidence[1] and cost-effectiveness (which is not
78 always at the forefront in professional football).
79



80 Overview of the process for developing and grading guideline recommendations

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

84
85 In the example (table 2), consider Whole-body Cryotherapy (WBC) as a recovery strategy.
86 According to the sources, quality of evidence, general consensus and considered judgment
87 (practitioners and researcher) the graded-recommendation for WBC is D (insufficient
88 evidence to recommend).

89
90 Table 2: Assigning a graded recommendation: Consideration of Whole-Body Cryotherapy as
91 a recovery modality using adapted evidence based medical guidelines[8]

92
93

Source of Evidence	Quality of Evidence	General consensus	Considered Judgement	Graded Recommendation
3 x Systematic Reviews & Meta-analyses	One study 1++ Two studies 1+	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	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)
2 x expert opinion	4	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		

- 94 *Quality of evidence ratings:*
95 1 (Meta-analysis, systematic review of randomised control trials (RCT) or RCT)
96 2 (Systematic review of case control studies or cohort studies, case control, cohort studies)
97 3 (Non-analytic studies e.g. case reports, case series)
98 4 (Expert opinion)
99 ++ (High quality, very low risk of bias)
100 + (Well conducted, low risk of bias)
101 - (Low quality, high risk of bias)
102 Graded recommendations: A (High), B (Acceptable), C (Weak), D (insufficient evidence)
103 WBC – Whole-body cryotherapy
104 CWI – Cold-water immersion
105

106

107

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

109

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

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

117

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

122

123

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149

150 **Figure Legend**

151

152 Figure 1: Proposed method to establish level of evidence and provide an overall graded
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