FRAM of two complex systems in health-care processes

Fetal monitoring at a maternity unit and outpatient care of patients with affective psychiatric disorder

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Disclaimer

• The models in this presentation are subjected to endless amendments and do not represent any final visualization of the systems

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Introduction

The functional resonance analysis method (FRAM) as developed by Eric Hollnagel is used to create models of the concerted actions of functions in defined systems. The models are useful to understand how and why the variabilities of individual functions result in a total system outcome of sometimes high and not always advantageous variability. Especially in health care the systems are often complex and may result in serious harm of the patient despite regulatory demands that should reassure strong system resilience and high outcome reliability. FRAM models can be useful for identifying and taking of measures that lead to a more stable and reliant system and thereby empower the quality and safety in health care.

The aim of this project was to create and study models of two different complex systems in patient care to gain experience and knowledge of how different systems can be visualized and whether functions can be identified that are crucial for the resilience and reliability of these systems.
Material and methods

The two systems analyzed were 1) a maternity unit at a county hospital (Norra Älvsborg hospital) with focus on fetal monitoring using cardiotocography (CTG), and 2) outpatient care of patients with affective psychiatric disorder at a regional hospital (Sahlgrenska university hospital). The reason for choosing these systems was to try to understand, using other methods than hitherto used, why these systems sometimes produce unacceptable outcomes, namely some children suffering asphyxia with subsequent death and some psychiatric patients committing suicide. FRAM (Hollnagel) was used to create system models based on information gathered from previous root cause analyses and interviews with staff members representing the different professional groups. Simplified versions of the models were created for instantiation of patient cases. Depth aspect analysis was performed of some key functions. Analysis of variability with negative influence on function performance was done using a modification of the method originally described by Hollnagel.
Results

Models could be created that visualize the high degree of complexity of both systems under study. The functions could be grouped to produce several domains in each model which enabled for explanations and subsequent discussions using the models. The maternity unit model visualized the importance of high competence and communication and collaboration within and between the two main and highly professional groups, the midwives and the obstetricians. The interpretation of CTG and correct decision making (reliability) followed by adequate and prompt action (resilience) were central issues that were also influenced by many other functions in the system. In the psychiatric setting, on the contrary, a great number of different professional groups and care givers were involved in the care of the patient. This puts high demands on individual competence and sound judgement of what to do and who is to do it. Two functions were especially crucial, the structured suicide risk assessment and the multi-professional team conference. The importance of using several structures, including the patient’s family, was clearly visualized. The instantiations revealed several functions that were repeatedly omitted (variability of time) or incorrectly performed (variability of precision). It was, however, possible to find remedies that may stabilize the systems to produce outcomes of higher quality and safety.
Conclusions

We could visualize two models that differed highly from each other and that pointed out some key issues of each system that are of crucial importance. It was possible two identify several key functions and to dissect the causes of variability of some of the functions. Measures can now be directly taken based on these findings to strengthen the systems, many of which were revealed during the process of modelling. Analysis of other functions can be pursued for further optimization, and be done in parallel by groups of staff members at the sharp end. This may produce continuous and simultaneous PDSA cycles in different parts of the system where the results of individual functions can be used as process quality indicators. The work with FRAM demands enthusiasm, energy and leadership commitment which pays off during all steps of the FRAM process. The concerted improvement of individual functions can hopefully be followed by a better outcome of the system, namely fewer babies suffering asphyxia with fewer subsequent perinatal deaths and fewer patients committing suicide.
FRAM: Functional resonance analysis method

- [Handbook](#) for the use of FRAM
Rational and incentives

• Health care processes may be associated with recurrent serious adverse outcomes such as death of the patient

• Current methods using linear approaches for understanding the often complex systems are not sufficient to identify and resolve the underlying problems

• A non-linear approach may give complementary information on how the activities/functions of the systems interact and emerge with non favourable outcomes

• FRAM provides a method that enables models that visualise complex systems and may have potential as basis for discussions of how the systems can be optimized and stabilised and thereby result in higher success rates
Two complex systems with emergent fatal outcomes

• Fetal monitoring at a maternity unit
  → Death of the child/fetus due to asphyxia

• Outpatient care of patients with affective psychiatric disorder
  → Suicide
Problems

• Root cause analyses (RCA) have revealed several serious flaws in the care of the individual patients (woman/fetus and psychiatric patient)
• Despite vast knowledge of dysfunctional activities in the processes the flaws persist
• Underlying potential causes
  - Care givers and providers lack knowledge about the total system and interactions of functions
  - Crucial functions (activities) have not been clearly identified
  → The safety culture is lacking key perspectives → improper vigilans and inadequate action at the sharp end
  → Resources allowing for adjustments are not sufficiently allocated by the blunt end → early system decompensation
Aims

• Create models of the two systems
• Identify special functions that contribute to emergens of unfavourable (and favourable) system outcomes
• Using the models to identify patterns in instantiations of unsuccessful and successful patient outcomes
• The results from these analyses be used for focussed allocations of resources and competence that lead to minimized unwanted variability in key functions and stabilisation of the system as a whole
Fetal monitoring at a maternity unit

• System boundaries
  Start: Pregnant woman arrives in active labor
  End: Final phase of delivery (no fetus monitoring is feasible)

• System outcome
  Favourable: child not suffering from prolonged anoxic brain injuries
  Unfavourable: child born death or dies shortly after birth, or suffers prolonged anoxic brain injuries

• Key focus
  CTG (cardiotocograph) surveillance and action on pathology
Reflections on the MU model

• The system is driven by the initiatives of the midwives
• Domains consist of groups of activities
• The connections between functions are tight and often take minutes-hours
• Few professions are involved and perform their work based mainly on routines (which of course depend on competence)
• The system is most often confined to the ward and does not involve other actors
• There has to be a culture of understanding the competence between the midwife and the obstetrician and willingness to call for help (mw) and to come to help (dr)
• Several functions may be used as quality markers/indicators
• Outcome success factors: culture, competence, availability, well informed patient and husband
Crucial functions (MU)

• Primary risk evaluation
• Level of monitoring
• CTG-evaluation
• Involvement of obstetrician
Instantiations using the MU model

• Normal delivery in general

• Two cases of perinatal infant death

  0-para, normal pregnancy, w40+5, contractions every 2nd min

  1-pregn, w 41+0, fluids per vaginam (thin, amniotic?), contr last 9 hrs
Reflections on instantiations

• Both insts: Early functions suboptimally activated/performed
  • Primary risk evaluation
  • Make delivery plan
  • Inform/support patient/partner

• Stilborn child
  • Requirements and competence for CTG evaluation not fulfilled

• Child death after VE
  • Delayed action in final chain: from decision of pH-assessment to start of VE – preparedness low for emergency situations (training, equipment ...)
Outpatient care of patients with affective psychiatric disorder (PSOC)

• System boundaries
  Start: Patient is admitted to and accepted for outpatient care at the psychiatric outpatient clinic (PSOC)
  End: Patient is in no further need of PSOC

• System outcome
  Favourable: psychiatric wellbeing (continuously during care and after discharge from PSOC)
  Unfavourable: suicidal attempt with or without death

• Key focus
  Suicide risk assessment (formal and informal) and action upon high risk
PSOC-model complex
PSOC-model less complex
Special features of the PSOC model – ”ad hoc” functions

• Many functions are performed ad hoc (non compulsory)
• Several of the ad hoc functions are performed by all professionals (e.g. non formal and formal suicide risk assessment)
• The ad hoc functions are performed as part of a patient visit or contact (major function)
• Ad hoc functions are not necessarily performed in a defined sequence and may themselves be performed in a fragmented fashion
• Ad hoc functions are resources in a major function: resources are not only activities that provide resources that are used but also activities/functions that are or may be performed as part of a major function
• The initiation and performance of ad hoc functions depends on the judgement of the professional that performs them
An example of a major function with “ad hoc” function

• Multiprofessional team conference (MPC)
  • All professionals (ideally) participate
  • Analogous to a round at the ward in an inpatient situation
  • The ”clockwork” of the system/process
  • The clockwork has a minimal frequency – or does it?
  • The signals that start the function should be clearly defined – are they?
Multiprofessional team conference (MPC)
An example of an “ad hoc”-function

- Suicidal risk assessment – formal and informal
  - All professional groups do it
  - Crucial for decisions of potential vital importance for the patient
  - The signals that trigger are subtle and not clearly defined but rely on the competence of the professional
Suicide risk assessment (SRA) at PSOC
Reflections on the PSOC model
• Domains consist mainly of professional involvements
• The system is highly dependent on patient motivation
• The connection between functions are loose and often take days-months
• Many different professions are involved and perform their work based on their individual competence
• Many actors outside PSOC (including the family) are involved and (can) contribute to the well being of the patient (and probably the outcome for the patient)
• There is a great potential in the system to satisfy the patients needs but coordination of efforts is crucial
• There is a high risk of lack of enough coordination (by the MPC) due to a high load on the system (many patients) and thereby scarce margins
• Several functions may be used as quality markers/indicators
Two instantiations of patient at PSOC that committed suicide

• Aim: look for patterns in use of functions/domains that may in part explain the unfavourable outcome for the patients

• Patient 1: Man 30, recurrent depressions and social anxiety, friend committed suicide before patient was admitted

• Patient 2: Woman 30, many years of depression, self destructive behaviour
Man 30
MCP 27 Oct
Dr visit 18 Nov
Dr phone calls 20 Nov, 11 Dec, 20 Feb
Planned dr phone call March 16 - no answer, no action
Suicide March 31
No formal/informal SRAs
For comparison what was possible!
Woman 30
MCP June 23 and Sept 22 2013
Dr visit July 10 2013, last visit April 30 2014
Supportive cancellations psychologist Oct 8-Nov 21 2013, attendant Dec 15 2013- May 29 2014
Planned MPC June 12 2014
No formal SRAs, no MPCs after Sept 22

Family and social network

Disease activity assessment

Multiple professional team guidance (MPC)

Psychologist (Psy)

Center (en)

No area
Reflections

• Few functions/domains were active
• Crucial functions were poorly recruited

• More instantiations of patients that committed suicide – will they confirm the same pattern of poverty?
• Instantiations of patients that have not committed suicide – do they present a richer pattern?
• Is it possible to use performance of indicator functions on a system level to predict high risk of system decompensation and on a patient level to assess the risk of an unfavourable outcome? Will it be possible to take actions (which?) in time to prevent system and patient disasters?
Reflections on complex modelling

• The raise of models of complex systems need a lot of support, time, enthusiasm and creativity (motivation)
• The models visualise the complexity needed in order to understand why there may be emergent outcomes
• The models can be grafically organized in domains and their number of functions reduced (simplification) to be comprehendable
• Can anyone that has not directly participated in the making of the model understand it?
• What messages can be delivered and which questions are evoked?
Reflections on resilience

• Questions pertaining to resilience engineering can be addressed during the creation of the models
Reflections on FRAM and RCA

• RCAs represent linear instantiations of individual cases
• RCAs often reveal several functions that performed improperly
• RCA causes represent aspects of main functions and demonstrate their nature of variability
• RCA instantiations can be fitted into FRAM-models
• RCA provide a lot of information concerning both systems in this presentation (reactive)
• RCA enables to learn from the past (to be proactive you need to be reactive)
What to do next

• At the sharp end
  • Individual groups analyzing and discussing crucial functions with the aim of optimization of the functions and thereby stabilising the system
  • Several groups can be working simultaneously

• On the organizational level
  • Discuss and identify resources that should be allocated (and allocate them) in order to allow for optimization of functions and resilience engineering at the sharp end
  • Understand that the systems are complex and depend on work as done and the need for competence, sound working conditions and personal professional responsibility

• On both levels
  • Identify quality and resilience indicators that should be followed and evaluated in real-time
  • Should the systems be reorganized?