Study Protocol to assess the implementation of the Four-Hour National Emergency Access Target (NEAT) in Australian Emergency Departments

R Forero, K Hillman, G McDonnell, P Tridgell, N Gibson, P Sprivulis, M Mohsin, S Green, D Fatovich, S McCarthy, D Mountain, S Hoy, G Fitzgerald, D Richardson, F Daly, K Burton, A Celenza, P Nugus, J Burke, P Middleton, T Williams, J Braithwaite

Stakeholders

1. *Simpson Centre for Health Services Research, South Western Sydney Clinical School (Liverpool Hospital) and The Australian Institute of Health Innovation (AIHI), University of New South Wales, Level 1, AGSM Building (G27), Kensington Campus, Gate 11, Botany Street, Randwick, NSW 2052, Australia*
2. *Centre for Health Informatics, The Australian Institute of Health Innovation (AIHI), University of New South Wales, Level 1, AGSM Building (G27), Kensington Campus, Gate 11, Botany Street, Randwick, NSW 2052, Australia*
3. *Paul Tridgell Pty Ltd, Health Management Consulting, 5 Seville Place Kenthurst, NSW, 2156*
4. *Emergency Medicine, University of Western Australia (M516), 35 Stirling Highway, Crawley, WA, 6009*
5. *Clinical Excellence Commission of New South Wales, Locked Bag A4062, Sydney South, NSW, 1235, Australia*
6. *School of Public Health and Community Medicine, University of New South Wales, Level 3, Samuels Building, Randwick, NSW 2052, Australia*
7. *Department of Health of Western Australia, 189 Royal Street, East Perth, WA 6004.*
8. *Centre for Clinical Research in Emergency Medicine, Department of Emergency Medicine, Royal Perth Hospital and University of Western Australia, GPO Box X2213, Perth WA, 6847*
9. *Australasian College for Emergency Medicine, 34 Jeffcott Street, West Melbourne, VIC 3003, Australia*
10. *Emergency Care Institute, NSW Agency for Clinical Innovation, Tower A, Level 15, Zenith Centre, 821-843 Pacific Highway, Chatswood, NSW 2067, Australia*
11. *NSW Ministry of Health, 73 Miller Street, North Sydney, NSW 2060*
12. *School of Public health and Social Work, Queensland University of Technology, Victoria Park Road, Kelvin Grove, Qld, 4059*
13. *Australian National University and Canberra Hospital, ACT*
14. *Centre for Clinical Governance Research in Health, Australian Institute of Health Innovation (AIHI), University of New South Wales, Level 1, AGSM Building (G27), Kensington Campus, Gate 11, Botany Street, Randwick, NSW 2052, Australia*
15. *Royal Brisbane and Women's Hospital Department of Emergency Medicine, Bowen Bridge Street, Herston, Qld, 4006*
16. *NSW Australian Resuscitation Council and NSW Agency for Clinical Innovation.*

Summary

Background Access block and ED overcrowding are the most serious issues confronting EDs in the developed world, which compromise quality and timeliness of patient care. There is an urgent need to understand which policy interventions are most effective in reducing the impact of access block and overcrowding on patients. As part of its Health Reform Agenda, the Australian Federal Government announced plans in 2011 for a Four-Hour National Emergency Access Target (NEAT). The NEAT, defined as a target, requires that by 2015, 90% of patients must spend less than four hours in the emergency department (ED) from arrival to admission, transfer or discharge to reduce access block and overcrowding. The main purpose of this study protocol is to find out if this strategy has been effective without producing unintended effects elsewhere in the system.

Methods To assess in a natural experiment study design, outcomes and impacts of the NEAT policy intervention, where WA Hospitals, the early adopters of the NEAT, will be the intervention group and non-Western Australia hospitals the control groups. The study will first examine key patient outcomes before, during and after the implementation of the NEAT, and secondly investigate which strategies were implemented under the 4 hour rule program in WA compared to similar strategies in other Australian States and Territories. Data linkage techniques will be used to examine patient as well as hospital key performance indicators (KPIs).

Expected findings and Discussion A mixed methods approach will be used to address the study objectives. We anticipate that the findings will enable us to effectively assess the drivers of policy interventions at the hospital, state and national levels; to develop strategies to inform policy changes and translate this knowledge across systems in Australia and overseas.

Funding National Health and Medical Research Council Partnership for Better Health Grant, Australia; App 1029492; with cash contributions from the Australasian College for Emergency Medicine, NSW Ministry for Health, Western Australian Department of Health and Emergency Care Institute, Agency for Clinical Innovation, NSW Health.

Key words:

Policy intervention, National Emergency Access Target, (NEAT), Australia, ED, Four-Hour-Rule, patient, outcomes, evaluation, assessment.

Background

In the first decade of this century, Australia experienced a sustained increase of 77% in ED presentations, from 3.8 million to 6.7 million per year, and ED hospital admissions increased at an average rate of 3.4% per year. This was compounded by worsening levels of access block and ED overcrowding and difficulty in discharge capacity management as hospital occupancy rates remained over 90% in most Australian major public hospitals.[1-4] These are global and persistent problems. [1, 5-13] There have been multiple efforts to reduce these problems in Australia and overseas, but they remain intractable. [2, 4, 14-19] Previous evidence has demonstrated that interventions to reduce access block and ED overcrowding, without a whole-of-system approach, are unable to address the root causes of the problem and have been of limited value in the long term. [1, 3, 4, 20] . There has also been little conclusive data to show which interventions have been effective and whether they improve patient outcomes.[21-25]

It has been estimated that 20% and 30% excess mortality is attributable to access block and ED overcrowding.[6, 7] In particular, trauma patients; [26] patients in transit to ICU; [27-31] patients

requiring urgent pain treatment; [32] and people who presented to ED, but as a result of delays, did not wait (DNW) for treatment[33, 34] have been affected.

In 2000, the United Kingdom's Blair Government developed a health plan containing a version of the "Four-Hour Rule.[18, 19] In 2005, the NHS reported significant changes. The reasons included better management, more resources, changed work flows, faster admission to beds and wards, better discharge processes and a stronger (enforced) managerial commitment to removing bottlenecks. [14, 15, 35-37] However, there have been reports that the four-hour rule target put patients at risk. [38, 39] As a result, the four-hour rule has now been modified with much less emphasis on time targets in the UK.[14, 16] At the same time in Australia, the WA Government decided to gradually implement the four-hour rule program.[37] In 2009-10, the Australian Government decided to develop and implement plans for a Four-Hour National Emergency Access Target (NEAT) for Emergency Departments. It was ratified by the Council of Australian Governments (COAG) in February 2011. [16, 36]. As a result of these announcements, there was widespread public concern and fears that medical practice could be driven by management and financial imperatives rather than evidence based and patient centred practice.[40] Thus, this generated an urgent need to develop a uniform methodology for assessing interventions of national significance such as the NEAT program.

The aims of this project are to better understand the effectiveness of the NEAT policy intervention in order to target and implement strategies that justify investment costs, to avoid preventable negative consequences and to have tangible benefits for patients. An important aspect is to improve access to emergency care for patients and to reduce the harmful effects of access block and ED overcrowding. [1, 8, 35, 37, 41, 42] without transferring the problem to other parts of the system [20, 43, 44] Consideration of patient outcomes is one of the key elements of

this proposal because it is vital that implementation of ED throughput targets does not negatively impact on patient welfare. The aim of this article is to share the study protocol for future research at the national and international level; to develop a platform for future Australian partnerships amongst hospitals, health services, ambulance services and researchers to conduct collaborative research related to adverse patient outcomes in ED as well as crowding and access block (boarding).

Methods/design

Study objectives The primary objective of this natural experiment study design is to evaluate the effectiveness and outcomes of NEAT as a policy intervention and to identify strategies implemented under this program. This will allow for better targeted evidence based policies, avoid harmful effects from this intervention and allow program modifications over time. The secondary objectives are to develop a basis for a long-term management approach based on Western Australian data to identify and prevent potential harmful effects of access block and ED overcrowding on patients; to promote evidence based policy interventions for future research at the national and international level; to develop a platform for future Australian partnerships amongst hospitals, health services, ambulance services and researchers to conduct collaborative research related to adverse patient outcomes in ED as well as overcrowding and access block. It is expected that this project will be able to establish, validate and standardise the methodology to be used nationwide in future assessments of NEAT. The methodology could also be applied to specific interventions across Australian EDs, such as the impact on specific patient groups, staff and flow management as well as in New Zealand, UK, Canda and US. [13, 18, 19, 32, 33, 45-51]

Study design The project will use a multilevel approach to a natural experiment study design, using a reference point model data linkage methodology to explore the incidence rates of ED

presentations, demographic characteristics, procedures and other patterns of care of patients admitted through ED before, during and after the policy implementation of the 4 hour rule program in WA. In order to explore the association between selected outcome variables and possible risk factors and explanatory variables, the study will draw on bivariate, descriptive, multivariate and time series analyses taking into account the multilevel structure of the population. The study will also use mixed methods multilevel modelling to explain the variance at the hospital and State levels.

Phase 1 comprises a before and after data linkage study to test and refine the methodology; to systematically establishing parameters for assessing the impact evaluation of the 4 hour rule program in Western Australia. Phase 2 comprises the external validation of this methodology across Australian States with data linkage capability, namely Western Australia, New South Wales, Queensland and ACT.

Phase 1: Demonstration study in WA: With WA Health implementing the 4 hour rule program between 2009 and 2011, there is an opportunity to obtain data on the transition to the NEAT in that State.[37] This phase of the study focuses on the initial intervention in WA. The demonstration study will establish the data linkage methodology using administrative data to evaluate the health care policy implemented in WA under the 4 hour rule program, before and during the policy implementation (2007-2009 versus 2009-2011). We will also test the ability of the system to identify major adverse patient outcomes that are always measured and are able to be retrieved through data linkage. Potential confounders will be explored using statistical techniques such as multilevel analysis, propensity scores and incidence rates of procedures using the most recent advances and concepts in data linkage epidemiology such as nested case-control studies.[40, 45-48]

Phase 2: Proposed nation-wide implementation of the assessment: Having established the methodology in Phase 1, we propose to conduct a secondary analysis comparing WA before (14 April 2007- 13 April 2009) during (14 April 2009- 13 April 2011) and after the implementation (2011-2013) with other states. In addition, we will use the validated methodology to compare WA during the implementation (2009-2011) with the other states where the Four-Hour NEAT has not yet been implemented.

Hypotheses

Analyses of access block and ED overcrowding have centred on delays between units, departments and services in a networked system. The study will test the following hypotheses in relation to ED and other services:

1. The 4 hour rule program (WA) is effective in reducing access block and ED overcrowding on patients admitted to hospital.
2. The NEAT is effective in reducing ED length of Stay.
3. There is a direct association between ED overcrowding and increased patient morbidity and mortality in particular patient groups.

Research Questions

1. What are the differences in EDLOS and total ED access block before, during and after the implementation of the 4 hour rule program in WA?
2. What is the effect of admission delay from the ED on patient outcomes (short and long term) and which patient groups are most affected? In particular, is there a clear and repeatable relationship between EDLOS and adverse events including hospital mortality rates, and readmissions to hospital; after adjusting for Australasian Triage

Scale (ATS) category and age?

3. Is hospital LOS and patient mortality associated with reduction in the ED LOS achieved by the NEAT? Does reduced EDLOS, stratified by ATS category correlate with improved patient outcomes? What contextual factors and indirect or unintended responses to NEAT can be identified and which tools can be developed to manage the dynamics of this complex system?
4. What strategies that have been implemented in WA can be identified and implemented in other state and territory health systems?

Target Population

The target population is all patients admitted to hospital via the ED between 2007 and 2011 in participating hospitals in WA (Phase 1); and between 2007-2013 in WA and in participating states with data linkage methodology between 2007 and 2013 (Phase 2).

Data Collection

The data collection comprises two stages: the first stage comprises the combination and data cleaning of the data sets from WA, preliminary analysis and reporting to WA Health. This is anticipated to take up to 18 months. The project team will coordinate the data linkage and obtain all the permits required including ethic approval applications, data linkage applications, and overall data analysis.

A unique identifier number will be used to establish the linked data. Data linkage involves the process of amalgamating several independent data sets into one. Where relevant, data linkage will be carried out by the *WA Data Linkage Branch* of the WA Department of Health. After linkage has been completed, the research team will use the relevant databases for the study;

namely, *Emergency Department Data Collection (EDDC), Hospital Morbidity data (HMDC), Mortality database (MDB),* and Ambulance datasets: *Patient Health Care Records (PHCR)* and *Computer Aided Dispatch (CAD*).

Participating hospitals:

The data from the following hospitals in WA will be included in the analysis: Royal Perth Hospital (647 beds), Sir Charles Gardiner (587 beds), Fremantle Hospital (461 beds), and Princess Margaret Hospital (220 beds).[37]

Data sources

In WA we will use the *Emergency Department Data Collection (EDDC), Hospital Morbidity data (HMDC), Mortality database (MDB),* and Ambulance datasets. A data file for patients whose admission is delayed will be assembled from the already existing datasets in WA (Phase 1). [49] If available, additional data linkages will be sought to enable uniform measure of occupancy rates, ambulance data, X-ray, computer tomography (CT) and theatre data.

Data Analysis

We propose to conduct the analysis at two levels: Primary and secondary analysis. **The primary analysis** comprises early stages of data linkage, preparation of data dictionary and comparability analysis of key variables to be used in Phase 1 and 2. **The secondary analysis** comprises a systemic perspective of the potential impact of the NEAT policy implementation at different levels, namely Commonwealth, State and Hospital level.

Primary Analysis

We will use data linkage methods and systems to identify episodes of care of people admitted through the ED before, during and after the implementation of the 4 hour rule program in WA using a secondary study base approach. Data linkage/ethics applications, data cleaning and preparation of platforms for the analysis will take at least 12 months. Data analysis is anticipated to take another 12 months. Patient outcomes for the whole sample will be: ED LOS, access block, Inpatient Length of Stay, Hospital Readmission within 30 days, ED re-presentation within seven days, and 30 day mortality. Based on these variables, the analyses will take into account other factors that have an influence on patient outcomes such as: acuity (ATS), age, sex, ED presentation time and seasonal variation. The linked data set will be subject to descriptive, multivariate and time series multilevel analyses to address the research questions. Other measures could include DNW rate, and Medical Emergency Team (MET) calls in the first 24 hrs. We also need to adjust for comorbidities using the Multipurpose Australian Comorbidity Scoring System (MACSS). Key unintended harms could be on the staff, the patient experience, the carer experience, the pre-ED diversion and the cancellations in elective surgery and delayed transfers among wards ICU and theatres, and the diagnostic errors (misdiagnosis, missed diagnosis and delayed diagnosis) associated with spending less time in ED, also delays in treatment and staff errors due to behavioural responses to work pressure. Staff burnout might be a useful measure. Violations of diagnostic workup and initial treatment protocols might also occur.

Multilevel Analysis.

Multilevel means that the intervention outcomes will be explored at the following levels, with the following indicators:

Level 3: Hospital: The sample comprises 4 participating hospitals in WA. Hospital-level indicators will include: Occupancy rate, Ambulance diversion, Ambulance ramping, ED bed

capacity/hospital ratio, and ED presentation/ED admission ratio; and Occupancy rates (defined as the average number of occupied beds divided by the average number of available beds per year multiplied by 100%). We will also explore another definition of occupancy rate, defined as: "Occupancy Rate is the number of "Inpatient Days" divided by the number of "Bed Days", where "bed days" equals number of "staffed beds" multiplied by number of days/hours in the reporting period." We will compare both definitions to assess its reliability and comparability.

The occupancy level will be calculated daily during Stage 1 of the data collection (midnight census). Access block occupancy rates will also be calculated at the same time every day using the ACEM Access Block point prevalence survey methodology.[50, 51] Other hospital-level indicators are: Ambulance diversion at time of arrival (Yes/No, Not applicable); and access block occupancy, defined as the proportion of access blocked patients in the ED (number of patients awaiting admission for > 8 hrs from arrival to discharge in all States, followed by examination of the four-hour targets for each of the sites and a four-hour NEAT comparison) continuous over 24 hours.

Level 2: Hospital Interventions. To measure the internal consistency of interventions conducted in hospitals, the project will identify contextual factors and interventions used in each hospital during the study period, such as hospital type, bed occupancy rates, staffing levels, number and characteristics of 4-hr NEAT policy changes designed and/or implemented.

Level 1: Patient level. This study will use ICD 9/10 Codes to measure co-morbidities including the Australian Comorbidity Scoring System. Patient level outcomes include: age;

gender; individual hospital length of stay (LOS), in hospital mortality (Yes/No); 30-day mortality (Yes/No); 7-day readmission to the ED (Yes/No); EDLOS (in hours); hospital readmission within 30 days (Yes/No); comorbidities (MACSS): total access block time (total time from ED arrival time to ED discharge). ICD9 codes will be needed because in other States other than WA may be in use. In addition, there is some information that we would like to collect but may not be readily available such as unexpected admission to the ICU (Yes/No); in hospital cardiac arrests (Yes/No); medical emergency team (MET) calls (Yes/No); and ambulance delay time (from time of arrival to hospital to off-stretcher time (in minutes) and hospital LOS (in hours or days).

Secondary analysis

At the secondary analysis level, we need to use the data and information obtained to combine qualitative and quantitative methods using a systems perspective. In relation to the qualitative component, we will explore factors that can impede or improve patient flow, using ethnographic observations or interviews. This will be based on previous research conducted by members of the research team [52-56]. See Table 1.

[Insert Table 1 about here]

Health systems research has recently been identified as a priority. [57] We expect that this research project will be able to translate the evidence in a way that can be used by policy makers. Computer simulation can be used to test whether a policy such as the NEAT will actually result in improvements in the right places and at the right times and the dependence of outcomes on contextual factors [58-62]

The first step is to identify and define opportunities for improvement. We will use a conceptual model of process data relevant to the ED, using an event analysis approach to ED.[58, 63] This will produce a concept map representation of the main concepts, their relationship and a clear statement of the variables of interest. For this purpose, we will use data dictionaries from existing linked data from WA,[49] NSW[64] and NZ. [11] Following the development of the concept map, the next step is to develop a Stock Flow representation of the dynamic process, from presentation to discharge within the NEAT policy framework similar to the one illustrated below.

[Insert Figure 1 About Here]

The second step will include building a computational model with iterative simulation testing and evaluation. In this phase we build a computational dynamic model from the qualitative static concept map. In this phase we will address the conceptual validity, structural and behavioural verification and simulation verification of the model. [58] Virtual experiments will be conducted to explore patient flow before and after the four hour rule intervention. In this phase we design and perform virtual experiments to test and mitigate the effects of our future interventions.

The third step will include integration and communication of insights and results. These simulated learning environments can be refined to provide more realistic decision-making challenges (the real test is whether the model will help to make better policy and practice decisions). We need to test how these broader simulations can improve dynamic models in various contexts and improve both systems design and individual contexts.

In addition, a systems approach[58] will be used to provide the basis for developing a strategy which, when implemented, would be highly likely to address the situation of interest as intended while minimizing the likelihood of unintended consequences. The key features of this systems perspective are:

[Insert Figure 2 about here]

Situation. A situation of interest considered warranting attention, along with an assessment of the implications of not acting, and a definition of the preferred alternative situation, forms the basis for developing understanding.

Behaviour. The patterns of behaviour represent an unfolding of some aspects of a network of interactions. As such we endeavour to understand the network of interactions responsible for creating the patterns of behaviour.

Interactions. The network of interactions is the result of some set of actions by one or more stakeholders. As such we endeavour to understand the mental models and motivations of the stakeholders responsible for the situation.

Stakeholders. We seek to understand the motivations and the mental models of the stakeholders and the motivations and mental models of those stakeholders who are influenced by the network of interactions.

Boundary. Based on an understanding of the network of interactions and stakeholders boundaries are established to keep track of which stakeholders are responsible for which aspects of the network of interactions and which set of interactions are considered to be part of the addressable network of interaction.

Challenge Assumptions. It is important that we challenge those assumptions because decisions made on invalid assumptions are unlikely to support the unintended results.

Leverage Points. It is essential to identify those leverage points which are likely to transform the current situation into the desired alternative situation.

Strategy. Unintended consequences are typically the result of actions taken without appropriate due systemic consideration.

Discussion

Demand for acute hospital services is increasing. Without effective interventions, the proportion of admission delays from EDs is likely to increase and most admitted ED patients are likely to be affected by access block. A better understanding of the effect of admission delays from the ED on different populations and types of patients is required in order to develop long-term sustainable policy and practice interventions. This is important for policy makers, administrators, researchers, clinicians and patients. We particularly need to gather evidence on the effectiveness of recent and current interventions, and on the capacity of interventions to improve flow and data exchange between agencies, such as ambulance services, EDs, hospital wards, theatres, and radiology departments. Most importantly we need to know which interventions actually reduce patient harm from overcrowding, rather than just refining KPIs.

The project will provide the foundation for a long term partnership at the National and State levels and will enable the partnership to provide a significant contribution to understanding the effects of access block and ED overcrowding and how to ameliorate their impact on patient outcomes. Specifically, the project will estimate the adverse effects on patient outcomes that are associated with admission delays from ED after controlling for system overcrowding (multi-level analysis) and assess evidence-based interventions to reduce access block.

The significance, overall feasibility, and innovativeness of the proposed project are strengthened through the convergence of several factors, including: recognized research leadership in access block and ED overcrowding within the investigator team; highly developed partnerships between the UNSW and WA research institutions; the implementation of a long term partnership project to assess interventions, including considerable in-kind contribution from all partner organisations; and the potential of the project to provide significant knowledge needed to prevent the escalating burden of access block and ED overcrowding in Australia.

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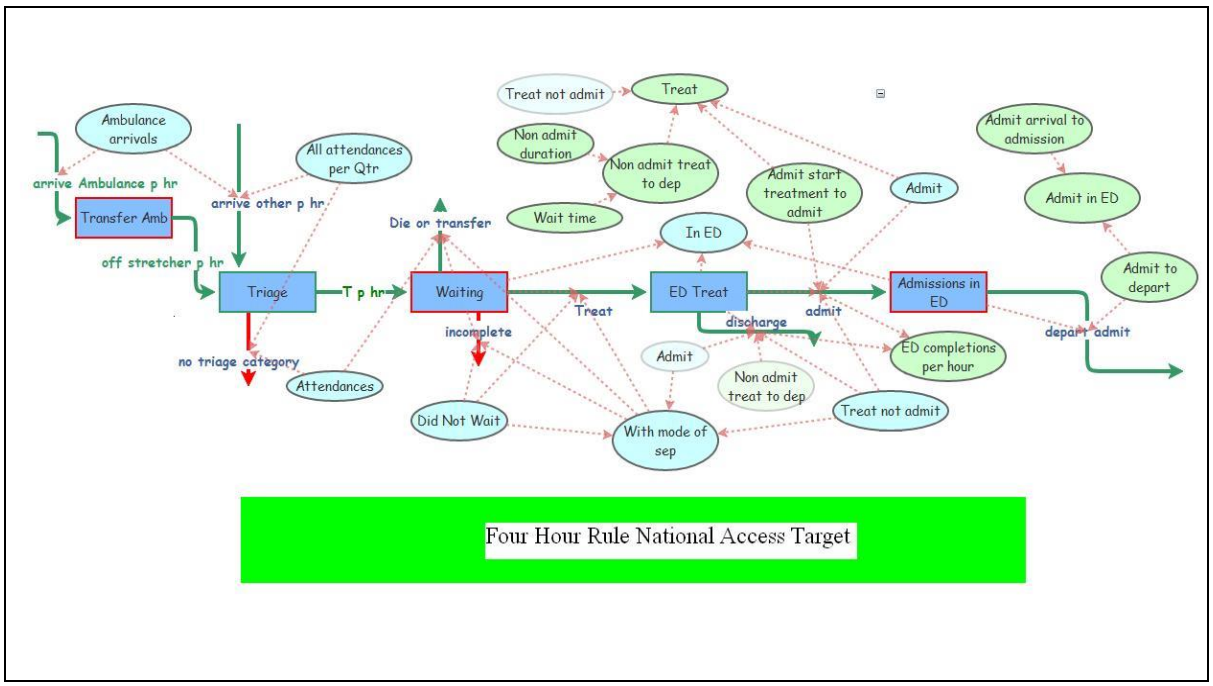
Ambulance arrivals
arrive Ambulance p hr
Transfer Amb
off stretcher p hr
arrive other p hr
All attendances per Qtr
Triage
T p hr
no triage category
Attendances
Waiting
Die or transfer
incomplete
Did Not Wait
Treat not admit
Treat
Non admit duration
Non admit treat to dep
Wait time
Admit start treatment to admit
Admit
In ED
Treat
ED Treat
discharge
admit
Admit
Non admit treat to dep
Treat not admit
With mode of sep
Admissions in ED
ED completions per hour
Admit arrival to admission
Admit in ED
Admit to depart
depart admit
Four Hour Rule National Access Target

Figure 2. Systems thinking approach to the four hour rule implementation program.

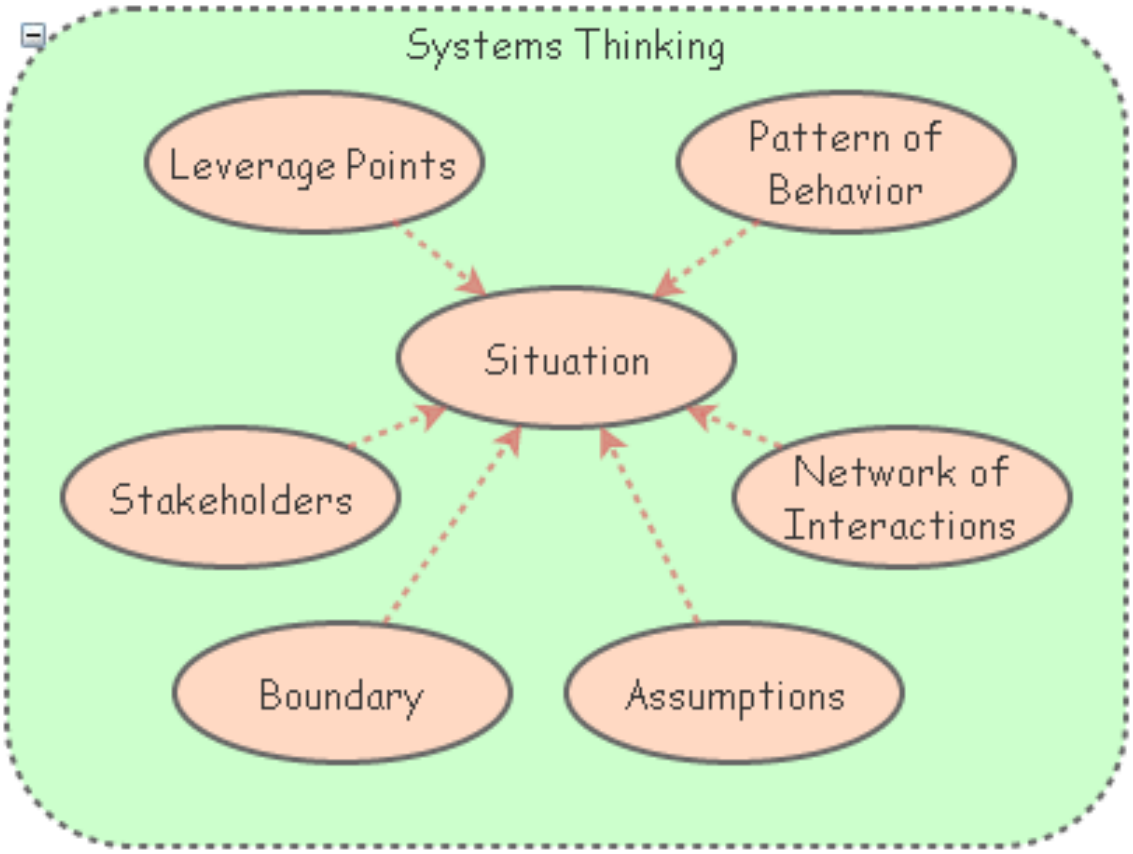

Table 1. Qualitative factors that influence the achievement of the four-hour rule

Factor	Themes to be explored or analysed at the hospital level
1	Communication skills of senior emergency doctors and nurses.
2	Training of junior emergency doctors and nurses by emergency seniors.
3	Strategies for implementing policy changes across hospital departments and specialties. The need to ration and, hence, manage time, space and human resources in the ED.
4	Strategies to transfer to general-system specialties."Dischargeability" – capacity to be safely discharged, as a preference over inpatient admission, if possible. Decreased relative interest in accepting older ED patients onto wards, in accordance with the "single-organ structure" of most of the hospital. For example, differences in timing, work and organisational patterns from between the ED and other hospital departments. Degree to which emergency doctors have "admitting rights" in particular hospitals.
5	Cultural changes and philosophical clash between ED and of other health systems. Different views between the ED and other hospital departments on the role of the ED (diagnosis versus "work up" versus management plan)
6	Competing priorities and interests of emergency nurses and nurses in some other hospital departments (e.g. needing fast throughput; preferring to see different patients; identity as "adrenalin nurses")
7	Hospital's organisational culture. Does it have the characteristics of a high performing organisation? E.g., Clear shared values; patient focused; Action orientated culture; succession planning.
8	Identify and develop an Essential Criteria, such as: •Quality improvement and patient focus throughout the program from inception •Ambitious timeframes to drive change •Use of a redesign methodology and project management (don't jump to solutions) •Standardised reporting and support structures via a central team; an 'impartial' reference point for sites and executives
9	Identify strong and visible Leadership. This may include devolved leadership and decision-making and clear leadership and management training
10	Other critical issues such as: absolute transparency about performance; Decisions based on data and clear roles and lines of accountability and evidence of integrated teamwork