Applying FRAM to support service delivery changes in a regional cancer network

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SUMMARY

This paper describes how Functional Resonance Analysis Method (FRAM) was used to produce a model to support a project team to deliver a planned service change in paediatric leukaemia care. With the anticipated wider use of the immunotherapy Blinatumomab, a regional initiative sought to introduce ambulatory shared care delivery of the medication across an operational delivery network of regional hospitals and family homes. The same team had previously used FRAM to analyse incidents, and the existing model was revisited and expanded to explore new system functions, dependencies, and sources of variability created by the change. By enabling multi professional staff to reason together across organisational boundaries, the model acted as a shared reference for understanding system resilience and guiding practical actions for a risk informed implementation of the proposed service delivery changes. Potential instantiations raised during this process were used to generate a Resilience Analysis Grid questionnaire intended to produce an early profile of the system's potentials for resilient performance and to help focus attention on areas requiring further support as the pathway is introduced.

KEYWORDS

FRAM, Resilience Engineering, Paediatric Leukaemia, Healthcare

Introduction

Blinatumomab is an immunotherapy for paediatric B-cell acute lymphoblastic leukaemia that has improved remission and survival outcomes and, following recent trials, is expected to see wider use in frontline treatment (Gupta et al., 2025; Litzow et al., 2024). It is delivered as a continuous 24-hour infusion over four-week cycles, with bag changes every four days. Treatment has traditionally taken place in Principal Treatment Centres (PTC), which are specialist tertiary hospitals. This limits inpatient capacity and keeps families away from home for extended periods. National policy encourages greater choice and access to treatment closer to home for cancer patients (Department of Health and Social Care, 2026).

The Children, Teenage and Young Adult Cancer Operational Delivery Network in the South West of England operates a shared care model between a Principal Treatment Centre and regional Paediatric Oncology Shared Care Units (POSCU). A project was developed to allow continuation of Blinatumomab treatment at shared care units after initial inpatient administration at the Principal Treatment Centre. This change introduced new functions, including a requirement for coordination of infusion and bag preparation between hospitals, training regional staff in administration of a continuous immunotherapy infusion, and supporting families to manage portable pumps at home.

The same team, facilitated by a patient safety investigator, had previously used Functional Resonance Analysis Method to analyse incidents within the pathway (Seaton et al., 2025). That existing model was revisited and extended to consider the additional functions and dependencies created by introducing shared care delivery of Blinatumomab. The model was used to bring together multi professional staff from across the network to explore where work may vary as shared care is introduced and to identify areas requiring attention as the new pathway is prepared for implementation.

Instantiations explored through the FRAM functions highlighted potential sources of variability. These informed development of a questionnaire based on the Resilience Analysis Grid method, which is intended to provide an initial profile of the system's potential for resilient performance and to help focus attention as the redesigned pathway is introduced.

Methods

Feedback from the wider Operational Delivery Network (ODN) ambulatory blinatumomab project (n = 10), gathered from parents and carers who had previously used infusion pumps at home, indicated support for local delivery but highlighted anxiety about managing pumps if problems occurred. The patient safety investigator (NS) met with ODN leads to understand the planned operational changes and to explore how FRAM (Hollnagel, 2012) could augment the project with a safety lens. A subsequent meeting with the Principal Treatment Centre project team was held to agree the analytical direction.

Draft organisational documents relating to the intended service change were reviewed by the investigator. Seven new functions associated with the redesigned pathway were derived through iterative review and synthesis of project discussions and draft documents. Additionally, data from an existing FRAM model of leukaemia chemotherapy delivery previously developed and applied by the same team in a retrospective analysis provided the basis for this work (Seaton et al., 2025). The existing model was refined into clusters of functions (see Figure 1): PTC assessment and care planning (blue), PTC medicines management (magenta), discharge processes (green), transfer of care [to family or POSCU] (orange), and family or carer responsibilities (yellow). The new functions were added as an additional cluster (light pink).

A two-hour multi professional workshop (n = 18) involving consultants, nurses, pharmacists, network managers and operational staff from the PTC, ODN and a regional POSCU was then held to co-design and define the new functions using the existing FRAM model as a basis. Presentations by the network lead nurse and the patient safety investigator introduced the project background and provided an overview of FRAM. A hypothetical scenario of a 7-year-old child with Acute Lymphoblastic Leukaemia who lives near a POSCU and will start on Blina provided the basis for walking through the functions as a group. Participants were oriented to the model and invited to consider how the new functions interacted with the wider system and the model was iterated live during the workshop. Discussion focused on function dependencies, aspect requirements (inputs, outputs, controls, time, preconditions and resources) and where variability in everyday work might arise. Inclusion of POSCU staff enriched the discussion by highlighting contextual differences in staffing, experience and capacity across sites in the South West of England. The workshop discussion generated a detailed picture of likely instantiations, that is, scenarios in which staff may need to make trade-offs or adjust plans in response to changing conditions.

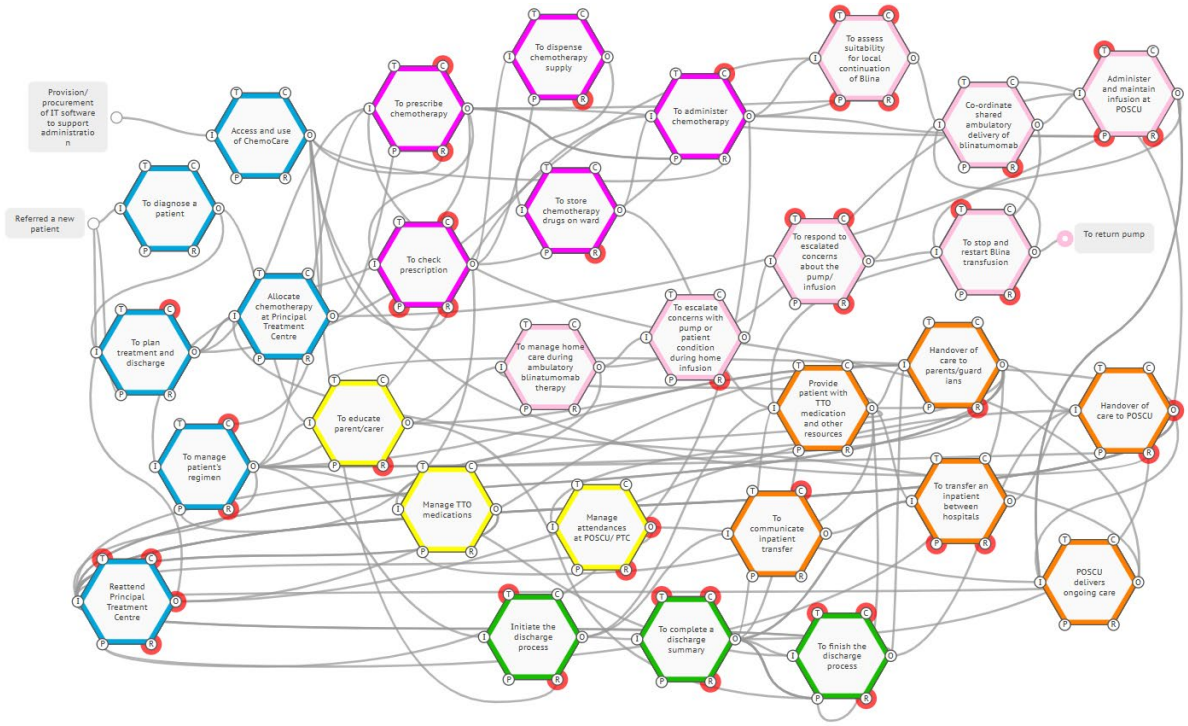

Figure 1: FRAM model of leukaemia treatment including ambulatory Blinatumomab functions

Instantiations identified through review of the workshop transcript suggested that three functions in the redesigned pathway require variability because they need coordination across different sites, time critical decision making and distributed cognition. The functions were coordinating shared ambulatory delivery of Blinatumomab, stopping and restarting Blinatumomab infusion, and responding to escalated pump or infusion concerns. Given the improvement focus of the project, it was agreed to develop a questionnaire informed by the Resilience Analysis Grid methodology (Hollnagel, 2012) using FRAM functions where potential variability had been identified. This approach is consistent with reported applications of the Resilience Analysis Grid in healthcare, where locally derived qualitative data are used to generate context specific questionnaire items linked to the resilience abilities (Safi et al., 2022), with items developed iteratively from analysis of system activities and practitioner input in line with established resilience engineering practice (Ferreira et al., 2010). Instantiations were used to generate questionnaire items. Questions were developed with the ODN Lead Nurse and reviewed by a human factors specialist (LP) to ensure clarity and alignment with the intentions of the method. Items were then mapped to the resilience abilities and organised into sets of three per ability to form a 15-item Likert scale questionnaire, with responses ranging from strongly disagree to strongly agree and an additional not applicable or don't know option. The Resilience Analysis Grid is not intended as a statistical measure of resilience but as a means of constructing a resilience profile based on ratings of the resilience abilities (Hollnagel, 2010); in this work, the questionnaire will be used to support discussion and to steer where prioritisation of improvement activity may be necessary.

Items were designed around the resilience abilities of anticipating, monitoring, responding and learning (Hollnagel, 2010), with an additional coordination ability, proposed by Anderson and Ross (2020), included to reflect the distributed nature of the shared care system and to capture the need to align work across different organisations in the network. The next steps in this work are to distribute the questionnaire with the intention to steer prioritisation and discussion within the ODN as the redesigned Blina pathway is introduced, and to repeat the questionnaire 12 months after implementation to review how system capabilities evolve, in line with the intended use of Resilience Analysis Grid (Hollnagel, 2010).

A grid showing resilience abilities, example instantiations identified at the FRAM workshop and example questionnaire items is shown in Table 1. The instantiations shown are illustrative extracts from the workshop discussion and are included to demonstrate the link between the modelling work and questionnaire development.

Table 1: Grid of resilience abilities, example FRAM instantiations and example questionnaire items

Resilience ability	**Example instantiations from FRAM workshop**	**Example questionnaire item**
Responding	A pump alarm or infusion concern reported by a family requiring rapid access to specialist advice from the Principal Treatment Centre	R1. If a pump or infusion concern is escalated, expert advice or necessary action(s) can be accessed quickly enough to avoid unnecessary delay or escalation, including out of hours.
Monitoring	The planned timing of a top-up or bag change is approaching but the current plan or escalation history is not easily visible across the Principal Treatment Centre and shared care unit	M1. Staff can identify or be alerted in advance when shared ambulatory delivery is at risk (for example because of short notice, end-of-week pressure, or delays in authorisation or drug availability).
Anticipating	A situation in which a family requires pump support or advice over a weekend or out-of-hours period when staffing, pharmacy access or transport options may be limited	A1. Planning for shared ambulatory delivery routinely considers predictable pressures, such as weekends or bank holidays, staffing levels, pharmacy capacity, and family travel distance.
Coordinating	A planned top-up at a shared care unit requires coordination with the Principal Treatment Centre, including agreement on timing, responsibilities and information sharing	C3. If something changes or a problem arises (for example delays, staffing issues, or pump problems), it is planned and recorded who needs to speak to who between the PTC and POSCU to agree the next steps.
Learning	Early patient cases prompt updates to guidance, training, re-design requirements or ways of working across the network	L2. Training and supporting materials (such as guidance, checklists, or troubleshooting resources) are adequate and accessible to help staff manage both routine and unexpected situations.

Results

The workshop to develop the FRAM model of the redesigned pathway was used to work through the new functions with staff responsible for delivery. Instantiations generated during the workshop provided examples of where potential variability may be present once ambulatory Blinatumomab delivery is shared between the Principal Treatment Centre and Paediatric Oncology Shared Care Units. Instantiations created examples of where potential variability may be required to support resilience in delivery of the new system and informed development of questionnaire items to profile resilience potentials and understand system capacity to manage variation during implementation.

One example concerned the function “to stop and restart Blina transfusion.” An instantiation involved a pump concern arising over a weekend where the infusion would have to be stopped and a replacement Blinatumomab bag or two chemotherapy trained nurses were not immediately

available at a POSCU. The instantiation raised reliance on access to specialist advice, interim management arrangements, shared decision making between teams, visibility of the current treatment plan, clarity of messaging to the family and escalation contacts and recording of escalation.

Actions were agreed following identification of issues raised during the workshop. The project team recorded actions to introduce a readiness sign off for POSCUs before accepting patients, clarify escalation route contacts at the PTC, develop guidance for infusion interruption and criteria for local restart, and revise training and supporting materials for staff and families. Further actions included updating contact lists and discharge checklists and exploring options for shared electronic patient tracking. Action owners were assigned and work remained in progress at the time of writing.

Instantiations were translated into questionnaire items mapped to the resilience abilities and organised into a 15-item instrument. The questionnaire, at the time of writing, is being circulated to staff involved in early pathway delivery across the South West ODN. Responses will be summarised descriptively to produce a profile of resilience potentials and to inform prioritisation during pathway introduction. The questionnaire will be repeated after approximately twelve months to review how resilience capabilities develop once the pathway is in routine use.

Key learning points

Earlier work within the network had already used FRAM to describe how the shared care pathway for Acute Lymphoblastic Leukaemia functions. That groundwork made it worthwhile to return to the method when plans emerged to extend Blinatumomab delivery into shared care. The existing model provided a common reference point and a set of functions already familiar to the project team. This meant attention could focus on what the proposed change adds to the pathway, where staff may be required to adjust their work as shared care is introduced and where variability is likely to emerge, or be required, as teams respond to local conditions, time pressures and resource constraints.

Using the model alongside draft guidance allowed discussion to focus on parts of the pathway most likely to be affected by the change. Staff from the PTC and a POSCU worked through situations that could arise once treatment is shared. POSCU staff provided healthy challenge and highlighted practical constraints, differences in familiarity with Blinatumomab and access to specialist advice that may not be obvious when plans are developed centrally. The discussion brought forward points that had not previously been explored in detail and linked written guidance with the circumstances in which it will be used.

Clinical time is limited, yet staff from multiple disciplines had a clear appetite to take part. Working through the pathway together brought forward practical points that had not previously been discussed. The presence of an existing FRAM model meant the session could focus on implications of the change rather than starting from first principles.

Knowledge of the method and human factors sat in the background with the patient safety investigator who provided the engine for using the method. The ODN convened the group and organised participation from a wide group of multi professional staff. A human factors specialist provided advice during development of the questionnaire and helped ensure the questions reflected the situations discussed. This aimed to keep outputs usable for the project team and connect the method with concerns raised by staff who will be involved in delivery. The work provides a way to bring to the table predictable situations in which staff may be required to make adjustments in their work as ambulatory blinatumomab is introduced across the network and where support or clarification may be required. It does not measure performance, and it does not show how the pathway will function in routine use.

For clinicians, the process created a model to test the system as it was being designed, bring to light practical concerns and connect written guidance with situations they may encounter. Its value lay in supporting understanding between the PTC and POSCU and in identifying where attention may be needed as the pathway begins to operate. In this sense the FRAM model functioned as a boundary object, an artifact which is adaptable to different professional viewpoints whilst maintaining a common representation of the system (Star & Griesemer, 1989).

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