



Can behavioural change interventions be used to tackle the misdiagnosis of appendicitis and improve patient outcomes?

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Right iliac fossa (RIF) pain represents the most prevalent emergency surgery presentation, often stemming from appendicitis. Appendicitis commonly manifests with nonspecific symptoms, posing challenges in diagnosis. Appendectomy, the surgical removal of the appendix, is widely regarded as the gold standard treatment for appendicitis, with approximately 50,000 procedures conducted annually in the UK (1). However, there is a mounting concern that a considerable proportion of patients (20-30%) undergo surgery despite having a normal appendix (2-6). This translates to as many as 15,000 unnecessary appendectomy operations each year, exposing numerous patients to the risks associated with surgery without therapeutic justification. Postoperative complications afflict around 1 in 7 patients and encompass various issues such as wound infections, pain, abscess formation in the skin and abdomen, pneumonia, reoperation, and even the necessity for intensive care (7-8). Notably, there appears to be a comparable complication rate between patients with a negative appendectomy and those with confirmed non-perforated appendicitis (9). Moreover, undergoing an unnecessary operation leaves the underlying condition untreated, potentially perpetuating symptoms. Given these risks, achieving an accurate diagnosis is paramount to circumvent unnecessary surgery. A report commissioned by a UK regulator identified diagnostic errors as the third leading cause of preventable harm (10). Thus, ensuring a positive diagnosis is crucial to prevent patients from undergoing unwarranted surgical interventions.

In comparison to other similarly developed countries, the UK's unnecessary operation rate for appendicitis is remarkably high (6). The use of different diagnostic

practices in the UK may help to explain this discrepancy. In the United States, the percentage of appendectomy patients receiving a diagnostic CT scan increased from 1% to 97.5% and in the exact 18-year time period the negative appendectomy rate dropped from 23% to 1.7%(11). In the Netherlands 99.5% of patients have preoperative imaging and the negative appendectomy rate is approximately 3% (2). In the UK, there is almost no preoperative risk scoring and only 32.5% of patients receive preoperative diagnostic imaging (2).

A change in the behaviour of surgeons is hard and takes time. The translation of high-quality evidence into clinical practice has traditionally taken time and can encounter resistance. NICE guidelines have a transition phase before widespread use, laparoscopic surgery took decades to be widely adopted in surgery, enhanced recovery after surgery and the World Health Organization trauma checklist have both been revolutionary improvements in surgical care but have taken decades to achieve universal adoption (12,13). Clinical risk scoring and CT scans with high levels of diagnostic accuracy have been available for years, however the overtreatment of these patients remains commonplace.

Behavioural change science is fast being recognised to have a pivotal role in the understanding of decision making and team dynamics. It has been successfully applied to public health promotion, economics, and policy implementation. In order to improve the translation and implementation of evidence-based medicine rapidly, a collaborative multidisciplinary approach should be adopted. This should start with examining the wider barriers and solutions to behavioural change, and how

this applies to contemporaneous surgical practice, Figure 1. The harmonisation of clinical practice, alignment of decision making and reinforcement of surgical teams would bring negative appendicectomy rates in the UK in line with global standards.

The EAGLE study was a cluster-randomised trial that implemented a complex behavioural change intervention aimed at reducing anastomotic leaks after right colectomy surgery (14). Across 2700 surgeons, 3200 patients from 64 countries (14), the findings showed that high team-engagement directly translated into higher implementation of clinical interventions (risk scoring, intraoperative checklist), and a significant reduction in anastomotic leak in adjusted analysis. EAGLE underlined the importance of imbuing good team practice by providing cohesion to teamwork and that multimodal approaches are needed for sustainable behavioural change.

High-quality educational modules, real-world tested, with process data to facilitate improvements in content, is needed to move implementation science in surgery forward. Modules can be easily scaled up and rolled out nationally and internationally, to be immediately effective in bringing benefit to patients. Ultimately, bring the UK in line with global standards for minimising unnecessary surgery in patients with right iliac fossa pain.

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Figure 1: Conceptual framework derived from the social ecological model for behavioural change in multidisciplinary surgical teams

	Engagement with online learning	Implementation in clinical practice	Behavioural Change Taxonomy	Targeted action
Individual	<ul style="list-style-type: none"> Design of learning materials: high quality, high production, good aesthetics Desirable outcomes for patients Estimated time to completion Topic of interest for user Clear and tangible outcomes 	<ul style="list-style-type: none"> Ease of implementation: weblink / phone app for risk scoring, stickers for ease of documentation in notes, pathways to request scans Communication skills for speaking to surgical team & radiology team Learned new skill 	<ul style="list-style-type: none"> Goal setting Problem solving Behavioural contract Credible source Demonstration of behaviour Reframing identity / roles 	<ul style="list-style-type: none"> Online education modules based on behavioural change science Face to face teaching and group training Reinforcement through intervention period and feedback
Inter-personal	<ul style="list-style-type: none"> Face to face teaching / hybrid approach Authority of sources High credibility of teachers 	<ul style="list-style-type: none"> Facilitate team building Harmonise decision making Correct treatment for patient 	<ul style="list-style-type: none"> Behavioural contract Social support Pros and cons 	<ul style="list-style-type: none"> Team wide engagement Consultant buy in for clear expression of support
Organisation	<ul style="list-style-type: none"> Supported by department IT availability Time set aside to complete online modules 	<ul style="list-style-type: none"> Departmental engagement Transferable skills between departments 	<ul style="list-style-type: none"> Antecedents Conserving mental resources Prompts / cues 	<ul style="list-style-type: none"> Liaise with departmental leads Availability of materials in all workspaces: posters, stickers
Community	<ul style="list-style-type: none"> Work based assessments to recognise completion from seniors, e.g., CEX / CBD Consultant support Registrar support 	<ul style="list-style-type: none"> Supported by seniors Supported by allied healthcare professions 	<ul style="list-style-type: none"> Commitment Monitoring behavioural by others Social reward Behavioural repetition 	<ul style="list-style-type: none"> Targeted materials for all levels of surgical seniority Engagement with nursing & other allied healthcare staff Templates for work-based assessments
Policy	<ul style="list-style-type: none"> Certification / validation e.g., CPD / CME Mandated policy: in deanery / hospital / nationally Accreditation for teaching 	<ul style="list-style-type: none"> Regular updates / newsletters Awards for performance 	<ul style="list-style-type: none"> Future reward Incentive (outcome) Associative learning 	<ul style="list-style-type: none"> Local deanery support Confirmed CPD accreditation from the Royal College of Surgeons of England Online policy and guidelines in hospital intranets

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