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Realist analysis of streaming interventions in emergency departments

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ABSTRACT

Background Several of the many emergency department (ED) interventions intended to address the complex problem of (over)crowding are based on the principle of *streaming*: directing different groups of patients to different processes of care. Although the theoretical basis of streaming is robust, evidence on the effectiveness of these interventions remains inconclusive.

Methods This qualitative research, grounded in the population-capacity-process model, sought to determine how, why and under what conditions streaming interventions may be effective. Data came from a broader study exploring patient flow strategies across Western Canada through in-depth interviews with managers at all levels. We undertook realist analysis of interview data from the 98 participants who discussed relevant interventions (fast-track/minor treatment areas, rapid assessment zones, diverse short-stay units), focusing on their explanations of initiatives' perceived outcomes.

Results Essential features of streaming interventions included separation of designated populations (population), provision of dedicated space and resources (capacity) and rapid cycle time (process). These features supported key mechanisms of impact: patients wait only for services they need; patient variability is reduced; lag time between steps is eliminated; and provider attitude change promotes prompt discharge. Conversely, reported failures usually involved neglect of one of these dimensions during intervention design and/or implementation. Participants also identified important contextual barriers to success, notably lack of outflow sites and demand outstripping capacity. Nonetheless, failure was more commonly attributed to intervention flaws than to context factors.

Conclusions While streaming interventions have the potential to reduce crowding, a theory-based intervention relies on its implementers' adherence to the theory. Streaming interventions cannot be expected to yield the desired results if operationalised in a manner incongruent with the theory on which they are supposedly based.

continuum of care in order to reduce input or facilitate output from the ED.² Of those interventions implemented within the ED, several of the most common are based on the principle of *streaming*: directing different groups of patients to different processes of care. The practice of streaming is based on queuing theory; the underlying principle is that by creating separate queues on the basis of service characteristics (eg, anticipated service time, need for particular resources), clients can be served more efficiently.^{3–6} It is not unique to EDs, but may be used to promote efficiency and well-targeted care in many clinical settings.

Some ED streaming interventions occur at, or shortly after triage. They may separate out either low-acuity patients whose needs can be met quickly (eg, moving such patients into fast-track/minor treatment areas), or medium-acuity patients who may not require a bed for most of their stay (eg, directing such patients to a rapid assessment zone or intake model). Other interventions (including diverse types of short-stay units, such as observation units, diagnostic and treatment units, medical assessment units) stream patients later in their stay, segregating those who require specialised investigations, longer treatment and/or consultations so that their care does not interfere with efficiency of care for other patients. Short-stay units may operate within or outside the ED and may manage patients prior to disposition or after admission. There is no standard definition of a short-stay unit (nor of its specific variants), and such units serve a variety of functions: providing tailored care to patients with specific conditions; preventing brief hospitalisations; or simply moving patients out of a crowded ED.⁷ While some hospitals have only one such unit, serving a broad purpose, others offer an escalating sequence of such units for patients with different intensities of need.

Systematic reviews have concluded that minor treatment areas can reduce ED length of stay; however, reported effect sizes vary considerably.^{8,9} There is limited evidence on effectiveness of rapid assessment zones^{10,11}; and evidence on short-stay units is inconclusive (perhaps unsurprisingly so, given the heterogeneity of interventions studied).^{7,12–14} Meanwhile, multisite studies consistently find that the same intervention may produce disparate results when implemented in different organisations and hospital EDs.^{15,16} This lack of clear direction presents challenges to health system leaders who may be struggling with the challenge of designing and implementing streaming interventions—be it in EDs or other healthcare settings.

BACKGROUND

Emergency department (ED) crowding is a common and potentially harmful phenomenon identified by several countries as a national crisis.¹ Crowding in this setting is a multifactorial issue conceptualised using a model that includes input, throughput, output and system-wide factors. Numerous interventions have been directed at this complex problem. Some initiatives focus on improving ED throughput (eg, the time from arrival in the ED to disposition from the ED); others intervene elsewhere along the



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This multijurisdictional, qualitative study was intended to gain a deeper understanding of how, why and under what conditions streaming can be effective. It used a realistic evaluation¹⁷ lens to examine hospitals' diverse experiences with ED-based streaming interventions.

Conceptual framework

Study design was informed by realistic evaluation,¹⁷ and analysis by the population-capacity-process model.¹⁸ Realistic evaluation is a type of theory-based evaluation that seeks to determine the causal *mechanisms* by which an intervention achieves its outcomes, and the *context* in which these mechanisms are able to operate.¹⁷ It is designed to determine the effectiveness of an intervention and to explore under what circumstances it works, and why it works (or does not work well). The realist approach begins by articulating the explicit or implicit theory by which an intervention is assumed to work. Then, what actually happens in practice is explored. An intervention may fail because there is a flaw in the programme theory—activities are not appropriately designed to trigger the intended mechanisms in the first place.¹⁹ In other cases, contextual factors may disrupt the posited causal chain that links intervention activities to outcomes via mechanisms. By looking beneath surface features of interventions in order to identify underlying mechanisms, realist analysis can generate 'middle-range theory' applicable to a broad family of interventions.

As streaming interventions are based on formal theory, it is possible to identify several potential mechanisms a priori. First, streaming interventions may ensure that patients wait for only those services they need; no patient must queue behind another who requires a different set of services.^{3 4 8} Second, they may reduce variability among patients, enabling them to flow more evenly, thus more efficiently, through the process of care.⁶ Third, by establishing these low-variability subgroups, interventions may facilitate the delivery of standardised care, thus promoting quicker recovery.^{5 13} The literature suggests two additional mechanisms specific to rapid assessment zones: (1) by establishing 'one-piece flow', they may eliminate lag time between the steps of assessment and treatment; (2) by keeping patients 'vertical' (ie, in chairs instead of beds or stretchers), they may optimise the use of space and physical resources.^{10 20}

In practice, however, the extent to which streaming interventions reflect the official theory remains unclear. The empirical literature has focused on assessing *whether* streaming interventions work, rather than on probing *why* or *under what conditions* they work. While some authors have suggested success factors related to particular types of interventions, these have not been investigated systematically. Thus, little is known about either specific features of the intervention or of the external context that may facilitate or hinder the mechanisms of streaming interventions. Accordingly, this study was designed to determine: (A) how and why ED-based streaming interventions improve patient flow; and (B) what factors are perceived to affect such an intervention's ability to achieve its desired impact.

To guide identification of relevant intervention design and context factors, we applied the population-capacity-process model of patient flow.¹⁸ This framework, generated from a case study of a poorly performing health system, was developed to explain why flow interventions fail. The study concluded that effective interventions link a defined *population* to appropriate *capacity* through an efficient *process*: ineffective interventions were found to have neglected one or more of these three crucial

aspects. The model is gaining currency^{21–23} but has not yet been applied to in-depth analysis of a family of interventions.

METHODS

Context

Canadian healthcare is organised at the provincial level, and many provinces have devolved its administration to regional health authorities, which are disparate in size, demographics, service landscape and organisational structure.²⁴ The problem of ED crowding appears particularly acute in Canada compared with other Organisation for Economic Co-operation and Development countries.²⁵ Almost all Canadian jurisdictions have launched strategies to relieve crowding and improve flow; in the vast majority, however, substantial improvements either have not occurred or have not been sustained.²⁶

Design

This substudy is one component of the Western Canadian Patient Flow (WeCanFlow) study, which explored flow initiatives, in context, across 10 urban health systems spanning four provinces. The WeCanFlow study included in-depth interviews with 300 senior, middle and front-line managers purposively sampled for their involvement in flow, whether in the ED or elsewhere along the continuum of care; sampling, recruitment and data collection are fully described in a companion article.²⁷ The interview guide featured questions about what had and had not worked to improve flow, yielding data on over 70 interventions spread across multiple domains (input/throughput/output/system-wide), each having been implemented by one or more sites in up to 10 regions. Following written informed consent, interviews were conducted in person or by telephone, audio recorded and transcribed verbatim.

Analysis

In a preliminary round of analysis, coders (MRA, ZA, NDS) identified which interventions were mentioned by each participant, revealing that 98 of 300 participants discussed ED-based streaming initiatives. We then undertook a realist approach, as described earlier.

It is important to note that we were unable to quantitatively assess outcomes of all these interventions (and thus conduct a full realistic evaluation). Rich data on *perceived* outcomes from participant perspectives, however, enabled us to undertake a robust realist analysis.

After reading the 98 transcripts thoroughly for initial impressions, we carried out qualitative content analysis, a process led by one researcher (MRA) in frequent interaction with another (SAK). The two reviewers worked independently but connected regularly to debate alternative interpretations and reach consensus at each stage. We first inductively identified all explanations provided for success or failure; then categorised these as having to do with population, capacity or process; then paraphrased them as 'because' (it works because...) or 'unless' (it will/won't work unless...) statements¹⁸ in order to identify them as pertaining to mechanisms or context. At this juncture, we discovered that many 'unless' factors were not true context factors but intervention factors, a point to which we will return. We also observed that some factors (eg, leadership support, clinician buy-in) constituted facilitators/barriers to the initial implementation of an initiative, rather than to its achievement of outcomes once implemented. In the interests of focus, implementation facilitators/barriers are excluded from further discussion.

Having revised the codes to ensure their accuracy and consistency, we clustered them into themes using Excel tables to facilitate iterative recategorisation and reorganisation of extracts. Interpretations were further refined through discussion with other members of the study team, which included both researchers and (clinician) managers.

RESULTS
Types of interventions

Three types of interventions were discussed by participants in sufficient detail to contribute to realist analysis: minor treatment areas (n=3), rapid assessment zones or ‘intake models’ (n=12) and short-stay units (eg, clinical decision unit, diagnostic and treatment unit, medical assessment unit, clinical assessment unit, rapid access and discharge unit) (n=22). Initiatives were spread across 26 hospitals. Of the 37 initiatives, 19 were described as effective and 14 as ineffective; in the remaining four cases, both benefits and limitations were reported by the same or different participants. Where more than one participant discussed the same intervention at the same site, they usually exhibited consensus on its overall effectiveness, although in a few cases some participant(s) emphasised the initiative’s benefits, other(s) its limitations.

Mechanisms

Very few participants explicitly articulated the intervention mechanisms of successful streaming initiatives. Nonetheless, their accounts implied certain mechanisms, including the five we had identified from the literature (ensuring that patients wait for only those services they need; reducing variability among patients; facilitating protocol-driven care; eliminating lag time between steps; and promoting the efficient use of space). We also identified an additional mechanism: some participants suggested that streaming interventions fostered an ethos of efficiency and rapid discharge, which permeated the units involved and could also spread beyond them. Implied mechanisms and exemplar quotations are presented in table 1.

Intervention factors

The bulk of the data addressed features of the intervention thought to enable or hinder the effectiveness of streaming interventions. These were analysed using the three domains of the population-capacity-process model (see tables 2 and 3).

Population

An essential design feature of streaming interventions identified was the separation of a particular kind of patient from the general ED population. While there was consensus on the nature of these subpopulations in the case of minor treatment areas (low-acuity cases) and rapid assessment zones (patients of moderate or indeterminate acuity), depictions of the intended population for short-stay units varied by site and intervention. Short-stay populations were variously described as patients requiring ‘short-term’ or ‘specialized’ care, and the time of the ‘short stay’ varied (from 24 up to 48 or 72 hours). Most participants agreed that such units were intended for complex or resource-intensive cases requiring a *somewhat* longer stay than the typical ED patient, although not so much longer as to preclude rapid turnover. Indeed, admission of long-stay patients was identified as a major flaw in the operationalisation of short-stay units; units that became occupied with frail elderly or alternate level-of-care patients lost the ability for rapid turnover and could no longer contribute to ED flow. This occurred when units either did not clearly define their intended population or intentionally admitted inappropriate patients in the attempt to free up space elsewhere. Only one participant argued that the practice of admitting long-stay patients to short-stay units was desirable (on the grounds that their site’s admission process was too time consuming to make short admissions worthwhile); all others characterised it as flaw in the intervention.

Capacity

The cornerstone of streaming interventions is the provision of separate capacity—that is, physical and human resources—for each stream. Participants reported that all such interventions

Table 1 Implied mechanisms	
Mechanism	Exemplar quotes
Patients wait only for those services they need.	<i>'We do all the work-up in the unit (RAZ) and then discharge them from the waiting room without them ever getting to the acute side.'</i> (1124) <i>'So that concept of rapid assessment areas: in the past where people were CTAS 1–5, and the 5s waited until the 1s were seen. Now by doing some differential flow you can deal with people and move them in different fashions as they go forward.'</i> (6109)
Variability among patients is reduced, thus increasing efficiency.	<i>'All the patients come through you. You tap them. You do their tests. You discharge them. And initially we said, you know, you are asking us to see five patients an hour. That's ridiculous in this complex department. But it turns out that's exactly what you see. You see five an hour.'</i> (6103)
Provision of standardised (protocol-driven) care enables quicker recovery.	<i>'.... Because sometimes people just need a quick med adjustment ... So just that ability to be able to do that. As opposed to immersing everyone into the general population of the ED where they often get neglected because, generally speaking, ED staff don't know how to deal well with mental health patients.'</i> (8205)
Eliminating lag time between multiple steps.	<i>'But we did it a little different in that we put a nurse with a physician and a nursing assistant together and they did their assessments together and therefore eliminated, for the most part, a lot of the documentation and history taking redundancies...'</i> (10102)
Promoting efficient use of available space.	<i>'... They order tests on you and blood work or whatever and then you go and sit here and have your test from here. Then we put another patient there, so no patient owns a stretcher. ... And it allows us to take spaces that would only hold one stretcher or two and make them into five or six spaces and people would actually rather sit up than lay down and rather sit up and watch TV. So by doing that, we changed the flow of patients...'</i> (5204)
Fostering an ethos of efficiency and rapid discharge.	<i>'... our hospitalists work in the rapid access unit—where it's really good towards getting a patient out as efficiently as possible. They (hospitalists) tend to take that mentality with them to their other patients. (name of unit) have a whole team that's really geared towards making that efficient discharge process, but ... that mentality of "let's get our patients out earlier" tends to spill over to other units, so we've seen some benefit in that respect.'</i> (5211) <i>'And they don't change you into a gown. Because once you're in a gown, then you think you're sick. So, then that's part of what we did to increase the flow in the Emergency Department.'</i> (5204)

Original research

Table 2 Intervention features

Domains	Intervention features	Exemplar quotes
Population	Defining less acute cases	'... So if you're a certain priority population or condition, there's fast tracks to get people in and out quickly. ... I took my son, for example, he had a pretty scary fall. Diagnosed pretty much by the triage nurse. He was in and out quite quickly because they know it's quick-turnaround condition. He was in and out within that hour and a half. Same condition, different hospital: he was there for three hours and took up a bed that someone was in the waiting room waiting for.' (2110)
	Defining mid-acuity cases of unknown severity	'[Some] people come in and they may be full out flat cardiac arrest. You're not breathing, your heart isn't beating; we need immediate resuscitation. Then there are the other groups of people that we don't know what's wrong with you. Your pain could be life-threatening or it could be food poisoning. So it was that group, the unknown, but potentially very serious that this intake model was built to address.' (5201)
	Defining patients who require a process of care of 24–48 hours	'... to try to look at patients that stay a long time in the ED that really shouldn't be cared for in an ED and looking at where the best place for that patients would be Like GI bleeds that are stable, for example, like, they shouldn't be prepped in an ED. They should be someplace else for that. So there's at least [a starting point] to identify those populations and potentially [move them] into a CAU or somewhere else to look after them. ... [where] they can be cared for there and then either discharged or admitted for longer.' (10112)
Capacity	Dedicated space	'And, really the idea is: pulling patients into a designated area ... a department that [is] sort of your mid-acuity patients. ... So trying to prioritize those patients, get them in front of a physician early ...and so minimize the time that they're actually in a treatment room.' (9106).
	Dedicated clinical resources	'...And then we try to have a physician dedicated to that area for the first two hours of their shift. So, if a physician is in one space in the Emergency Department in terms of flow, it's way more efficient [to] have all your patients and your nurses in close proximity, and your exam rooms.' (5211)
Process	Rapid cycle time	'...So we direct those patients to Intake and the way Intake works is you have a number of stretchers which are necessary for evaluating patients, but they're used in a touchdown mode, meaning that the patients are brought in quickly and they're quickly assessed by the physician and they're taken out of the stretcher. So it's kind of a rapid cycle, quick assessment area.' (5219)
	Rapid and targeted discharge planning	'I'm talking about your frail elderly population, right. ... [Within] 72 hours if you can actually get in there and have some home support set up and a quick OT assessment at home to reduce the risk on the falls, the doc will ...sign off on the discharge plan.' (4110)
	Having a strict time frame	[How to ensure that it didn't become a parking lot] 'They did try to keep rules around, you really don't want a patient in the Diagnostic Treatment Unit for more than 48 hours, better yet not more than 24 hours and probably a dozen is more, like right.' (1119)

required dedicated space separate from the main ED (even if located in the waiting room), as well as dedicated physicians and other clinical staff. The most commonly reported intervention flaw was a lack of earmarked space and/or providers, which occurred either by policy (eg, some sites that did not believe they could resource an actual short-stay unit instituted a 'virtual' one) or as a result of the misuse of allocated space (eg, beds intended for high turnover being used for overflow of long-stay patients).

When patients from multiple streams converged on the same resources, streaming interventions reportedly failed to improve flow.

Process

Participants identified rapid cycle time (for minor treatment areas and rapid assessment zones), targeted discharge planning

Table 3 Intervention flaws

Domains	Intervention flaws	Exemplar quotes
Population	Admission of long-term patients in SSUs	'The one at XX in particular has great flow. It turns over 40% to 50% of its beds every day. So, what we did right there is identify the right sub-set of patients with the right staffing mix and the right philosophy of care which helps us move them around. And what we didn't do at that site, that our other two sites have had issues with, is admitting people that clearly are going to be in hospital for a longer period of time but were sub-acute and were undesirable to the internal medicine service.... so they would just put them into a bed and that would block a bed and then you've lost the ability to bring in the short stay people that you could quickly turn around ...' (10127)
Capacity	Lack of dedicated space	'Most of those where they've worked, they've had physical space to do it properly. And where they haven't worked they have not... So [Hospital A] kind of had a virtual DTU [diagnostic treatment unit] kind of thing. It sucks. Those things don't work. And the rapid assessment zone works at [Hospital B]. It does not work at the other sites. Again, they don't have a dedicated space with chairs where they can move patients in and out when they are done. That is huge ...they don't have the space to do what they want to.' (1107)
	Misuse of allocated space	'Oh, the minor treatment areas, they are non-functional.... Because half the time they are being used as parking spaces for people who need to be admitted.' (10108) 'Well, what happened was as everything got full, you ended up staying in a medical assessment unit and getting discharged from there. It became a holding unit.' (5204)
	No dedicated physician	'... The way our physician schedule is set out is that you start out in PTA [Physician in Triage Area] for your first three hours and then move to the core for more acute patients. and then you're supposed to end up with your last two hours managing those lumps, bumps and bruises easily. For a number of months [staff at Physician Triage Area] were very keen on it, but what they found out is that they were still responsible for the [other] patients... So I had to go back and reassess [already assessed patients]; consult; discharge; more tests; review ultrasounds; while still managing the acute patients [in the ED]. So I think, that way some of the, you know, I think some of the work has slowed down in PTA [Physician in Triage Area] which didn't manage flow because of the way that it was set up...' (9108)
Process	Inappropriate staffing/ confusion over staffing the streaming units	'...we implemented this medical admitting unit to improve our processes and it had a very detrimental effect. You know, our patients, we actually started having codes down there and we didn't really know how to staff it ... So you staff it with people who have a lot of experience, but could be better used in other parts of the hospital or you could staff it with what they chose was mostly health care aides and then we ended up having critical events.' (5215)
	Time frame not strictly maintained	'I've seen this concept many times but I've never seen it work before. ...I have seen this rapid access unit in every emergency room I've worked in and I've never seen it work because it's always just an in-patient unit where people end up staying for a ridiculous length of time.' (2105)

SSUs, short stay units.

Table 4 Context factors

Domain	Context	Exemplar quotes
Capacity	Lack of outflow sites/ access block	'[So] then the patient should go... to the next phase of care. Well, that never happens. So, all these programs come and they go, "[the patient] doesn't meet my program. Ask him. Ask that one. Ask this one." And the patient stays.' (10132)
	Inadequate resources	'Exactly, like the RAU (Rapid Assessment Unit), the idea was that this was successful, it could be something that could be modeled at other sites, but I have yet to see any funding or discussion. But we know it works but it's very expensive.' (5228) 'I think fast tracks have lots of value but you also have to have the staff to do it. The other piece that we're running into is PTA (Physician in Triage Area). We're moving more patients through quickly but we've outstripped our housekeeping ability to keep up and we've outstripped our unit support workers ability to keep up... what the nurses are doing in PTA is non-nursing: it is washing stretchers; making [up] stretchers and physicians too, I've got pictures of physicians washing stretchers somewhere; stocking equipment; moving patients around the department; porter entry; a lot of that stuff.' (9106)
Population and capacity	Demand Outstrips Capacity	'Actually the metrics improved for a short while. We are at a point now where the metrics actually returned to where they were initially. Which is very discouraging but ...could [reflect] the fact that our numbers increased dramatically. ...our patient numbers are about 10% higher than they were last year and last year they were 10% higher than the year before. So that's a lot of people when you see 100,000 people over the course of two emergency rooms in a year. So we're a little discouraged.' (9108)
Population, capacity and process	Inadequate demand for designated streams (carve-out effect)	'...the whole thing about assigning a physician to the back area was an epic fail, because sometimes it wasn't busy enough and sometimes the doctors didn't take it serious[ly]. So they'd be like oh, we're not that busy and I'm just going to step out and go get a haircut....' (7225)

and maintenance of a strict time frame (for short-stay units) as process elements essential to the success of streaming interventions. They described how a consistent, disciplined process enabled the appropriate population of patients to flow rapidly through the designated capacity. The most commonly reported process-related intervention flaw was failure to maintain a strict time frame; short-stay units that failed in this regard soon became occupied with long-stay patients.

Context factors

Relatively few of the success/failure factors described were true context factors (ie, external to the intervention); however, participants did describe how certain population characteristics and capacity constraints could impede the functioning of streaming initiatives (see table 4).

Population characteristics

A few participants reported context factors related to the size of the eligible population, for instance, that streaming units had run out of space when ever-increasing patient demand ultimately outstripped capacity, or that reserving provider time for a low or variable volume of patients resulted in wasted capacity. The latter would be most likely to occur in hospitals that serve a small overall population—a context factor—although it could also reflect a flaw in the intervention itself (eg, overly strict admission criteria or failure to appropriately define the population). Moreover, this failure to anticipate the need (either by too few or too many referrals) suggested a lack of congruence between the intervention proposed and the site needs.

Capacity constraints

By far, the most widely reported contextual barrier to effective streaming was a lack of outflow capacity. This issue was primarily reported for units serving patients who could not be discharged home; while such units might manage patients efficiently, they failed to improve flow unless they were able to readily transfer patients to their next destination. Also, several participants stated that their site had inadequate resources to sustain streaming interventions—in particular, short-stay units, whose geographic footprint made them expensive.

DISCUSSION

This study used qualitative methods to conduct a realist analysis of streaming interventions designed and implemented to mitigate

ED crowding. Using nearly 100 transcripts from 300 interviews and independent coding methods, this review provides insights into what factors may contribute to the effectiveness of several important throughput interventions.

While many participants reported effective interventions whose design was congruent with the theoretical basis of streaming, many others described interventions which—owing to their incongruence with this theory—could have been predicted to fail. These interventions either failed to clearly define separate streams (limiting their potential to reduce patient variability or promote standardised care); failed to provide each stream with separate capacity (forcing patients to wait behind individuals belonging to other streams); or allowed the designated capacity to fill up with long-stay patients. Such glaring flaws in intervention design and/or operationalisation suggest that not all planners clearly understood the theory underpinning streaming interventions. Some sites might have adopted such interventions imitatively, without understanding the theory behind them,²⁸ or been compelled by higher level decision-makers to adopt a potentially inappropriate intervention. It seems noteworthy that participants offered very few explicit accounts of intervention mechanisms. Some participants, of course, might have merely neglected to mention mechanisms, but others might have neglected to consider them when choosing and adapting the intervention.

A realist approach, guided by the population-capacity-process model, helped to uncover why what was supposedly the 'same' intervention might work at one site but not another. Given increasing recognition of the importance of context, one might expect context factors to explain such differences—and indeed, the analysis revealed certain important external context factors, particularly the access block known to hinder patient outflow in many sites. However, variation in reported effectiveness seemed even more attributable to variation in *intervention fidelity*; that is, ineffective interventions lacked one or more core features of streaming. While it is perhaps unsurprising that low-fidelity interventions are perceived as ineffective, it does seem surprising that many sites are implementing such interventions and expecting them to work.

Of the external context factors we identified, one (inadequate or inconsistent demand for a particular stream) is well known to investigators of streaming, who have termed it the 'anti-pooling' or 'carve-out' effect.^{29 30} Another factor, lack of outflow sites, has previously been dubbed the 'parking lot' problem (ie, patients

Table 5 Guiding questions

Domain	Design	Operationalisation	Context
Population	Has the intended population been clearly defined? Does this definition exclude long-stay patients?	Can this definition be maintained rigorously, despite any pressure to admit ineligible patients?	Are patient volumes sufficient to maintain steady demand for all streams? Does patient demand outstrip the intervention's capacity, creating a backlog?
Capacity	Does the design identify dedicated clinicians for the intervention? Is there dedicated physical space for the intervention? Is the use of physical space optimised (eg, are suitable patients treated in chairs)?	Can the space be protected from other uses? Is there a team of service providers (physician, nurses, support staff) available for the intervention, in adequate numbers to meet demand?	Are there adequate resources to maintain designated clinicians and space? If patients are not to be discharged home, are there available sites to which they can flow?
Process	Is the care process from assessment to discharge as streamlined as it can be, enabling rapid cycle time?	Is the time frame intended for the intervention maintained?	

become 'parked' in capacity intended for short-term use because appropriate long-term capacity is unavailable).²⁰ Greater familiarity with the theoretical basis of streaming might help planners to avoid introducing interventions into unsuitable contexts.

Our findings confirm the applicability of the population-capacity-process model²⁰ to a range of diverse health systems; across numerous regions and sites. Findings also extend prior work by identifying common flaws in streaming interventions. This research also contributes to the literature by identifying an additional mechanism that may contribute to the effectiveness of streaming, namely the promotion of attitude change among staff. Unlike the other identified mechanisms, which are operational in nature, this one is psychological; future research might consider its potential role.

The idea of streaming, although not always identified as such, underpins diverse healthcare interventions: separation of emergency from elective general surgery,³¹ direct-entry subacute care,³² risk-stratified chronic disease management,³³ stepped care for mental health,³⁴ and so on. Our specific findings may not apply to other interventions, some of which serve easily defined groups; deliver care virtually (not requiring designated physical space); or stream patients to facilitate ongoing targeted care, not rapid discharge. However, we believe the following broad principles are transferable: prior to embarking on streaming, leaders should ensure that the intended populations are sufficiently clear and large; that enough capacity can be protected for the streams to run without mutual interference; and that the proposed process does not create new inefficiencies. Furthermore, our findings suggest two takeaway messages for health leaders that extend beyond streaming. First, in order to prevent design and operationalisation flaws, planners must clearly understand the underlying theory of the intervention. Second, it is important to ensure that both the external and internal contexts are favourable to the intervention before attempting implementation.

Limitations

This study had several limitations. As objective data on outcomes of the 37 initiatives were unavailable, we were limited to analysis of *perceived* outcomes. Although we observed that participants rarely gave discrepant accounts of the outcomes of the same initiative (suggesting that such perceptions had some consistency), inferences must be drawn cautiously. No more than four people (and often only one person) discussed the same intervention at the same site, and even shared perceptions may be biased. In particular, responses may have been subject to social desirability bias, as managers may have been reluctant to admit the failure of their own interventions—indeed, most of the critical comments were applied to initiatives for which someone else was responsible. While we were able to glean valuable insights

about potential drivers of both success and failure, we cannot establish the reliability of participants' observations, and our study must be regarded as hypothesis generating.

Data were drawn from interviews that covered a broad range of flow-related issues; some participants mentioned such interventions only in passing and might have provided more detail had such interventions been the sole focus of the interviews. There was particularly limited coverage of minor treatment areas; it may be that because these were a long-standing intervention at many sites, participants took them for granted or felt unable to comment on their impacts. This same limitation in design meant that our study may not have uncovered all the risks or potential inefficiencies associated with streaming. For example, if streams are defined too narrowly or cannot accommodate fluctuation in patients' conditions, patients may have to be redistributed among streams. Participants did not report this problem, nor is it noted in the literature on ED streaming; however, it has been observed in relation to other kinds of streaming (eg, of subacute from acute inpatients²⁰). Another limitation is that participants were limited to those in managerial roles at various levels and few front-line providers and did not include patients who might have offered broader perspectives on specific interventions. Despite these gaps, we were able to assemble a large data set comprising information from multiple and diverse sites.

Finally, this study was restricted to Canada; while there is no reason to expect that streaming interventions in other jurisdictions would operate via different mechanisms, context factors might vary widely, as might the prevalence of intervention flaws. Full-scale realistic evaluation of streaming interventions in different countries, as well as across clinical settings, would be a valuable direction for future research.

Implications

If the failure of a streaming intervention turns out to result from flaws in its own design or operationalisation, EDs may be able to address the flaws and make the intervention functional. Unfortunately, some intervention flaws may reflect deeper contextual factors that lie beyond the ED's control. For example, short-stay units may persist in admitting long-stay patients due to an actual or perceived inability to access more appropriate destinations for them; small hospitals may hesitate to enforce clear admission criteria for fear of inducing a carve-out effect; or organisations may assign the same space and physicians to multiple streams because they lack resources to design the intervention optimally. These context factors are external to the intervention, thus resolving them would require collaborative commitment and/or environmental modification. Before introducing a streaming intervention, it is important to ensure that the context will permit such an intervention to be properly designed and

executed. On the basis of our findings, we have developed a set of guiding questions for decision-makers who are contemplating such an intervention (table 5).

CONCLUSION

Interventions based on the principle of *streaming* have the potential to increase efficiency in EDs and in other areas.^{3–6} However, our findings provide evidence that a theory-based intervention is only as good as its implementers' understanding of and adherence to the theory. If those designing and implementing streaming interventions do not follow the principles on which the intervention is premised, potentially valuable strategies are likely to fall short of their potential contributions.

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