

Knowledge mobilisation for translating evidence-based guidelines into practice. Lessons from using the Normalisation Process Theory to understand adherence to guidance on MgSO₄ in preterm labour

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Tables 1-2 are available in the supplementary files section.

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17

18 **Abstract**

19 **Background**

20 The administration of magnesium sulphate (MgSO₄) in preterm labour is an
21 evidence-based intervention recommended by the United Kingdom's National
22 Institute for Health and Care Excellence (NICE) to prevent neurological damage
23 to the infant. However, uptake varies across UK maternity units. We used
24 findings from implementation research in England, Scotland and Wales to
25 explore knowledge mobilisation as a mechanism for improving adherence to
26 clinical guidance.

27 **Methods**

28 Data were collected using semi-structured interviews for a process evaluation of
29 the PReCePT (Preventing Cerebral Palsy in Pre-Term Labour) National
30 Programme, the PReCePT cRCT study, and a study investigating MgSO₄ guidance
31 implementation in Scotland and Wales. Normalisation Process Theory informed
32 data collection and analysis. Data were analysed using the framework method.

33 **Results**

34 Interviews with 68 strategic and clinical leads and implementers from the three
35 nations suggested that despite evidence being necessary and important for
36 policy decision-making, clinical leadership intervention decisions were motivated
37 by audit data and benchmarking. Implementation success was impaired by
38 degrees of silo working and rigid role boundaries, alongside differences in
39 implementers' ability to mobilise social-cognitive (e.g. commitment by maternity,
40 neonatal and obstetric teams), and social-structural resources such as staff
41 capacity, articulated workflows, and culture.

42 Cross-organisational, diverse and collaborative communities of practice (CoPs)
43 rooted in distributed leadership created a nexus between national and regional
44 leadership, patient group representatives, implementers i.e. clinical leads and
45 champions, and perinatal clinical teams. They provided a platform for CoP
46 participants to build relationships and share knowledge, and together negotiate
47 meaning, co-design implementation plans, share operational enablers such as
48 strategies and products, and assess progress. Where training opportunities were
49 provided alongside mentoring and peer support, CoPs created implementation
50 resource i.e. capacity and capability within the perinatal system. Backfill funding
51 for champions and protected time away from clinical duties were required to
52 enable participation, especially for champions in resource-poor settings.

53 **Conclusions**

54 Opportunities to participate in collaborative, diverse, cross-organisational CoPs
55 where knowledge and innovation can be co-created, shared, and spread across
56 the perinatal ecosystem, can help address disparities in clinical teams' ability to
57 implement evidence-based interventions. Participation relies on backfill funding
58 for champions, and a system-wide commitment to improvement.

59

60 **Contribution to the literature**

- 61 □ Some settings are better than others at embedding evidence-based
62 guidance in routine practice. Understanding how best to scale and spread
63 evidence-based interventions can address disparities in clinical practice.
- 64 □ Using the Normalisation Process Theory, we show how settings differ in
65 their access and ability to mobilise resources and initiate implementation
66 mechanisms.
- 67 □ Investment – e.g. in backfill funding and capacity-building - and
68 opportunities for implementers, clinical and managerial leadership, and
69 patient group representatives to share knowledge and shape
70 implementation practice (knowledge mobilisation) is important for
71 spreading improvement.
- 72 □ Our findings contribute to our understanding of knowledge mobilisation
73 mechanisms, and their role in creating improvement capacity and
74 capability across the perinatal ecosystem.

75

76 **Keywords**

77 Quality Improvement, Normalisation Process Theory, Knowledge Mobilisation,
78 Magnesium Sulphate, preterm labour, evidence-based guidelines

79

80

81 Background

82 Improvements in quality and safety in maternity and neonatal care depend on
83 evidence-informed policy and practice that ensure all mothers and babies
84 receive effective, cost-effective and equitable care (1, 2). However, numerous
85 patient safety investigations have highlighted gaps between evidence and
86 practice, variation in clinical practice within and between teams, and ethnic
87 disparities in outcomes (3). National improvement initiatives offer a pathway to
88 scaling and spreading good practice (4, 5), but innovations often struggle to
89 make an impact beyond their original settings (6-8). The process of mobilising
90 evidence to change clinical practice is complex (9), often leading to unplanned
91 outcomes and possible resistance from intended adopters, particularly in
92 contexts marked by unequal power distribution (8), such as perinatal clinical
93 microsystems (10).

94 Several examples within maternity and neonatal care illustrate the challenges of
95 bridging the evidence-to-practice gap. For instance, it took 22 years for the
96 routine administration of antenatal corticosteroids to become standard practice
97 in the healthcare system of a rich country (11). Similarly, the clinical guidance to
98 administer antenatal magnesium sulphate (MgSO₄) as a neonatal
99 neuroprotectant for preterm infants has seen low and inconsistent adherence
100 within and across different settings (12). However, interventions to improve
101 uptake of MgSO₄ that employed knowledge mobilisation (KM) or knowledge
102 translation approaches were more effective in expediting uptake of the
103 intervention (11-13). The use of KM alongside implementation science is
104 gaining momentum, but the mechanisms driving KM processes remain poorly
105 understood (14).

106 Knowledge mobilisation refers to the processes by which research-based
107 knowledge is accessed, applied and embedded into practice, through
108 stakeholder collaboration and engagement (15). Understanding the contextual
109 and cultural forces, including the perspectives of those intended to use the
110 knowledge, is crucial (8, 16). Teams vary in their implementation readiness (9)
111 and improvement capability (17), which influences how interventions are
112 adopted and adapted in different contexts, impacting implementation processes
113 and outcomes (18), and potentially hindering efforts to scale and spread
114 successful practices (7).

115 Our team has evaluated the implementation of a national quality improvement
116 (QI) programme - the National PReCePT Programme or NPP - and an embedded
117 cluster randomised controlled trial (cRCT) that compared the effectiveness of the
118 standard model of implementation support delivered by NPP against an
119 enhanced support model (the PReCePT study). Our evaluations demonstrated
120 that PReCePT, a QI intervention that includes a toolkit, funded PReCePT
121 champions, and enhanced or standard levels of mentoring and support for
122 champions provided by improvement and clinical leads, (12) effectively
123 expedited the scaling up of MgSO₄ administration in preterm labour and reduced
124 regional disparities (19, 20). Further details on the PReCePT studies can be
125 found here (10, 12, 13, 20-22).

126 In this paper, we focus on the KM strategies employed as part of the scaling of
127 PReCePT in England, as well as those used in Scotland and Wales to implement
128 MgSO₄ guidance. By using MgSO₄ as an example of an evidence-based
129 intervention embedded in national and professional guidelines, yet inconsistently
130 adopted across units, we explore the KM process within a CoP as an
131 implementation strategy and mechanism for spreading improvement. We draw
132 on findings from our evaluations of the NPP, PReCePT study, and the PReCePT
133 Devolved Nations (DN) study, which examined the implementation strategies in
134 Scotland and Wales (21), to illustrate how system-wide KM can effectively and
135 equitably accelerate the spread of improvement. Our analysis is grounded in the
136 Normalisation Process Theory (NPT) (e.g. 18, 23), a sociological theory which
137 identifies, characterises, and explains key mechanisms promoting and inhibiting
138 implementation, embeddedness, and integration (normalisation) of complex
139 interventions into routine practice (24). In addition to the four mechanisms -
140 coherence, cognitive participation, collective action and reflexive monitoring -
141 that describe the implementation and normalisation process, NPT also accounts
142 for contextual factors and defines outcomes associated with the implementation
143 process (23). The theory is frequently used to provide explanatory power in
144 implementation evaluations (25).

145 [Methods](#)

146 [Setting](#)

147 Healthcare in the United Kingdom (UK) is a devolved responsibility, meaning
148 each of the four nations - England, Northern Ireland, Scotland and Wales - sets

149 its own healthcare policies and delivers services to its population. PReCePT (NPP
150 and PReCePT study) was implemented across all National Health Service (NHS)
151 maternity units in England. Implementation was overseen by Academic Health
152 Science Networks (AHSNs), now known as Health Innovation Networks, which
153 have a mandate for fostering innovation within their regions. AHSNs were tasked
154 with (1) recruiting regional clinical champions and unit midwife champions, (2)
155 providing leadership, (3) supporting champions in the local implementation of
156 the Toolkit, and (4) monitoring the performance of maternity units within their
157 region.

158 A total of 150 maternity units participated in the NPP. Of these, 13 were
159 randomised to the Enhanced Support Package (ESP) arm of the PReCePT study,
160 while 27 were assigned to the Standard Support Package (SSP) arm, which
161 received the same level of support as the other NPP units. The NPP has since
162 been succeeded by PERIPRem (26), a QI toolkit based on PReCePT methodology
163 that targets a bundle of care for perinatal optimisation, including the use of
164 MgSO₄. Wales has also commissioned the implementation of PERIPrem Cymru
165 across all maternity units (27). In Scotland, the use of MgSO₄ for preterm labour
166 was an intervention included in the Preterm Perinatal Wellbeing Package (PPWP),
167 and captured in the Core Measurement Plan implemented by the Maternity and
168 Children Quality Improvement Collaborative (MCQIC), launched in 2017. This
169 package has since been restructured into the Scottish Patient Safety Programme
170 (SPSP) Perinatal (28).

171 Design and recruitment

172 A detailed description of the mixed-methods evaluation of the NPP, PReCePT
173 Study and PReCePT DN has been provided in previous publications (10, 13, 21,
174 22).

175 For the qualitative process evaluations of the NPP and PReCePT study we
176 conducted semi-structured telephone interviews with the following participants:

177 (1) AHSN quality improvement managers: these managers provided
178 implementation leadership and delivered the standard support package to
179 units within their catchment areas as part of the NPP.

180 (2) Regional clinical leads: These leads were enrolled by AHSNs to provide
181 clinical leadership to the units.

182 (3) Champion midwives and clinical lead obstetricians and neonatologists:
183 These participants were from units that received a standard level of
184 support from AHSNs and were randomised to the control arm of the
185 PReCePT Study (SSP).

186 (4) Champion midwives and clinical lead obstetricians and neonatologists :
187 These participants were from units randomised to the enhanced support
188 package (ESP) of the RCT study receiving intensive, personalised QI input
189 from the PReCePT Study management team and QI coaches.

190 To explore the strategies, implementation processes, and factors influencing
191 implementation in the two devolved nations (Scotland and Wales), we conducted
192 semi-structured remote interviews via MS Teams with:

- 193 1. Perinatal network leads involved in the strategic planning of national
194 clinical guidance implementation activities.
- 195 2. National leads responsible for implementing national quality improvement
196 initiatives.
- 197 3. Local clinical leads involved in improvement efforts and the
198 implementation of clinical guidance.

199 Recruitment for all three studies was guided by the concept of information power
200 (29) which suggests that the number of participants recruited is determined by
201 the richness of responses and the depth of participants' knowledge on the topic
202 of interest.

203 The topic guides were informed by the Normalisation Process Theory
204 implementation mechanisms (30).

205 Data collection and analysis

206 Data for the NPP and PReCePT Study were collected between July 2019 and
207 December 2020 by CP-McK and TS, while data for the PReCePT DN study were
208 collected between November 2022 and July 2023 by CP-McK. Interviews lasted
209 between 28 and 58 minutes. All interviews were audio-recorded with
210 participants' consent, transcribed, and analysed in QSR NVivo using the
211 framework method (31). Normalisation Process Theory (NPT) (23) was used as
212 an analytic framework to understand and evaluate the implementation
213 processes, allowing us to focus on individual and collective behaviours, as well as

214 the intervention and contextual factors important in the implementation
215 processes.

216 Findings

217 For the NPP and PReCePT Study, we conducted 55 interviews with participants
218 including 13 midwives, 11 obstetricians, 10 neonatologists, 9 regional clinical
219 leads, and 12 AHSN staff responsible for providing QI support to champions.

220 In the PReCePT DN study, 13 participants were recruited - 8 from Wales, and 5
221 from Scotland. Among these, 6 held national strategic leadership roles, while the
222 remaining participants were leading on national or local implementation efforts.
223 The group included 7 members of the neonatal team (consultant neonatologists
224 and one Advanced Neonatal Nurse Practitioner (ANNP), and 5 members of the
225 maternity team (consultant obstetricians and one midwife). Additionally, one
226 participant served as a QI coach involved in implementing MCQIC PPWP.

227 Our process evaluation of the NPP and PReCePT Study revealed that the PReCePT
228 drivers for change (21) addressed all four NPT mechanisms: coherence, cognitive
229 participation, collective action and reflexive monitoring. Table 1 summarises the
230 PReCePT implementation process and illustrates how these NPT mechanisms
231 align with the four primary PReCePT drivers of change. By activating these
232 mechanisms and offering opportunities to build improvement capacity and
233 capability among champions - particularly when tailored to the specific needs of
234 each champion and their context - PReCePT proved successful in achieving NPT
235 implementation outcomes (10).

236 In this paper, we expand on these findings by describing the challenges faced by
237 strategic and clinical leadership, as well as staff on the ground, when
238 implementing clinical guidance. Using the NPT mechanisms, we explore how KM
239 can help address these challenges, drawing on lessons from the PReCePT
240 evaluations.

241 Coherence: *What is the work?*

242 Coherence refers to how individuals understand and make sense of a change to
243 practice (23), such as the administration of MgSO₄ to women in preterm labour.
244 This involves understanding how individuals think the change differs from
245 current practices, how they assess its impact on their roles and responsibilities,

246 and how they value it. In 2016, MgSO₄ was included in National Institute for
247 Health and Care Excellence (NICE) preterm labour guidance and the National
248 Neonatal Audit Programme's (NNAP) quality indicators list, which facilitated its
249 integration into local clinical guidelines. Despite this, uptake remained patchy
250 and sub-optimal, even though our analysis indicated high commitment to the
251 intervention among implementers.

252 Participants described senior clinicians, particularly neonatologists, to hold more
253 knowledge around the intervention, compared to junior staff, midwives, and
254 anaesthesiologists, who were not always aware of MgSO₄ evidence or of its
255 relevance to their own practice (the intended adopters). Not all settings included
256 the intervention in staff training or invited all perinatal team members to
257 meetings where the intervention was discussed. Additionally, obstetric and
258 neonatal professional bodies published what was perceived as conflicting
259 guidelines on how the intervention should be operationalised, leading to
260 misunderstandings and disagreements among team members about when, how
261 and to whom, MgSO₄ should be administered which jeopardised timely and
262 appropriate administration. This lack of a shared understanding of the
263 intervention and its rationale made it difficult to secure support for
264 implementation activities as illustrated by the following excerpt:

265 *A lot of it was understanding the why we want you to change*
266 *your behaviours, and if you don't know the evidence why would*
267 *you change your behaviour? So, I think it's having those shared*
268 *common goals across all of our specialties, and building the team*
269 *from that joined-up approach from the start, and not just working*
270 *in a silo. (P13, Neonatologist, DN Scotland)*

271 PReCePT was a collaborative effort involving midwives, obstetricians,
272 neonatologists, QI managers, QI coaches, and patient champions - mothers with
273 lived experience of preterm labour - who collaboratively co-created meaning
274 around the intervention, developed innovations such as documentation (e.g.
275 guidance, proformas and Patient Information Leaflets), and content for
276 PReCePT's communication strategy on digital and professional platforms. In
277 some cases, local adaptations were made to align the message with the local
278 context, such as AHSNs creating their own digital content. Bringing together
279 stakeholders from various backgrounds, levels and roles and with diverse
280 perspectives, helped co-create coherence around MgSO₄, form strategic

281 alliances, and align PReCePT with existing perinatal and QI efforts, such as the
282 Maternity and Neonatal Safety Improvement Programme (MatNeo SIP) and the
283 British Association for Perinatal Medicine (BAPM). The PReCePT message was
284 then communicated to actors and partners on all levels of the perinatal eco-
285 system helping to create shared understandings and bring everyone onboard.
286 Creating a shared narrative was useful for creating the right conditions for
287 cognitive participation as the following excerpt illustrates:

288 *Our neonatologist did a lot of access to great big meetings, so*
289 *she accessed a regional anaesthetic network to go and talk to*
290 *them about PReCePT. She's talked to trainees on a regional basis*
291 *and she's infiltrated lots of these regional medical meetings so*
292 *we've made sure it's on everybody's agenda. But in order to start*
293 *having governance ownership it starts to then go into the wider*
294 *system and away from the frontline staff, so you need to be able*
295 *to have the contacts for people at the CCGs or those within the*
296 *local maternity systems (P02 AHSN lead, NPP)*

297 Cognitive participation: *Who does the work*

298 Cognitive participation is the relational work people do to build and sustain a
299 community of practice around a complex intervention, the space where
300 knowledge sharing and co-creation take place. It also relates to people's
301 understanding of their role and that of their team in implementing the
302 intervention (23). National policies on optimising perinatal care during
303 premature labour (32), and the allocation of clinical governance responsibilities
304 to neonatologists created both geographical and symbolic boundaries between
305 teams, hindering collaboration and communication.

306 At the clinical leadership level, our analysis revealed that, despite the availability
307 of national networking opportunities for relational work to take place (e.g. within
308 national and professional perinatal networks), engaging midwifery, obstetric, and
309 neonatal actors proved challenging. In the PReCePT NPP, where implementation
310 responsibilities were assigned to maternity teams, and in Scotland and Wales,
311 where they were assigned to neonatology teams, other specialties often felt
312 disincentivised to participate in CoPs due to a perceived lack of shared
313 ownership of the intervention and its implementation. Factors related to culture,
314 such as silo working, distinct professional conventions and priorities,
315 commissioning and funding mechanisms which acted as organisational
316 incentives for improvement (the Clinical Negligence Scheme for Trusts in
317 England incentivised organisations to support quality improvement, but Wales
318 and Scotland did not have a similar scheme), and organisational factors such as

319 staff capacity, intersected with perceived ownership, affecting motivation and
320 engagement, as illustrated by the following excerpt:

321 *If I go to a (joint perinatal improvement) meeting where there is*
322 *only two obstetricians and 12 neonatal consultants and 12*
323 *advanced neonatal practitioners and they are talking in terms*
324 *which I am not familiar with, certain things I've never heard of,*
325 *next time, when I have to prioritise (which meetings I can*
326 *attend), I will say, okay, I am probably not needed there. (P07,*
327 *Obstetrics, DN Wales)*

328 Even when cultural challenges were addressed, Welsh and Scottish participants
329 described participation in CoPs as sporadic and fragmented, especially when
330 teams lacked named champions with protected time for meetings and
331 implementation activities. Champion duties were often carried out by different
332 staff members based on daily capacity, compromising the continuity and impact
333 of improvement work as reflected in the following excerpt:

334 *The difference with PERIPrem is that we were doing all this unfunded*
335 *through the network, so people were doing it as additional roles, and*
336 *the main challenge that we have had is [...] It's almost been*
337 *different people on different meetings, and that's been one of the*
338 *biggest challenges. (P03, Neonatologist, DN Wales)*

339 In contrast, PReCePT not only facilitated bringing together implementers, clinical
340 leads, and patient representatives with lived experience but also clarified
341 implementation roles and distributed responsibilities across all perinatal actors.
342 Within organisations, implementation leadership roles were shifted from
343 neonatal leads to midwifery champions with labour ward presence and protected
344 time. PReCePT CoPs allowed knowledge and innovations to spread across
345 settings, regardless of organisational capacity. Importantly, backfill funding
346 created capacity within organisations to release champions from clinical duties,
347 demonstrating the need for investment in implementation for equitable
348 improvement, as reflected in the following excerpt:

349 *It's good having a midwife with time, with dedicated time, to go*
350 *around doing some teaching, [...] to be honest a lot of that was*
351 *stuff that I was doing and I was juggling it in with other stuff, so I*
352 *wasn't doing it very well. (P27, Obstetrician, PReCePT SSP)*

353 Our research showed that involving local obstetric and neonatal leads alongside
354 midwifery champions in intervention CoPs as part of the ESP led to more
355 successful relational restructuring – teamworking – compared to SSP (10, 20).
356 Opportunities for creating social bonds within CoPs and access to co-produced
357 tools and products enabling teamwork empowered champions to conduct
358 relational work within and across settings, such as when working with other
359 teams to organise *in utero* transfers. However, champions often required
360 additional mentoring to build confidence and skills in mobilising staff and
361 resources, as illustrated by the following excerpt:

362 *When you're going to these team building exercises you realise*
363 *that okay now I have to convince this person for magnesium*
364 *sulphate. You just don't go in front of him with the magnesium*
365 *pack and say give it. (P42, Obstetrician, PReCePT ESP)*

366 On the ground, professional and clinical role boundaries, lack of articulated
367 workflows and pathways, and confining governance responsibilities to neonatal
368 teams posed challenges to administration. Our research demonstrated how KM
369 within CoPs facilitated the cascading of successful implementation strategies –
370 such as shared governance and operational enablers like staff training modules –
371 through the system. For instance, embedding PReCePT training into
372 organisational interprofessional learning activities clarified team roles and
373 responsibilities in administering MgSO₄, and distributed ownership across all
374 teams involved in preterm labour, as illustrated by the following excerpt:

375 *For us, having it in the [...] annual mandatory teaching helps a lot*
376 *because as well as the midwives and the doctors, that reaches*
377 *out to our support staff and our anaesthetic staff so it means the*
378 *whole team is aware of it and understands its significance and*
379 *that's helped an awful lot. (P22 Obstetrician, PReCePT SSP)*

380 *Collective Action: How does the work get done*

381 Collective action refers to the operational work people do to support a new
382 practice (23). In this case, it refers to what members of the perinatal team do
383 individually and collectively to ensure MgSO₄ is administered and data are
384 captured accurately. It involves appropriate task allocation, workflow articulation,
385 and collaboration among perinatal team members.

386 While maternity teams were generally administering MgSO₄, uptake varied
387 significantly between and within units. Smaller units, not equipped for preterm
388 care and lacking neonatal resource, often struggled more than units with high
389 preterm exposure to implement MgSO₄ guidance. Administering MgSO₄
390 involves multiple linked tasks: identifying women at risk of preterm labour,
391 organising their admission to a labour ward, and sometimes transferring them to
392 a different setting according to “birth in the right place” pathways. Maternity
393 teams, operating under pressure and facing challenges in diagnosing preterm
394 labour, had to make quick decisions and coordinate with neonatal teams for
395 intervention eligibility and timings. Delays in these tasks could hinder MgSO₄
396 administration, as illustrated by the following excerpt:

397 *There sometimes is a difficult conversation with the*
398 *obstetricians where they have got a lady on the antenatal*
399 *ward. Say she's 24 weeks. And they say, '[...] She's not in*
400 *labour.'* [...] *that lady doesn't get steroids necessarily. She*
401 *doesn't necessarily get magnesium sulphate and nor does*
402 *she get transferred to a unit who could cope more*
403 *effectively if the baby was delivered. And then what*
404 *happens is [...] this lady is now in established labour and of*
405 *course then they do think to give steroids and to give*
406 *magnesium sulphate but it might be a little bit too late.*
407 *(P06 ANNP, DN Wales)*

408 Implementation strategies had to augment a complex array of skills and
409 competencies across diverse clinical teams, specialties and settings, which relied
410 on teamworking. QI toolkits like PReCePT, PERIPrem, and BAPM perinatal
411 optimisation provided teams with toolkits and operational aids – the products of
412 co-production – such as documentation (e.g. preterm labour clinical guidance,
413 pathways and proformas) and equipment (e.g. MgSO₄ prefilled syringes). These
414 products provided strategies for improvement, clarified clinical pathways, roles
415 and tasks, reducing the cognitive and operational workload involved in
416 administering the intervention. Some settings developed their own tools, but
417 teams in less resourced organisations often faced challenges. Using strategies
418 and products from other teams proved beneficial, enhancing teamwork and

419 building confidence across all team members, as illustrated by the following
420 excerpt:

421 *The whole team (now is) pulling in. If someone comes in, in*
422 *preterm labour, our maternity support workers know, oh I need to*
423 *go and get the magnesium sulphate box. Our anaesthetists know*
424 *[...] they're going to come to theatre after we've given the*
425 *loading dose and they may come with the infusion running of the*
426 *magnesium and they understand that and they don't question it.*
427 *(P22, Obstetrician, PReCePT SSP)*

428 Reflexive monitoring: *How is the work understood?*

429 Reflexive monitoring is the appraisal work people do to assess and understand the
430 ways a new set of practices affect them and others around them, and how well
431 they think they are working (23). In this case, appraisal work refers to outcome
432 measurement and audit activities taking place to assess adherence to MgSO₄
433 clinical guidance. MgSO₄ data are captured in Neonatal Badgernet, typically by
434 junior or administrative staff, and submitted annually to NNAP which publishes the
435 data the following year. Evidence and knowledge from clinical audits, NNAP data,
436 and benchmarking by clinical leads, guide strategic improvement and
437 implementation efforts. However, without continuous monitoring and
438 communication of performance information to frontline staff, normalising the
439 intervention proved challenging, as reflected in the following excerpt:

440 *When something goes wrong people will concentrate on that. So*
441 *it will improve and after that they even take it for granted . [...],*
442 *then it goes back to the default. (P04 Neonatologist DN Wales)*

443 Participants noted issues with Badgernet data quality, stemming from poor
444 communication between maternity and neonatal teams, low awareness of MgSO₄
445 among junior staff, and lack of interconnectivity between maternity and neonatal
446 patient record systems. Clinical network leads prioritised building infrastructure
447 for appraisal work, and addressing performance disparities. QI initiatives, inhouse
448 and national such as PReCePT, developed tools like preterm labour proformas and
449 dashboards to enhance data capture and performance monitoring, and improve
450 perinatal communication. Effective communication of meaningful data to teams
451 on the ground was crucial for driving improvements. Dashboards that converted
452 data into visual feedback displayed in wards and shared within the organisation

453 were particularly useful. Providing these tools to all units tackled resource
454 disparities, but implementers needed the support and involvement of their peers
455 and managers to be able to make changes to the system. Organisational factors
456 such as access to organisation networks where performance could be discussed
457 were also crucial for driving improvements. Protected time for appraisal work and
458 participation in clinical and improvement CoPs was essential for accessing peer
459 and expert advice and creating capabilities, as illustrated by the following excerpt:

460 *I do think that particularly going to the sessions with [AHSN*
461 *contact] definitely helped, because she was really good at*
462 *giving advice as to how we can work around our situations.*
463 *[...] if we had problems in between the meetings we would*
464 *just send each other messages [on the shared WhatsApp*
465 *group) and give quick advice to each other or get quick*
466 *advice (from the regional clinical lead and AHSN lead) that*
467 *way. (P02, Midwife, PReCePT SSP)*

468 Discussion

469 By comparing the experiences of strategic and clinical leads, as well as
470 implementers in Scotland and Wales, with the findings from the process
471 evaluation of the PReCePT Programme and cRCT study, we identified barriers to
472 scaling and spreading interventions and explored the persistent evidence-to-
473 practice gap and clinical variation within and between maternity units (12, 22).
474 Recommendations for scaling and spreading evidence-based interventions are
475 summarised in Table 2.

476 Our research underscored the importance of involving all actors in sharing and
477 co-creating knowledge about the intervention and its implementation – this
478 includes patient groups, different disciplines, teams, and roles. Ensuring that
479 everyone has a shared understanding of the intervention and its associated
480 practices is crucial for achieving consensus on implementation strategies,
481 sharing operational enablers, and discussing performance. CoPs are a popular
482 strategy for mobilising knowledge into practice, but so far the features and
483 mechanisms of a high-impact CoP were not clearly understood (33). In our
484 research, cross-organisational diverse CoPs emerged as a valuable mechanism
485 for KM. However, professional and disciplinary divisions, as well as limitations in

486 organisational and staff capacity, can hinder participation in such CoPs (33). Our
487 analyses demonstrated that a quality improvement intervention, which included
488 (1) backfill funding for local champions to facilitate participation in
489 implementation activities including CoP, (2) perinatal collaboratives with
490 distributed leadership linking strategic and clinical leads with improvement
491 experts, individuals with lived experience, champions and intervention adopters
492 i.e. clinical, and (3) interdisciplinary perinatal shared governance structures,
493 created a network of networks that effectively mobilised knowledge and drove
494 system-wide change (10).

495 These findings align with the recent shift towards Learning Health Systems (LHS),
496 defined as “a team, provider, or group of providers that, working with a
497 community of stakeholders, has developed the ability to learn from the routine
498 care it delivers and improve as a result” (34). This concept reflects the essence
499 of CoPs: a community with a shared focus of interest continually renegotiated by
500 members, mutual engagement, and shared repertoire of communal resources
501 (35). Our work shows how CoPs underpin implementation by negotiating
502 meaning, roles and implementation processes and activities, diffusing
503 operational enablers, and providing a platform for reflexive monitoring, capacity
504 building, and future improvement. In PReCePT, CoPs, facilitated the exchange of
505 implementation knowledge among experts and knowledge users, in ways which
506 allowed responsiveness to context and knowledge adaption to address the needs
507 of implementers and adopters on the ground. This adaptability and
508 responsiveness to context are crucial for bridging the gap between
509 implementation research and implementation practice (36).

510 Data-driven improvement was central to the work of MgSO₄ and PReCePT CoPs ,
511 reiterating the importance of robust data infrastructure, as emphasised in LHS
512 literature (34). Accurate, meaningful, and timely data are essential for assessing
513 practice, identifying improvement gaps, and galvanising implementers and
514 adopters. However, for data to be impactful, it must be effectively
515 communicated to all relevant actors, especially those involved in the enactment
516 of the set of practices, with lessons learned guiding future improvement efforts.
517 Champions, as intermediaries between clinical leadership and frontline staff,
518 played a critical role in facilitating and brokering knowledge. Their engagement
519 in implementation activities was constrained by their own, their teams’ and their
520 organisations’ implementation capacity and capability.

521 Variations in implementers' and organisations' access to material, cognitive and
522 cultural resources shaped settings' readiness and capability for implementation
523 (9, 10, 20). Our study found that participation in collaborative communities was
524 more feasible for implementers in settings with ample resources, such as
525 adequate staffing and a strong safety culture, and where the intervention was a
526 high priority. Units with greater socio-cognitive and socio-structural resources
527 tend to demonstrate safer practices (37) illustrating a cycle of inequity whereby
528 settings with the greatest need for improvement may lack the resources to
529 engage in improvement activities.

530 Our evaluation of the PReCePT QI intervention revealed that some settings
531 require additional resources and targeted support to implement interventions
532 successfully (10, 19). Participation of implementers in collaboratives with clinical
533 and improvement leads provide opportunities for leadership to assess and
534 address setting-specific implementation needs early, and deliver enhanced
535 coaching based on support needs, enhancing implementation capabilities.
536 When PReCePT champions from poorly performing units received extra QI
537 coaching and mentoring, as well as the knowledge sharing taking place within
538 CoPs, they were able to match the performance of better-performing units (10).

539 Our findings reinforce the importance of networks and communities with rich
540 team capital – those that can draw from the skills, resources, networks and
541 alliances of members from a diverse range of disciplines and clinical and non-
542 clinical roles - in driving successful improvement efforts (38). By embedding
543 opportunities for champions to engage in multiorganizational, perinatal,
544 improvement-focused CoPs, we can mitigate some contextual differences in
545 access to team capital and distribute improvement capability more equitably
546 across teams.

547 Participatory approaches and co-production are crucial for grounding
548 implementation and improvement within an equity and justice frame (4, 39).
549 However, without appropriate resource allocation, teams in resource-strapped
550 settings may struggle to participate effectively, despite access to such
551 opportunities. Our research highlights the necessity of enrolling, and supporting
552 clinical champions with protected, funded time to engage in implementation and
553 improvement activities. This aligns with broader concerns about how staffing
554 and resources can impact engagement with new practices and innovations (9),
555 and improvement initiatives (5).

556 Such disparities contribute to the ‘postcode lottery’ in perinatal care quality and
557 safety, ultimately affecting health outcomes. Opportunity and ability-boosting
558 interventions need to be part of any scaling and spread effort to channel support
559 and resources to those teams in most need (5, 40). Organising diverse, system-
560 wide collaborative CoPs to facilitate KM and diffusion of tools and products, and
561 funding champions in each setting are key strategies for driving improvement
562 through KM and capacity-building.

563 **Strengths and limitations**

564 We interviewed PReCePT implementers (champions, clinical leads, and QI
565 managers) in England, and strategic and clinical leads and implementers in
566 Scotland and Wales to understand their experiences with improving MgSO₄
567 uptake. Strengths and limitations of the NPP and cRCT Study qualitative
568 evaluations have been reported (10, 13, 20). Our study’s limitations include that
569 we only interviewed strategic and clinical leads in Scotland and Wales whose
570 perspectives may not fully represent staff at the forefront of care. Additionally,
571 participants volunteering to participate in the study may have been more
572 experienced in quality improvement, and/or working in settings high in
573 improvement capability compared to those not coming forward. We also
574 acknowledge the voice of service users is absent from our study.

575 Our analysis highlights how KM helped set in motion NPT implementation
576 mechanisms which operated in an iterative, dynamic, and interconnected way.
577 Our research contributes to the NPT literature by illustrating how implementation
578 work must engage actors from and activities in all levels of the perinatal
579 ecosystem, and relies on knowledge-sharing and collaboration within diverse
580 networks and CoPs (41). QI strategies and products such as QI toolkits, co-
581 production, PDSA cycles, and clinical microsystem approaches helped create and
582 redistribute socio-cognitive and socio-structural resources tailored to each
583 setting’s needs. Current debates within the scaling and spreading of
584 improvement literature discuss the need for intervention fidelity versus
585 adaptability (7). Our findings suggest the usefulness of NPT as a theory of
586 change denoting the *function* of improvement interventions as opposed to
587 process fidelity. In this sense our work situates the NPT as a useful framework
588 for aligning implementation science with improvement practice (42), allowing for
589 tailoring of implementation interventions (43) to fit the culture, infrastructure,
590 and practice of specific health care systems.

591 Further work is needed to understand how KM communities can not only
592 facilitate implementation, but also sustainment, discontinuation or tailoring of
593 interventions to accommodate for new knowledge. This would require
594 longitudinal evaluation studies, and measuring outcomes beyond clinical
595 performance. Our previous work demonstrated how even though a quantitative
596 evaluation demonstrated no impact of enhanced coaching compared to the
597 standard package of support on the primary outcome i.e. MgSO₄ uptake, a
598 qualitative process evaluation demonstrated differences between the two groups
599 when the NPT implementation outcomes were used (10).

600 Conclusions

601 The research aimed to understand the process of scaling and spreading
602 implementation of MgSO₄ in preterm labour clinical guidelines in England,
603 Scotland and Wales using quality improvement initiatives, focusing on KM as a
604 mechanism for improvement. Results highlight barriers and enablers to
605 implementation across all levels of the system, but it was the differences in the
606 abilities of implementers in different settings to mobilise social-cognitive and
607 social structural resources for implementation that drove differences in clinical
608 practice between settings. Findings show how knowledge sharing within inter-
609 and intra-organizational, perinatal collaborative communities of practice (CoPs)
610 high in team capital (i.e. with diverse role, professional, discipline and
611 stakeholder representation) can diffuse knowledge and assets e.g. QI products,
612 across the perinatal ecosystem helping to create shared understandings of
613 evidence and clinical guidelines, and use collective knowledge to drive further
614 improvement. Our research adds to the clinical guidelines implementation
615 literature by showing that alongside KM, such CoPs need to offer capacity-
616 building opportunities to clinical champions with funded and protected time,
617 tailored coaching to meet individual support needs, and address disparities in QI
618 capacity and capability. Strong perinatal leadership is needed however to
619 ensure success in creating alliances and synergies, ensure equitable power
620 distribution between members and create a shared sense of culture, ownership,
621 and commitment.

622

623

624 *Table 1: PReCePT implementation and comparison with PReCePT primary and secondary drivers of change*

PReCePT Implementation			
<p>COHERENCE MAKING</p> <ul style="list-style-type: none"> □ Intervention situated in wider policy, evidence-base & organisational context □ Stakeholders including parents understand intervention goals, message, & approach □ Implementers understand intervention and implementation pathway, including own & others' roles □ Adopters are clear of clinical intervention pathways, patient eligibility and safety nuances, & administration procedures □ Adopters understand how intervention fits professional roles & priorities, workflows and procedures 	<p>COGNITIVE PARTICIPATION</p> <ul style="list-style-type: none"> □ Enroll implementers with invested interest & enthusiasm for clinical intervention, & with right skills, roles & networks □ Networks of participation connect implementers across the ecosystem over the implementation period i.e. strategic management, senior clinicians, and clinical teams □ Champions have protected time and space to design and discuss local implementation strategies & activities, & enroll other staff and parents in implementation support roles 	<p>COLLECTIVE ACTION</p> <ul style="list-style-type: none"> □ The clinical intervention is embedded in the organizational & wider system, and resources/capital are allocated to its enactment □ Maternity and neonatal staff routinely discuss the intervention □ Products and innovations make it as easy and quick as possible to enact the intervention set of practices □ Clinical pathways, workflows and procedures are streamlined □ Shared governance □ Training is delivered to all teams as part of inter-professional Continuing Personal Development and Induction activities 	<p>REFLEXIVE MONITORING</p> <ul style="list-style-type: none"> □ Using data for improvement i.e. number & characteristics of staff trained, MgSO4 uptake rates □ Real-time performance monitoring □ (Perinatal team) Audit and Feedback embedded in formal and informal modalities e.g. patient safety and audit meetings; team and individual feedback on shop floor □ Missed case analyses □ Sharing & discussing performance (data) across teams, the organization, CoP & perinatal safety & optimization networks
PReCePT Primary and Secondary Drivers of change			
AWARENESS RAISING	KNOWLEDGE MOBILISATION	OPERATIONAL ENABLERS	BEHAVIOUR CHANGE/USING DATA FOR IMPROVEMENT
		<ul style="list-style-type: none"> □ Care pathway developed 	

<ul style="list-style-type: none"> □ PReCePT Champions in each site to create awareness □ Awareness raising communication pack including marketing material, video, infographics etc. □ Patient stories and patient leadership □ Executive sponsorship 	<ul style="list-style-type: none"> □ PReCePT champions and clinical leads identified □ Staff training □ Staff and patient leaflets □ Posters □ Collective learning via IHI Breakthrough collaborative series □ Improvement knowledge capture in place 	<ul style="list-style-type: none"> □ Clinical decision tool in place □ Local policies refreshed □ PReCePT “How To” pack in use by local champions 	<ul style="list-style-type: none"> □ Staff confidence □ Central coaching of champions □ Culture and Leadership □ PReCePT CoP for peer-to peer support in place □ Visual data management in place
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626 *Table 2: Recommendations for scaling and spreading evidence-based interventions*

<p>1. Assess Implementation Readiness</p> <ul style="list-style-type: none"> □ Conduct a thorough assessment of each setting's resources, including staffing, data infrastructure, and cultural readiness. □ Identify settings with low socio-cognitive and socio-structural resources and prioritize them for additional support.
<p>2. Provide Targeted Support</p> <ul style="list-style-type: none"> □ Offer additional coaching, mentoring, and resources to settings identified as needing more support to align their performance with better-performing units. □ Ensure that all teams have access to quality improvement (QI) training and resources, especially those in resource-strained settings.

3. Strengthen Collaborative Communities of Practice

- Foster the development of interdisciplinary collaborative communities of practice that include maternity, neonatal, public involvement, safety and improvement stakeholders.
- Promote distributed leadership within these communities to ensure equal participation and knowledge-sharing across all roles and disciplines.

4. Enhance Data Infrastructure

- Improve data infrastructure to ensure that data is accurate, timely, and meaningful for all actors involved in implementation.
- Facilitate effective communication of data across all levels of the system to inform ongoing improvement efforts.

5. Ensure Protected Time for Champions

- Recognize the importance of champions as crucial facilitators and brokers of knowledge and support their active engagement.
- Secure funding and organizational support to provide champions with protected, backfilled time for participating in implementation activities.

6. Promote Equity in Implementation

- Implement strategies to ensure equitable distribution of resources and opportunities across all settings, especially those facing greater challenges.
- Understand issues of power and agency among actors which impact on ability to take advantage of opportunities and mobilise resources.

- Embed participatory approaches and co-production methods to ground implementation efforts within an equity and justice framework.

7. Monitor and Evaluate Progress

- Continuously monitor the impact of interventions and the effectiveness of collaborative communities.
- Conduct longitudinal evaluations to measure not only clinical outcomes but also the sustainability of interventions and the adaptability to new knowledge.

8. Scale and Spread Successful Practices

- Identify and document successful practices and innovations to facilitate their scaling and spread across different settings.
- Ensure that any scaling efforts are accompanied by opportunity- and capability- boosting interventions for teams most in need.

9. Foster Strong Perinatal Leadership

- Develop strong perinatal leadership to drive the creation of alliances, ensure equitable power distribution, and cultivate a shared sense of culture and commitment within the collaborative communities.

10. Plan for Continuous Improvement

- Embed continuous improvement strategies within the system to sustain and refine interventions over time.
- Encourage reflexive monitoring and feedback loops to adapt interventions as new challenges and opportunities arise.

628 [Abbreviations](#)

- 629 AHSNs: Academic Health Science Networks
- 630 ANNP: Advanced Neonatal Nurse Practitioner
- 631 BAPM: British Association for Perinatal Medicine
- 632 CoP: Communities of Practice
- 633 cRCT: cluster Randomised Controlled Trial
- 634 DN: Devolved Nations
- 635 ESP: Enhanced Support Package
- 636 KM: Knowledge Mobilisation
- 637 LHS: Learning Health Systems
- 638 MatNeo SIP : Maternity and Neonatal Safety Improvement Programme
- 639 MCQIC: Maternity and Children Quality Improvement Collaborative
- 640 MgSO₄: Magnesium Sulphate
- 641 NHS: National Health Service
- 642 NICE: National Institute for Health and Clinical Excellence
- 643 NNAP: National Neonatal Audit Programme
- 644 NPP: National PReCePT Programme
- 645 NPT: Normalisation Process Theory
- 646 PERIPrem: Perinatal Excellence to Reduce Injury in Premature Birth
- 647 PPWP: Preterm Perinatal Wellbeing Package
- 648 PReCePT: Prevention of Cerebral Palsy in PreTerm Labour
- 649 QI: Quality Improvement
- 650 SPSP Perinatal: Scottish Patient Safety Programme Perinatal
- 651 SSP: Standard Support Package
- 652 UK: United Kingdom
- 653

654

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672 DECLARATIONS

673 Ethical approval and consent to participate

674 The National PReCePT Programme evaluation (which includes the Devolved
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676 Health Sciences Research Ethics Committee at the University Bristol (FREC ID:
677 84582) and the UK National Health Service Health Research Authority (HRA ref:
678 19/HRA/4874). The PReCePT cRCT Study was granted approval by the UK
679 National Health Service Health Research Authority (Ref: 19/HRA/0323).

680 All participants were provided with a Participant Information Sheet before
681 providing oral or written informed consent.

682 Consent for publication

683 All participants consented to the publication of anonymised excerpts.

684 **Availability of data and materials**

685 The datasets generated and/or analysed during the current study are not publicly
686 available to protect the anonymity of staff and their employers but are available
687 from the corresponding author on reasonable request.

688 **Competing interests**

689 The authors declare that they have no competing interests.

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701 **Authors' contributions**

702 SR, JLD, ET and KL contributed to the conception of this work; SR and JLD
703 designed the process evaluations; CP-McK and TS collected the data; SR, CP-McK,
704 TS, JLD, ET and KL contributed to the interpretation of the data; CP-McK drafted
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