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1 **EDITORIAL:** Why complexity matters in physiotherapy research

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## 12 **Main Text**

13 We talk of complexity throughout physiotherapy and rehabilitation - complex interventions,  
14 complex patients and complex conditions are all too familiar phrases in both research and  
15 practice [1]. But what does complexity mean? It may be helpful to start with a distinction – a  
16 complicated system (such as a space rocket) comprises many intricate, multi-faceted elements  
17 which behave linearly and as we would predict. Each of these constituent parts have a clearly  
18 defined and constant relationship with each other and the external context and so can be  
19 reliably replicated *ad infinitum* [2]. In contrast, the behaviour of a complex system is often  
20 unpredictable, non-linear and is difficult to replicate. It has many interacting elements; these  
21 elements directly influence and are influenced by each other and the wider context. Complex  
22 systems are emergent and adaptive, that is, their overall effect is greater than the sum of their  
23 parts and they change over time. This means that in a complex system it is impossible to  
24 reliably identify or predict the contribution of a single element on the overall outcome [2].

25  
26 Why does this matter for physiotherapy? In clinical practice, a holistic approach has long  
27 recognised complexity –we understand that the context, belief and behaviours of both  
28 therapists and patients affect the response to any intervention we provide [3]. Yet many of  
29 our research trials do not reflect, measure or acknowledge these factors, despite them having  
30 a pivotal influence on both the effectiveness and implementation of interventions in the real-  
31 world. Research designs that search for a single effective ingredient in a restrictive context  
32 and control as many variables as possible may appear attractive [4], but they risk stifling the  
33 emergent interactions that influence the effectiveness of a complex intervention [5]. Put  
34 simply, constraining complex interventions in research means that beneficial interventions  
35 could be incorrectly judged as ineffective and *vice versa*. Findings of this reductive research  
36 is also likely to be difficult to implement as the controlled context in which it was conducted

37 bears little resemblance to realistic practice [6]. Ultimately, attempting to reduce or control  
38 the complexity that is inherent to many physiotherapy interventions reduces the power of  
39 research to improve practice and results in patients being offered suboptimal care. However,  
40 trials with little definition or control of potentially confounding variables will not generate  
41 data that can be confidently applied to an individual patient. Clearly, embracing complexity  
42 in our research is important but it does not mean that we should abandon controlled designs;  
43 randomised controlled trials (RCTs) are our most powerful tool to test effectiveness and it is  
44 entirely appropriate to control extraneous variables when assessing efficacy. However,  
45 understanding complexity should prompt us to contemplate different trial designs that enable  
46 us to recognise rather than constrain complexity in our research [6].

47

48 The recent revision of the NIHR/MRC framework for the development and evaluation of  
49 complex interventions [6] builds on an established recognition of the importance of  
50 complexity in public health, basic science and more latterly, health research [4,7]. It is  
51 particularly pertinent for physiotherapy researchers because, as we know, most of our  
52 interventions can be defined as complex. The framework explicitly highlights the need to  
53 consider the behaviour of complex systems in research, stresses the importance of context  
54 and prioritises designs that generate clinically valuable data over those that simply seek to  
55 minimise bias [6]. It recommends that researchers and stakeholders work together to identify  
56 the most pressing questions that the research should address, rigorously develop the  
57 intervention to be tested and articulate a (programme) theory that describes how an  
58 intervention will produce an outcome. This should not only detail the effect of the  
59 intervention on the individual but also consider complexity – that is, the wider dynamic  
60 context that will influence, and be influenced by, an intervention. A comprehensive  
61 programme theory also supports implementation, economic evaluation and enables changes

62 to be made to the intervention even during a trial [6] so that recent developments in  
63 knowledge, practice or context can be incorporated into the interventions once a trial has  
64 begun. This is particularly advantageous in light of how quickly practice can change in  
65 response to internal and external influences and how slowly large clinical trials progress.  
66 Developing this theory is vital *prior* to considering or conducting an evaluative trial as it  
67 guides the decision whether to proceed to a trial and ensures that many potential problems  
68 that would undermine evaluation are identified and proactively managed. Once it has been  
69 decided to move to a trial, process evaluations within a RCT and novel pragmatic and critical  
70 realist RCT designs present established methods to determine both the effects of an  
71 intervention but also explain how these effects were created [8,9]. Novel efficient RCT  
72 designs (e.g. master protocol trials) enable multiple treatments and people with different  
73 clinical presentations to be evaluated simultaneously, but are not yet used widely in  
74 rehabilitation [10]. These trials enable clinicians to understand what works, for whom and  
75 should a trial not show significant benefit, still provides useful knowledge to inform other  
76 research studies which reduces research waste.

77

78 In conclusion, physiotherapy practice is complex and this complexity should be reflected in  
79 how we design and conduct research into our interventions. Now more than ever,  
80 physiotherapy researchers have a clear mandate to undertake ambitious studies of complex  
81 interventions that go beyond traditional reductionist designs and have the opportunity to  
82 become recognised leaders in complexity-informed health research. This approach not only  
83 supports high-quality research that addresses many of the key uncertainties in physiotherapy  
84 practice but also provides a mechanism for implementation, so that effective interventions  
85 bring benefit to patients more quickly. However, the developmental studies which are  
86 necessary to prioritise, develop and refine complex interventions can be overlooked in favour

87 of evaluative trials, perhaps because complex designs are more unpredictable and are unlikely  
88 to be easy or cheap to conduct [7]. Yet if the complex studies that are vital to advance our  
89 practice are rejected in favour of simplistic, ‘neat’ research designs that answer easily  
90 definable yet irrelevant questions [6] our profession and our patients will pay a significant  
91 price. To make progress in developing effective, implementable physiotherapeutic  
92 interventions we must conduct research using new tools designed to deal with the  
93 complexities that are inherent to healthcare. This will enable us to answer clinically important  
94 questions, advance our evidence-base, benefit our profession and, most importantly,  
95 transform outcomes for our patients.

96

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