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Drivers of low-value diagnostic tests in emergency medicine practice: a qualitative descriptive study

Vinay Gangathimmaiah ,[1,2] Rebecca Evans,[2] Nishila Moodley,[1,2] Tarun Sen Gupta,[2] Karen Carlisle[2]

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[1]Townsville Hospital and Health Service, Townsville, Queensland, Australia
[2]James Cook University College of Medicine and Dentistry, Townsville, Queensland, Australia

Correspondence to
Dr Vinay Gangathimmaiah; drvinaybg@gmail.com

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ABSTRACT

Introduction Low-value diagnostic tests harm patients and healthcare systems. Elucidation of determinants of low-value tests is essential for their de-implementation. The aim of this study was to understand the drivers of low-value tests in emergency medicine (EM) practice.

Methods A qualitative descriptive study was conducted at an Australian academic ED. Purposive sampling was used to recruit participants. Semistructured interviews were used to collect data between February 2023 and May 2023. Interviews were audio-recorded, transcribed verbatim and uploaded to NVivo. Data were thematically analysed through line-by-line and axial coding. Codes were assigned to categories, subthemes and themes. Themes were further analysed using the behavioural domains of the Theoretical Domains Framework. Trustworthiness was ensured through reflexivity, data triangulation, thick description, audit trail and member checking.

Results Twenty-four interviews were conducted with participants who had a breadth of EM experience: 19 senior EM doctors and 5 doctors in EM training. Low-value tests were inherently understood and unanimously acknowledged by participants. Six drivers of low-value tests emerged: efficiency, culture, resources, complexity, consequences and abilities. Drivers exerted influence at systemic and individual levels by hindering (barriers) or facilitating (enablers) de-implementation of low-value tests. Drivers mapped to the following behavioural domains of the Theoretical Domains Framework: environmental resources and context (resources, complexity, efficiency), social influences (culture), belief about consequences (consequences), and beliefs about capabilities (abilities).

Conclusion An interconnected web of systemic and individual drivers is influencing emergency doctors' behaviour to perform low-value tests. De-implementation of low-value tests will require behavioural change through contemporaneous navigation of multilevel drivers. Behavioural change theories like the Theoretical Domains Framework provide a robust framework to navigate change in collaboration with multidisciplinary clinicians and community. Evidence-based, theory-informed, co-designed interventions are needed to address the drivers of low-value tests.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Low-value tests account for up to 30% of diagnostic tests in emergency medicine (EM) practice.
⇒ Despite a decade of de-implementation endeavours, several EM studies have highlighted the persistence of low-value tests.
⇒ An in-depth exploration of drivers of low-value tests through emergency clinician engagement is necessary to better inform de-implementation.

WHAT THIS STUDY ADDS

⇒ Low-value diagnostic tests in emergency medicine (EM) practice are rooted in an interconnected web of drivers that are driving doctors' behaviour.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Effective and sustainable de-implementation of low-value diagnostic tests in EM practice will require contemporaneous navigation of drivers to facilitate behavioural change in doctors.

INTRODUCTION

Low-value care refers to tests, treatment or procedures that are ineffective, inefficient and do not benefit patients.[1] Low-value care is a major global healthcare problem accounting for at least 30% of healthcare in some emergency medicine (EM) studies.[2 3] Low-value care harms patients, clinicians and healthcare systems.[4–6] Patient harm from low-value diagnostic tests stems from pain from unnecessary needles, cancer risk from unnecessary radiation, distress from false-positive test results and suboptimal care from unnecessarily long wait times.[4 5] This harm is compounded by misdirection of limited clinician time, misallocation of finite healthcare resources and unnecessary costs to patients due to low-value tests.[6]

Global initiatives such as the Choosing Wisely campaign have strived to de-implement low-value tests in practice.[7] These efforts have been paralleled by an exponential growth in EM literature exploring de-implementation in the last decade.[8] This growth is exemplified by de-implementation studies of low-value tests in infants with bronchiolitis[9] and adults with non-specific low-back pain.[10] Validated clinical decision instruments, such as the Paediatric Emergency Care Applied Research Network (PECARN) head injury rule and Canadian CT head rule, further illustrate efforts to reduce low-value tests in EM practice. Despite ongoing pursuit of de-implementation, recent EM studies have highlighted the persistence of low-value tests

Table 1 Characteristics of participants interviewed about drivers of low-value diagnostic tests in emergency medicine (EM) practice

Participant characteristics			Number of participants (n=24)
Role	Senior EM doctor		19
	Doctor in EM training*		5
Sex	Male		12
	Female		12
EM experience	Senior EM doctor†	≥7 years	13
		<7 years	6
	Doctors in EM training‡	≥3 years	2
		<3 years	3

*Medical graduates are eligible to apply for the 5-year Australian EM training program in their third postgraduate year.
†Experience as senior EM doctor.
‡Experience as doctor in EM training.

in patients with minor head injury (cranial imaging),[2] bronchiolitis (chest imaging)[2 3] and atraumatic back pain (lumbar spine imaging).[3]

Lack of clinician and community engagement has been reported as a key factor underpinning the persistence of low-value care.[11] Engaging clinicians and communities in order to elucidate context-specific drivers of low-value care is critical to effective de-implementation of low-value tests.[11] Implementation science frameworks like the Theoretical Domains Framework[12] can facilitate better engagement of clinicians and communities during de-implementation of EM low-value care.[13] Behavioural change theories that underpin the Theoretical Domains Framework enable a deeper understanding of the drivers of EM low-value care.[13] Theory-informed, qualitative studies are necessary to gain insight into drivers of EM low-value care and bolster de-implementation.[8] The aim of this Theoretical Domains Framework-informed, qualitative study was to understand drivers of low-value tests in EM practice to inform future de-implementation interventions.

Table 2 Themes and subthemes of drivers of low-value diagnostic tests in emergency medicine (EM) practice

Themes	Subthemes
Efficiency (S)	Assessment
	Automation
	Time pressures
	Patient flow
Resources (S)	Space
	Staff
	Tests
Complexity (S)	Competing priorities
	Cognitive load
	Diagnostic uncertainty
	Change management
Culture (S)	Care standards
	Habit
	Role modelling
	Practice variation
	Scope of EM
	Leadership
	Engagement
Consequences (I)	Benefits
	Harms
Abilities (I)	Knowledge
	Skills
	Experience

I, individual-level driver; S, system-level driver.

METHODS

Design

This was a single-site, qualitative descriptive study underpinned by the Theoretical Domains Framework, an implementation science framework synthesised from 33 behavioural change theories.[12] The framework provides a structured approach for investigation of behavioural problems using 14 unique behavioural domains. Exposition of behaviours underlying the problem (ie, ordering low-value tests) enables the design of targeted interventions to achieve behavioural change (ie, ordering value-based tests).

Setting

This study was conducted at the Townsville University Hospital ED, a public, academic, tertiary ED in Queensland, Australia with 99 748 patient presentations (including 20% paediatric) in 2023. A multidisciplinary team of doctors, physician assistants, nurse practitioners, nurses and allied health practitioners provided emergency care at the study site. Diagnostic tests were ordered by doctors, physician assistants and nurse practitioners. Over 95% of clinicians ordering tests were doctors.

Participant selection

Doctors, physician assistants and nurse practitioners were invited to participate via email, posters and face-to-face interactions. Nurses and allied health practitioners were not invited as they did not order tests. Purposive sampling—subjective, deliberate selection of specific individuals based on their experience and knowledge relevant to the phenomena under study—was employed to recruit consenting participants with a breadth of EM experience. Recruitment was continued until no new meaningful data emerged and thematic saturation was attained.

Data collection, data analysis and trustworthiness

Data triangulation, reflexivity, audit trail, member checking and thick description were the methodological strategies employed to ensure trustworthiness of data collection and analysis.[14]

Purposive sampling of participants enabled collection of data from multiple sources who had varying levels of experience with EM low-value tests (ie, data triangulation).[14] Data were collected through individual in-person, semi-structured interviews conducted at the participants' workplace in a private meeting room. Interviews were conducted at participants' convenience at a time without competing clinical responsibilities.

An interview guide (online supplemental appendix 1) with prompts and probes was employed to conduct the semistructured interviews which lasted 30–45 min. The interview guide elucidated participants' thoughts about the meaning and drivers of low-value tests at their workplace. Pilot interviews with two participants resulted in no changes to the interview guide. Interviews were audio recorded and transcribed manually with the assistance of commercial transcription software (Otter ai). Transcripts were manually verified for accuracy. Transcripts were imported into NVivo[15] software which was used to manage data.

Participants were interviewed by the first author, a mid-career, male, emergency physician conducting their first qualitative research project (VG). The first author's interest in the research topic and the current project are driven by the

Table 3 Illustrative interview participant quotes for themes and subthemes of drivers of low-value diagnostic tests in emergency medicine (EM) practice

Subthemes	Barriers to de-implementing low-value tests	Enablers to de-implementing low-value tests
Theme: Efficiency (S)		
Assessment	'…the time that patients take to…have their full assessment done is dead time…so…we…front load their assessment by a senior clinician ordering tests based on their triage note' (P13).	'…part of that would be promoting a sequential process, where history and examination…come first…then a discussion…then…tests' (P3).
Automation	'…the chest pain…and…abdo pain bloods…tend to be ordered as a set…everyone with chest pain gets a chest X ray even if they have chest pain every week' (P2).	'… You can use…pre-sets of ordering stuff. But then just a quick pause before you sign off on it…It is relatively easier to unclick…' (P6).
Time pressures	'So you end up ordering tests that…if you'd had more time… to…make a clinical decision, you probably wouldn't have ordered…' (P12).	'Time can be a great aid in clinical decision making. In fact, time is probably the best substitute for most low value tests' (P24).
Patient flow	'My…view is most of this is a system issue… access block… not something that as the individual ED registrar, you can fix.' (P5).	'…saying to people, we got more patients, we need to get through them efficiently. And we're wasting investigations 25% of the time, which is slowing down everybody, the next patient who's even sicker' (P10)
Theme: Resources (S)		
Space	'…if someone is complaining of chest pain, and there's no beds… will inevitably order a chest X ray and…a troponin' (P4).	'…it would be reliant on having a system that was much more functional…not bed blocked, and… good turnaround times' (P19).
Staff	'…what feeds into that is the rotational nature of our workforce…they may have very different views on how to use those tests' (P23).	'…excellent staffing for both doctors and nurses…will go a long way in reducing unnecessary tests' (P4).
Tests	'There's a bit of… just because…tests are available, we'll do it and it's just another blood test' (P9).	'…I've…ordered bloods on a patient. And then found out they had bloods done…this morning and I did not need to order them again… that's a bit painful' (P1).
Theme: Complexity (S)		
Competing priorities	'… it's hard to drive change, particularly when everyone is very busy, very tired and there's other kind of competing priorities… in the current environment.' (P5).	'…by providing low-value…testing, we're building inefficiencies …we can fix them and make the whole thing better, but it requires a bit more effort to begin with' (P9).
Cognitive load	'… early intervention model…I'm just going to just go to do all these tests. Some of them I know will be unnecessary, but that's the brain power…I have' (P11)	'… if I have noticeably fewer calls…at the end of my shift. I'm like, oh, that phone wasn't crazy today. I was actually able to go and pick up patients of my own and work through them' (P20)
Diagnostic uncertainty	'…we don't know what's going on. And that's…where you see uncertainty……cast net to try and find a diagnosis…I practice that way, sometimes' (P11)	'…juniors… can understand…whilst we are expert clinicians…We… bring…humanness into our decision making…… sometimes over investigate…sometimes under investigate…hopefully…find a nice medium' (P13)
Change management	'…it is exhausting, mentally, to actually practice best… investigation/ care…In a way that not all of our juniors would be necessarily expecting. I know why a lot of seniors don't want to get involved with this' (P22)	'…this is all a period of molding, informing and that can be quite difficult to get people to follow in the right direction. But once the benefit is established…momentum is gained… everything can start to progress quickly.' (P24)
Theme: Culture (S)		
Care standards	'and increasingly…the standard of care seems to be moving… towards more investigation…all this is very unlikely to come back positive, but we still do the tests because we all do the tests' (P8).	'…from an institutional perspective, it needs to be…a direction that our department…hospital… health service is going. Rather than becoming the outlier in trying to fight the low value care battle' (P8)
Habit	'…we're not thinking clearly about what we're actually ordering for people…ordering the wrong things…ordering too much. or sometimes…not ordering enough' (P10).	'…education, research, auditing, feedback. If we want to debunk… historical practices…we both have to prove they're not necessary and… get that information out there.' (P17)
Role modelling	'… a culture within our profession…that …feels less and less safe for our juniors…juniors cannot rely on the security of their senior support… might be torn apart for not doing something…' (P22)	'…juniors…have to feel enabled and encouraged. And I think role modelling is really the key way to do that… need both enthusiasm and…being gentle' (P24)
Practice variation	'…some people might not order a CRP…other consultants… do…use it in…practice. And so you as a junior in the role, you kind of have to appease whoever's sort of there' (P12).	'…variation…you'll never…fix…Everybody's got their story of the one thing they missed and they never want to miss it…somebody will probably always order more CTPA's…a good thing…that you don't want to miss something.' (P14)
Scope of EM	'… ED as a specialty has evolved…15 years ago…we would do very little testing unless it was really indicated…a lot more responsibility on us has probably backed us into this corner where we feel like we have to do a lot more tests' (P14).	'…we're doing a lot of stuff…but…acute care has to be our purview even if it's not emergent care because patients don't know the difference…often we don't know the difference until we spend… hours…… meeting that demand is just what we should be thinking about long term.' (P17)
Leadership	'…the culture is probably SMO driven…a…culture of doing lots of investigations…obviously permeates through the junior staff…' (P22)	'the goal…is maximizing benefit to the patient…the principle of justice where resources have been used as well as possible… giving people the vision to follow can be quite satisfying for… junior clinicians because they get a real sense…that they're doing the right thing.' (P24)

Continued

Table 3 Continued

Subthemes	Barriers to de-implementing low-value tests	Enablers to de-implementing low-value tests
Engagement	'…a reflection of the siloed…approach to health care with specialties working sequential rather than together… it would be a challenge to provide that education across.' (P15) 'patients… through the culture…we in part are guilty of creating…expect the need for a test to validate……don't feel…they're getting adequate care unless they actually have an investigation' (P22)	'…interdepartment relationships can…become… positive and strong through…joint teaching exercises, simulation…presentations…audit…review…having a shared vision… and…an agreed process.' (P24) '… if as a profession and as an institution, we move increasingly towards…not doing lots of low-value work …if that becomes the standard …the public perception … follows with it.' (P8)
Theme: Consequences (I)		
Benefits	'…we use test as a screening tool, sometimes rather than a diagnostic tool…when you listen to the history…probably wasn't…needed…rely on our tests rather than our clinical judgment, which sounds terrible' (P16).	'…some tests may be low-value but they are opportunistic for population…who don't attend health care, I think it's really good to get that opportunistic testing done on them.' (P14).
Harms	'…fear of missing something… is really, really high. CTPA's in PE's…fear of missing a PE…is so great that it drives us to do an expensive test…on a patient who doesn't need it' (P21).	'…guidelines can empower, even if the clinician is a bit nervous… hospital guideline… that has been endorsed will take away some of the personal responsibility' (P18)
Theme: Abilities (I)		
Knowledge	'…I'm quite aware that I am doing low value tests. But there are reasons behind that' (P1).	'…Education about not only the need to not do tests … it's reasonable to make decisions without…tests but also that some tests are harmful' (P18).
Skills	'…the senior staff…will perform tests that are often likely to give a low yield but give a rapid decision-making tool' (P3).	'So having…ordering barriers in place…to…make the clinicians question or seek senior review before ordering specific tests' (P7).
Experience	'…if… in the past…you've had a miss on something, you probably tend to over investigate' (P16).	'…past experiences…the best way to overcome is…a good debrief …so your fears are put into the right place, not into…ordering undervalued tests…' (P12).

CRP, C reactive protein; CTPA, CT pulmonary angiography; I, individual-level driver; PE, pulmonary embolism; P1–P24, participants 1–24; S, system-level driver; SMO, senior medical officer.

assumption—based on observation, published literature and ongoing research—that EM low-value tests are prevalent and causing patient harm. Two coauthors with a combined qualitative research experience of 45 years (KC—25 years, RE—20 years) supervised the first author during the design and conduct of the study. KC and RE are senior academic researchers with a background in psychology and health services research and had no prior assumptions about EM low-value tests or de-implementation. KC and RE critically appraised how VG's prior assumptions about EM low-value tests influenced data collection and analysis (ie, reflexivity).[14]

Data were subjected to inductive coding by the first author using line-by-line and axial coding.[16] Initial codes generated by the first author (VG) were discussed with the research team for refinement and clarification. Any disagreements from initial coding were resolved through consensus within the team. Two co-authors (KC, RE) then independently coded a subset of the transcripts (n=2) to ensure rigour of the coding process and minimise bias.[16] Codes were sequentially synthesised into categories, subthemes and themes. The research team reviewed and agreed on finalised codes, subthemes and themes. Emergent themes and subthemes were analysed using the Theoretical Domains Framework. The process of transforming data into findings was recorded in detail (ie, audit trail).[14]

Findings derived from the analysed data were validated by participants who reviewed interview transcripts and provided feedback on study findings (ie, member checking).[14] Data analysis using the Theoretical Domains Framework facilitated accurate contextual description and interpretation of participant perspectives, thoughts, emotions, motivations and intentions about low-value tests (ie, thick description).[17]

The study report adheres to the Consolidated Criteria for Reporting Qualitative Research[18] guideline.

Patient and public involvement

Patients or members of the public were not involved in the conception, design or dissemination of results of this study.

RESULTS

Participant characteristics

Twenty-four participants were interviewed between February 2023 and May 2023. All participants were doctors. Physician assistants and nurse practitioners did not respond. Participant characteristics are summarised in table 1.

Understanding

Participant understanding of low-value tests was a key theme. Understanding encompassed the subthemes of meaning, acknowledgement, emotions and challenges.

Low-value tests were perceived as those tests performed for conditions with a low pretest probability, tests not clinically indicated, tests not informing decision making and tests not altering patient management.

> '…a test that…which doesn't… prognostically alter your planning or clinical management…' (P22)

Participants (P) acknowledged that low-value tests were common, had risks that outweighed benefits and needed to be de-implemented.

> 'And obviously, we do a lot of low-value tests…' (P4)

The performance of low-value tests triggered emotions including frustration, surprise, regret and discomfort.

> *'I'm always surprised at how many juniors but also seniors are doing stuff* (performing low-value tests).' *(P2)*

The definition of low-value was felt to be challenging, context-dependent and evidence-dependent. A negative test

Table 4 Mapping of themes and subthemes of drivers of low-value diagnostic tests in emergency medicine practice to the domains of the Theoretical Domains Framework

Themes	Subthemes	Theoretical Domains Framework domains*†	Description of the Theoretical Domains Framework domains*
Efficiency	Assessment Automation Patient flow Time pressures	Environmental context and resources	Any circumstance of a person's situation or environment that discourages or encourages the development of skills and abilities, independence, social competence, and adaptive behaviour
Resources	Space Staff Tests		
Complexity	Competing priorities Change management		
	Cognitive load Uncertainty	Memory, attention and decision processes	The ability to retain information, focus selectively on aspects of the environment and choose between two or more alternatives
Culture	Care standards Habit Role modelling Practice variation Role modelling Leadership Engagement	Social/professional role and identity Social influences Behavioural regulation	A coherent set of behaviours and displayed personal qualities of an individual in a social or work setting. Those interpersonal processes that can cause individuals to change their thoughts, feelings or behaviours. Anything aimed at managing or changing objectively observed or measured actions
Consequences	Benefits Harms	Belief about consequences Emotion	Acceptance of the truth, reality or validity about outcomes of a behaviour in a given situation. A complex reaction pattern, involving experiential, behavioural and physiological elements, by which the individual attempts to deal with a personally significant matter or event
Abilities	Knowledge	Knowledge	An awareness of the existence of something
	Skills	Training	An ability or proficiency acquired through practice
	Experience	Beliefs about capabilities	Acceptance of the truth, reality or validity about an ability, talent or facility that a person can put to constructive use

**Adapted from Cane et al*[12] *under creative commons attribution licence CC BY 2.0*
†Elements of four Theoretical Domains Framework domains were implicit in discussions about culture. These included Goals (mental representation of outcomes or end states that individuals want to achieve), Intentions (conscious decision to perform a behaviour or resolve to act in a certain way), Reinforcement (increasing the probability of a response by arranging a dependent relationship, or contingency, between the response and a given stimulus) and Optimism (the confidence that things will happen for the best or that desired goals will be attained)

result was not perceived as a criterion to retrospectively label a test low-value.

> '…value is always a really difficult thing to define. Because it depends on what you're trying to address' (P5)

> *'And I think sometimes that's where it's very easy to tar something as low-value care because it was a negative result'* (*P11*).

Drivers

Six themes of low-value test drivers—four systemic, two individual—emerged from the interviews: efficiency, resources, complexity, culture, consequences and abilities. The themes and subthemes of drivers are presented in table 2.

Drivers were similar across participant experience level (doctor in EM training vs senior EM doctor) and sex (male vs female). Participants perceived contemporaneous influence of multiple drivers on performance of low-value tests. Participant-level drivers, coding trees and coding density are presented in the online supplemental appendices 2–5.

The six drivers either hindered (barriers) or facilitated (enablers) de-implementation of low-value tests. Efficiency and consequences were the most perceived barriers while culture was the most multifaceted. Illustrative quotes are presented in table 3.

Efficiency—timely completion of emergency care—was felt to be the most complex barrier. Participants sought efficiency through front-loading (ie, performance of tests early in the patient's care journey, sometimes based on triage notes) and automation (ie, performing multiple tests with a single click, as exemplified by chest pain test panels). Adequate patient assessment before ordering tests was highlighted as a better alternative to achieve efficiency.

Participants described beneficial and harmful consequences of low-value tests. Low-value tests reassured doctors and patients, addressed valid patient concerns and provided a safety net in vulnerable patients. Omission of low-value tests was associated with harm to patients (missed diagnoses) and doctors (complaints, medicolegal risk, media scrutiny, reputational damage) whereas commission of low-value tests was related to system harm (misdirected limited staff time, suboptimal use of finite resources, prolonged ED length of stay).

Patient expectations stood out as a cultural subtheme with most variability in the degree of perceived influence—significant to none—on low-value tests. Long ED wait times, limited primary care access, information age and instant gratification culture were perceived to contribute to patient expectations in our study.

The themes and subthemes of drivers were mapped to the Theoretical Domains Framework. The mapping highlighted environmental context and resources as the principal behavioural domain that straddled three drivers (efficiency, resources and complexity). The mapping is presented in table 4.

DISCUSSION

Emergency doctors in this study inherently grasped the meaning of low-value tests and uniformly acknowledged their prevalence. Low-value tests in EM are being driven by systemic

and individual factors with a powerful influence on doctors' behaviour. Given the centrality of behaviour in low-value test performance, the discussion is anchored to the behavioural domains of the Theoretical Domains Framework (corresponding drivers in parentheses).

Environment context and resources; memory, attention and decision processes (efficiency, complexity, resources)

Efficiency was identified as the predominant systemic driver of low-value tests in our study. Optimising patient flow underpinned this drive for efficiency in the context of worsening ED overcrowding. Participants felt compelled to pursue efficiency to care for an ever-increasing patient volume in a time-constrained, space-constrained, staff-constrained and information-constrained environment. The competing priorities of managing undifferentiated patients, supervising staff with variable experience, navigating access block and negotiating time-based targets generated participant ambivalence about value and efficiency. The need for efficiency in a stretched environment, coupled with perceived patient flow and safety benefits of low-value tests, nudged participants into a value-efficiency trade-off. The resultant internal turmoil about test omission versus commission was resolved by choosing low-value tests as a path of least resistance that resulted in the choice of efficiency over value. The prime role of efficiency in our study builds on the findings of a previous qualitative, focus group study of 31 US physicians from specialties including EM.[19] Contrarily, Lin *et al* found efficiency to be a minor influence in a cross-sectional survey of 765 US emergency physicians about Choosing Wisely recommendations.[20] These disparate findings could be due to our qualitative design which enabled deeper exploration of participant perspectives.[21]

The cognitive load of decision-making while wrestling with diagnostic uncertainty propelled participants towards low-value tests. This impact of cognitive load is aligned with previously documented cognitive challenges of minimising low-value care.[22] Tolerating diagnostic uncertainty as the natural order—through clinical reasoning—could empower doctors to overcome the urge for certainty.[23–25] A patient-centred approach to diagnostic testing—validation of symptoms, explanation of diagnosis, acknowledgement of test limitations in eliminating uncertainty, formulation of consensual plans—could enable better navigation of diagnostic uncertainty.[23]

De-implementation of low-value tests was considered a challenging change management endeavour complicated by a transient ED workforce. The carrot-stick approach of reward and punishment was felt to be ineffective in motivating change, whereas fairness, justice and a sense of purpose were considered strong motivators. Bishop *et al* affirm internal motivation to be a good doctor as a change enabler in a study of academic physicians' views about low-value care.[19] Value change was judged by our study participants to require implementation science, be incremental and demonstrate tangible benefits (exemplified by suspected acute coronary syndrome accelerated diagnostic pathways).

Social/professional role and identity, social influences, behavioural regulation (culture)

The changing scope of EM—care of patients traditionally managed in general practice—encouraged low-value tests due to participant quandary about the value of tests in patients needing non-urgent care. Habitual performance of routine tests—underpinned by an absence of clinical rationale—was highlighted as a source of patient harm. Education about clinical reasoning and harm could break habits. This view lends credence to prior low-value care literature emphasising harm.[4 23] While practice variation was acknowledged as a potential source of low-value tests in our study, variation informed by clinical context and reasoning was considered integral to expert EM practice. Participants felt that the absence of senior role models in diagnostic stewardship, coupled with peer intolerance of errors of omission, contributed to a culture of low-value tests.

Our finding of variability in perceived patient expectations mirrors Lin *et al*, who found expectations drove imaging for low-back pain but not CT pulmonary angiography (CTPA) in patients with normal D-dimer.[20] According to our participants, patient expectations resulted from feeling unheard and being inadequately engaged in decision-making. Lack of involvement in decision-making has been previously noted to influence ED patient expectations of diagnostic imaging for low back pain.[26] Our study participants also felt that institutional and professional standards, along with community engagement, could assist navigation of expectations. This view mirrors the reported benefit of aligning institutional goals with value-based healthcare to achieve de-implementation.[19]

Interdisciplinary conflict affected low-value tests. Data-driven collegiate, collaborative and iterative discussions through shared knowledge, goals and vision could minimise conflict. These views echo the relational coordination theory where shared knowledge, shared goals and mutual respect enhance the ability of multidisciplinary teams to achieve desired outcomes.[27] Proactive multidisciplinary collaboration will be critical for effective de-implementation of low-value tests. Intradisciplinary (medical, nursing and allied health EM clinicians) and interdisciplinary collaboration (EM and other specialty clinicians) will be necessary to avoid siloed decision-making and develop shared understanding of value-based diagnostic tests.

Enthusiastic, kind, role-modelling paired with a non-punitive approach was held to be pivotal in reducing low-value tests. Ethical, fair, just and visionary leadership was viewed as fundamental in creating a value-based care culture. The salience of leadership in the change management of low-value care de-implementation is reinforced by prior literature.[8 11]

Beliefs about consequences, emotion (consequences)

The perceived harm from omission of low-value tests has been previously noted by an Australian study on defensive practice and low-value care.[28] Variability in perceived harm of omission led to differential participant risk tolerance shaped by experience, knowledge, training, role-modelling and community expectations. The omission/commission of low-value tests triggered a suite of emotions—regret, concern, worry, fear, discomfort, anxiety, conflict—which are likely at the core of the behaviour.

Knowledge, training, beliefs about capabilities (abilities)

Iterative education about best available evidence was felt to be necessary but not sufficient for reducing low-value tests. This limited impact of education has been noted in previous studies exploring de-implementation of CTPA scans.[29] Our participants thought that evidence-based guidelines—exemplified by pulmonary embolism diagnostic pathways—coupled with training could support value-based decision-making. Implementation science research was observed to empower doctors to resolve value-efficiency trade-offs, negotiate risk, tolerate uncertainty, navigate inexperience, and change habits. This enabling effect of research on behavioural change has been noted previously.[19]

We have not discussed the identification of specific low-value test targets for de-implementation as this was beyond the scope of our study. Specific low-value test targets, like drivers, may be context-dependent. Identification will therefore require stakeholder consensus about the definition of low-value tests and data-driven prioritisation of targets.[30]

Strengths and limitations

The qualitative expertise of the research team minimised the impact of the first author's inexperience in qualitative research. Reflexivity reduced bias arising from the first author's preconceptions about low-value tests. Trusting relationships with participants mitigated potential power differentials during interviews. Data triangulation and member checking assured credibility. Audit trail ensured dependability and confirmability. Thick description of contextualised participant behaviour and experiences enhanced transferability. As drivers of low-value care are context-specific,[11] transferability of this single-site study will likely be limited to adequately resourced, high-volume, academic EM centres. However, broader learnings about behaviours underpinning low-value tests may be generalisable to other EM settings. Transferability is further limited by the absence of perspectives of other emergency clinicians including physician assistants, nurse practitioners, nurses and allied health practitioners. This limits the applicability of our findings to low-value tests ordered by doctors.

Implications

Low-value tests in EM practice are rooted in the complex interactions between the drivers elucidated in our study. Low-value tests will persist in a setting with insufficient doctor abilities, inadequate resources, excessive concern about consequences, extreme complexity, powerful cultural influences, or the overwhelming need for efficiency. De-implementation of low-value tests will require contemporaneous navigation of drivers to facilitate behaviour change in doctors. Literature suggests that de-implementation is best achieved through multifaceted, high-fidelity interventions which are informed by behavioural change theories and co-designed with clinicians and communities.[8] Drivers elucidated in our study can better inform the design of interventions to effectively de-implement EM low-value tests. Future studies exploring de-implementation of EM low-value tests will need to engage multidisciplinary clinicians involved in the decision-making about diagnostic tests.

Conclusion

EM low-value tests are being driven by doctors' behaviour influenced by an interconnected web of drivers. Behavioural change will be critical for de-implementation and will require engagement of multidisciplinary clinicians and communities. Drivers of low-value tests identified in this study can inform de-implementation interventions to augment behavioural change.

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ORCID iD

Vinay Gangathimmaiah http://orcid.org/0000-0002-9813-4044

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