APPLICATION OF SIMULATION AND MODELLING IN MANAGING UNPLANNED HEALTHCARE DEMAND

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ABSTRACT

Patients who attend Accident and Emergency (A & E) departments with problems that could be dealt with by their general practitioners (GPs) use time and resources of the department that could be otherwise used for patients with more appropriate needs. Hospital managers throughout the world are facing increasing pressure to introduce measures and initiatives to significantly ease the problem of such inappropriate attendances at A&E departments. This study looks at an initiative in which primary care clinicians are used to help deflect patients with non-urgent needs away from A&E. Simulation and modelling was used to assess the impact that this initiative would have on A&E workflow. The results suggest that the deflection of patients attending A&E with non-urgent needs may reduce the time spent in A&E by all patients attending A&E.

KEYWORDS

Demand management, discrete event simulation, patient deflection

INTRODUCTION

Accident and Emergency departments (A&E) are designed to provide medical treatment to those who need urgent or emergency care. However, many studies in the UK (Martin et al., 2002; Sanders, 2000; Patton and Thakore, 2012) and abroad (Van Uden and Crebolder, 2004; Jiménez et al., 2005; Sempere-Selva et al., 2001; Murphy et al., 2000) have found that some of the patients attending A&E do not require urgent or emergency treatment, and that such patients could have been treated in primary care settings (Dale, 1992). Inappropriate use of the A&E is considered to result in overcrowding (Shih et al., 1999) and to contribute substantially to increased costs (Baker et al., 1994) and to decreased quality of care (Derlet and Richards, 2000). Other studies have also looked at attendance patterns and they have found that there may be a relatively small number of patients that use A&E frequently and that such patients may constitute a considerable proportion of the total number of visits (Huang et al., 2003; Okuyemi and Frey, 2001; Olsson and Hansagi, 2001).

This paper assesses the benefits of a patient deflection scheme in which primary care clinicians and A&E Triage nurses work together as gatekeepers at the front of the A&E department. This scheme draws on strengths of a number of different initiatives that have been suggested in literature. Under this deflected scheme, patients are triaged upon arrival by A&E personnel and any suspected non-urgent cases are re-directed to primary care clinicians located adjacent to A&E. The primary care clinicians facilitate the deflection of patients with non-urgent primary care needs and they provide treatment only in those cases where the patient has urgent care needs. The main role of the primary care clinicians is to inform and

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educate patients with non-urgent needs on the primary care services provided in the community and to then redirect such patients to the appropriate primary care services.

Simulation modelling was used in this study to evaluate the impact of the patient deflection scheme on the workflow of an A&E department. The proposed scheme will be compared against a benchmark scheme in which patients with non-urgent needs are not deflected but are instead treated within A&E. The simulation models used in this exercise were developed based on publically available data of A&E departments in North-West England. The results suggest that the proposed scheme may reduce the time spent in A&E by patients with emergency or urgent needs. This study considers only the operational benefits in terms of time spent within A&E; the clinical feasibility of the proposed scheme was not assessed at this stage and more work is required to verify the safety of such a scheme.

RESEARCH BACKGROUND

Studies both in the UK and abroad indicate that a considerable proportion of patients attending A&E could be managed as well by general practitioners. Factors that have been shown to determine why patients choose A&E over general practice are travelling distance, lack of knowledge of the range of GP services, perceived need for immediate attention, and more advanced technology (Siminski et al., 2005; Smith and Roth, 2008). Other patients (for instance, visitors or the homeless) may also attend A&E because they are not registered with a GP. Addressing the problem of inappropriate attendances at A&E presents a challenge because patients, general practitioners (GPs) and A&E personnel may not agree on what constitutes 'appropriate' care within A&E. As others (Murphy, 1998; Carson et al., 2010) have pointed out, there is no widely accepted definition, either in literature or on in practice, of what should be considered 'appropriate' care or an 'emergency'. The decision as to whether an attendance is appropriate is usually made prospectively by A&E personnel based on medical grounds (i.e. based on the assessment and treatment that was provided to the patient). However, the decision to attend A&E instead of consulting a GP may depend not only on medical need but also the social circumstances in which illness occurs (Smith and Roth, 2008; Carson et al., 2010). GPs and A&E personnel may also disagree on what constitutes 'appropriate' care and, as a consequence, A&E personnel may consider some of the GP referrals as inappropriate (Chew-Graham et al., 2004). This problem suggests that it might be helpful to have a shared agreement on what constitutes inappropriate care. Others (for example, Chew-Graham et al., 2004) have advocated a shift away from the view that individual patients were 'inappropriate' to a focus on the system and service deficiencies. According to this view, the questions that should be considered is whether the health services available are 'appropriate' to meet the current demand for healthcare services.

Given that there is accepted definition of what constitutes an appropriate attender to an A&E department, it is not surprising that there is enormous variability regarding the proportion of visits that are considered inappropriate in the various studies in literature. One review of the literature in this area (Murphy, 1998) found that estimates ranged from 6% to 80%. A more recent study (Carson et al., 2010) applied a consistent definition for inappropriate attendances, the definition being those cases that are regularly seen in general practice. The proportion of patients attending A&E with primary care type conditions was estimated in this study to range from 10% to 30%.

Initiatives for managing inappropriate attendance can be placed in two broad categories. The first category includes initiatives that attempt to facilitate the treatment of such patients in A&E. Such initiatives include providing primary care services (Van Uden and Crebolder,

2004; Jiménez et al., 2005; Murphy et al., 2000; Kool et al., 2008) or pathways to social care within A&E (Brady et al., 2000; Gordon, 2001; Bywaters et al., 2002). All these initiatives represent, to some extent, a redrawing of the boundaries between A&E and primary/social care. The second category includes initiatives that aim to deflect away from A&E patients that do not require emergency or urgent care. With these initiatives, the boundary between primary and secondary care is preserved. Beyond the question of whether to deflect or to treat, there is also a growing recognition that if the right alternative services were in place then inappropriate attendances at A&E could be reduced (Chew-Graham et al., 2004). Efforts in this area might included greater provision of GP services 'out of hours' (van Charante et al., 2007; Van Uden et al., 2005) and better co-ordination between services provided by different agencies (Carson et al., 2010).

Cooke et al. (2004) have suggested that, while individual initiatives may reduce inappropriate attendances, there might be scope for achieving even greater success by adopting multiple initiatives. They also pointed out that simulation modelling might be helpful in identifying where changes can be made and in testing the effects of those changes. This study uses simulation modelling to assess the operational benefits of a proposed deflection scheme that attempts to bring together the beneficial features of a number of individual initiatives. The next section explains how the proposed deflection scheme compares with some of individual initiatives that have been suggested in literature.

METHODOLOGY

This study was carried as part of a research project on the management of unplanned care where 'unplanned care' is defined as any unplanned contact with the NHS by a person requiring or seeking help, care or advice. A summary of this project can be found in Marshall-Ponting et al (2012). Unplanned care includes unplanned attendances at A&E and emergency into hospitals. One of the objectives in this research was to identify initiatives for reducing inappropriate attendances at A&E. A three-step process was used to identify such initiatives. Firstly, a review of the literature in this area was carried out and the strengths and weaknesses of the various initiatives suggested in literature were identified. Following on from this exercise, an attempt was made to develop 'hybrid' initiatives that build on the strengths of the suggested initiatives while also mitigating their weaknesses. The deflection scheme proposed in this study is one such hybrid initiative. Finally, a simulation study was carried out to assess whether the scheme would lead to a reduction in the time spent in A&E by the patients. Subsection 3.1 below will provide a brief summary of the various initiatives for managing or reducing inappropriate attendances that have been suggested in literature. Subsection 3.2 will explain how the proposed deflection scheme draws on strengths of the suggested initiatives. Later on in the next section, a simulation exercise will be carried out in order to compare the performance of the proposed deflection scheme against an alternative scheme in which inappropriate attenders are not deflected but are instead treated within A&E. In this exercise, performance will be assessed in terms of times spent by patients in A&E.

3.1 Literature overview of the suggested initiatives for managing or reducing inappropriate attendances in A&E

A literature review was carried out in order to get a better understanding of the contributions that have been made in this area. Cooke et al. (2004) have carried out a literature review of the studies that have examined initiatives for reducing inappropriate attendances at A&E. However, there have been other studies since this review was carried out. Carlson et al (2010) have also carried out a review exploring the interface between primary and emergency care in

England. Based on the literature review that was carried out for the purposes of our study, the initiatives that have currently be suggested in literature can be broken down into five broad categories as indicated in Table 1 below. Within each of the categories, there may be considerable variability in the initiatives in terms of the clinical and operation protocols, resources committed and other factors. This should not be surprising since individual hospitals develop measures and initiatives to suit their own circumstances. The categories are discussed in more detail below.

Table 1 - Classification of initiatives for managing inappropriate attendance at A&E

Category	Description
A	Deflection by A&E personnel
B	Managing patients within A&E
C	Educating the public not to use A&E inappropriately
D	Improving co-ordination between A&E, primary care and social services
E	Making primary care more accessible for patients

3.1.1 Deflection by A&E personnel

With these initiatives, the aim is to prevent patients with non-urgent problems receiving treatment from the emergency department. Upon arrival, patients are triaged and only those patients assessed as requiring emergency or urgent treatment get referred to an A&E department. The decision to deflect is usually made by an A&E triage nurse. By deflecting patients with non-urgent problems, such initiatives allow A&E personnel to focus on acute cases where their expertise are most valuable. Moreover, the waiting times for the patients treated in A&E may fall as a consequence of the lower throughput. However, there is an inherent risk that A&E personnel may make the wrong judgement and deflect away from A&E patients who truly need urgent care. In such cases, the quality of care may compromised and the patient's safety may be endangered. Patients and GPs may also not agree with the deflection guidelines set by A&E and this may lead to conflict and distrust between the different parties.

Some studies (Van Uden et al., 2005; Piehl et al., 2000) have found that deflection may lead to an increase in primary care attendance and a decrease in A&E attendance but others (Washington et al., 2002) have found no such evidence. Studies on the safety of redirecting patients have found no evidence of such measures having detrimental effects on patient health (Gadomski et al., 1995; Washington et al., 2002).

3.1.2 Managing patients within A&E

This category includes all those initiatives in which GPs are placed within A&E or alongside A&E (either as an on-site walk in centre or GP out of hours service). All patients arriving at A&E are treated by the GPs on site. In some cases, the patients are triaged and patients with non-urgent needs may be given lower priority. Alternatively, such patients may be sent down a separate ('fast-track') stream dedicated for primary care cases. These initiatives are likely to lead to higher throughput in A&E and higher staffing levels may be required. The provision of primary care services at A&E may also encourage patients with non-urgent needs to attend A&E rather than their own GP.

The evidence in favour the initiatives in this category seem to be mixed. Some studies have reported a number of benefits including fewer investigations requested (Murphy et al., 1996; Dale et al., 1996), fewer prescriptions issued (Dale et al., 1996), fewer referrals (Dale et al., 1996), reduction in A&E attendance (Van Uden et al., 2005), fewer hospital admissions (Van Uden et al., 2005; Jiménez et al., 2005) and increased patient satisfaction (Jiménez et al., 2005). Others found that there is no differences in the number of prescriptions issued (Gibney et al., 1999) or in the number of referrals (Murphy et al., 1996). The contradictory findings may be explained by the differences between the studies in terms on study design, study lengths and the samples being considered.

3.1.3 Educating the public not to use A&E inappropriately

This category includes campaigns launched in order to encourage the public to confine their attendance at A&E to emergency or urgent conditions that require hospital treatment. The campaigns will usually seek to inform the public that inappropriate attendances at A&E may endanger the lives of other patients' worth more urgent needs. Such campaigns may also highlight the financial cost of inappropriate attendances. The benefit of patient education is of unproven in most areas except chronic disease management (Scherer and Bruce, 2001; Gibson et al., 2002). There is little empirical evidence that general educational campaigns significantly reduce the number of inappropriate attendances at A&E. A number of studies (including Murphy et al., 2000 and Rector et al., 1999) have found that there was little change in A&E attendance patterns following public engagement campaigns.

3.1.4 Improving co-ordination between A&E, primary care and social services

A number of authors (Chew-Graham et al., 2004; Carson et al., 2010) have pointed out that the problem of inappropriate attendances can be reduced by having better co-ordination between A&E and primary care and social services. Patients who attend A&E because of mental or social problems or lack of primary care services can be re-directed to the appropriate services. A&E and GPs can also improve co-ordination by negotiating an agreed set of guidelines identifying the conditions that warrant a visit to A&E (Chew-Graham, 2004). In some case, GPs may refer a patient to A&E but A&E personnel may be of the opinion that the patient's needs are non-urgent. There should also be a clear clinical and operational governance process specifying the party that is responsible to provide care for a patient in any given case (Carson, 2010).

3.1.5 Making primary care more accessible for patients

A number of initiatives have been introduced to make primary care more accessible to patients. These include walk in centres, minor injury clinics, telephone advice lines and longer GP out-of-hours services. There is a number of studies that have been carried out in order to determine the impact of these initiatives on A&E utilisation. However, most of the studies were carried out more than ten years ago. The evidence in favour of the different initiatives seems to be mostly mixed. Walk in centres and minor injury clinics have not been demonstrated to reduce attendances at emergency departments. (Coleman et al., 2001; Dale and Dolan, 1996; Salisbury et al., 2002; Chalder et al., 2003) The other initiatives seem to have fared better. A number of studies (Heyworth and Egleston, 1998; McLauchlan and Harris, 1998; Stoddart et al., 1999; Van Uden and Crebolder, 2004) that have found that the introduction of out-of-hours primary care services can lead to a significant decrease in the number of non-urgent patients attending A&E. There is also evidence that telephone advice lines such as NHS Direct are effective in reducing inappropriate attendances in A&E (Jones

and Playforth, 2001; Munro et al., 2000). However, Bunn et al. (2005) found that telephone advice lines did not have any significant effect in their study.

3.2 The benefits of the proposed deflection scheme when compared with the initiatives suggested in literature

One of the questions that arose during the literature review was whether it was possible to develop hybrid initiatives that incorporate the best from a number of different initiatives while at the same time alleviating their weaknesses. The proposed deflection is one such initiative. As Figure 3 below illustrates, the proposed scheme adopts some of the best features of the initiatives in categories A to D. In particular,

- Patients with non-urgent needs are redirected from A&E, thereby reducing throughout in A&E. If resources in A&E are maintained, then the reduction in throughput may possibly translate into shorter waiting times for the more urgent cases treated within A&E. With A&E personnel freed to concentrate on those cases that require their expertise, there may also be a benefit in terms of improved morale among the A&E personnel.
- Primary care clinicians facilitate the deflection of patients with non-urgent needs. They also ensure that the patients deflected do not have urgent clinical needs and that their safety is not endangered. Treatment is only provided if the primary care clinicians feel that the patient has urgent needs. With the provision of primary care services limited, there is less incentive for patients with non-urgent needs to attend A&E. The primary care clinicians also make GP appointments for patients with non-urgent needs and they follow up on the patients to determine if the attended the GP appointment. Some studies (Smith et al., 2001; Lanter et al., 2001a; Lanter et al., 2001b) have found that patients failing to attend their GP appointments after an A&E attendance are more likely to re-attend the A&E.
- The primary care clinicians educate patients with non-urgent needs on the appropriate use of A&E and inform them of the primary care services available in the community.
- The primary care clinicians can facilitate better co-ordination between A&E and GPs. A periodic review of the deflection decisions made the A&E personnel and primary care clinicians may help GPs and A&E personnel to better understanding each other's perspectives and to appreciate the inter-dependency between A&E and primary care. A number of authors including (Dattée and Barlow, 2010) have highlighted the importance of considering the inter-dependency between different parts of the healthcare system. With both A&E personnel and primary care clinicians involved in the deflection decision, there might also be an opportunity for A&E and primary care professionals to narrow their differences on the type of conditions that should be considered appropriate for A&E.

The proposed scheme is also likely to less costly than initiatives in category E such as walk in centres and minor injury units. These initiatives may offer considerable benefits but these benefits will have to be weighed against the level of additional investment required. Cooke et al. (2004) have acknowledged the benefits that such initiative may offer in terms of greater patient choice. However, they also point out that the greater choice may lead to confusion among patients when they are trying to decide between alternative health care services.

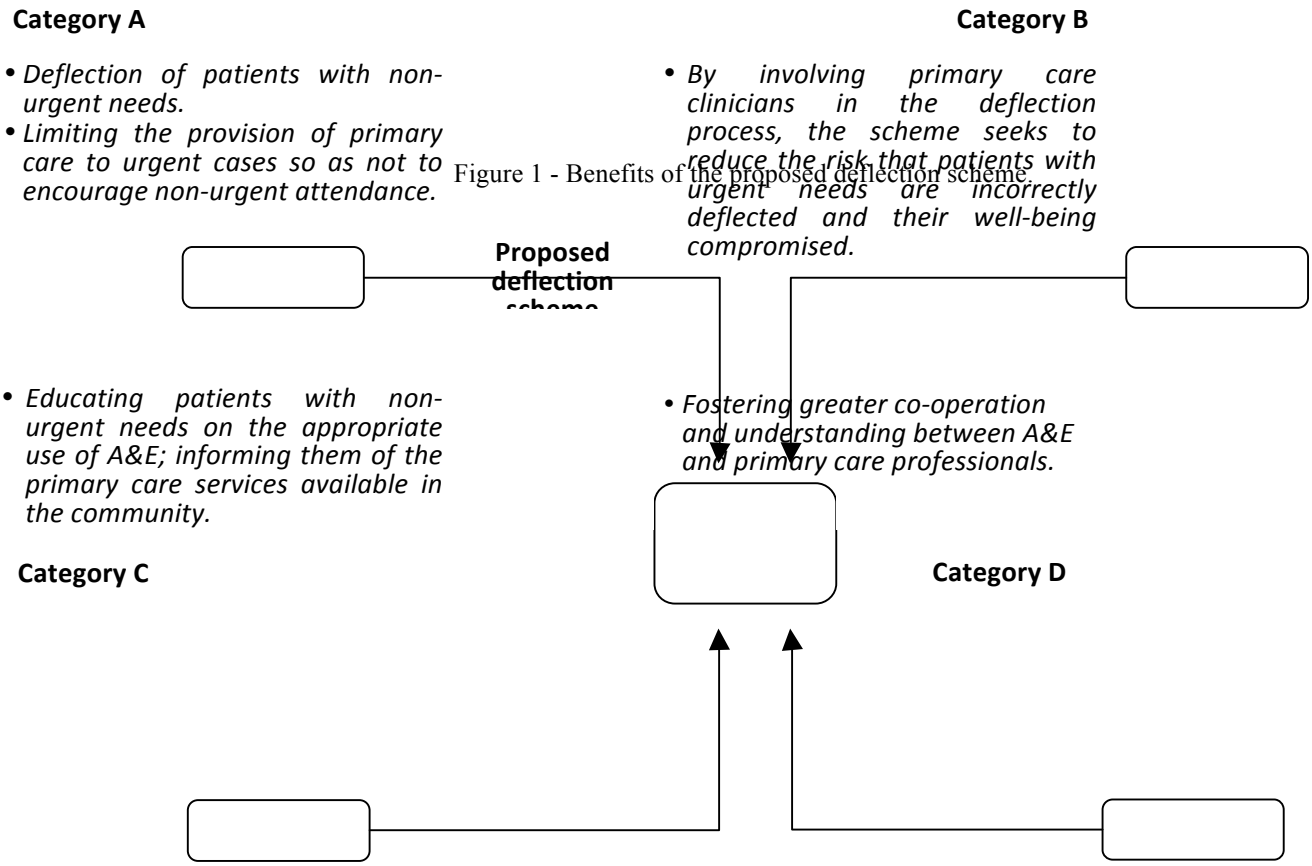


Figure 1 - Benefits of the proposed deflection scheme

SIMULATION MODELS AND RESULTS

A discrete-event simulation (DES) model was developed, using a Simul8, to assess whether the proposed scheme would lead to reductions in the times spent by patients in A&E. The data used in the model was based on health episode statistics (HES) for a major A&E department in Greater Manchester. Patients attending A&E were divided into five triage levels as illustrated in Table 2 below. Patients with non-urgent needs were placed in Level 5. The proportions of patients in Levels 1, 2 and 3 were kept the same throughout the study. The sum of the proportions of patients falling in Level 4 and Level 5 was also kept constant at 60%. The impact of inappropriate attendances on the times spent by patients in A&E was evaluated by varying the proportion of patients falling in Level 4 and Level 5. Seven different values for the proportion of patients in Level 5 were used, ranging from 5% to 20% in increments of 2.5%. This range is quite conservative when compared to the estimates that have been given in literature. The performance of the proposed scheme is therefore being assessed under conditions that are exceptionally favourable to this scheme.

Table 2 - Triage system

Triage	Description	Share of patient population
1	Emergency	1%
2	Very urgent	10%
3	Urgent	29%
4	Standard	Remainder
5	Non-urgent	5%, 7.5%, 10%, 12.5%, 15%, 17.5%, 20%

Two different schemes were considered in this study and a schematic of the patient flows in the two scheme is given in Figure 2 below. In the first scheme (also known as the Benchmark scheme), patients arrive at A&E and they are registered at the reception. An A&E nurse then

Arrival

Minors

Registration

carries out triage based on the five-level triage system given above. Once the patients are triaged, they are then directed to the appropriate A&E department ('Paediatrics' for all under-17s, 'Major/Resuscitation' for all adults in Levels 1 and 2 or 'Minors' for all adults in Levels 3 to 5). All patients (including Level 5 patients) are treated within A&E. After receiving treatment, patients are then discharged or admitted. The second scheme is the proposed deflection scheme described the previous section. The proposed deflection scheme is the same as the Benchmark scheme, the only difference being that, in the former scheme, all Level 5 patients (including under-17s) are deflected away to the primary care clinicians.

Triage

Majors/Resus

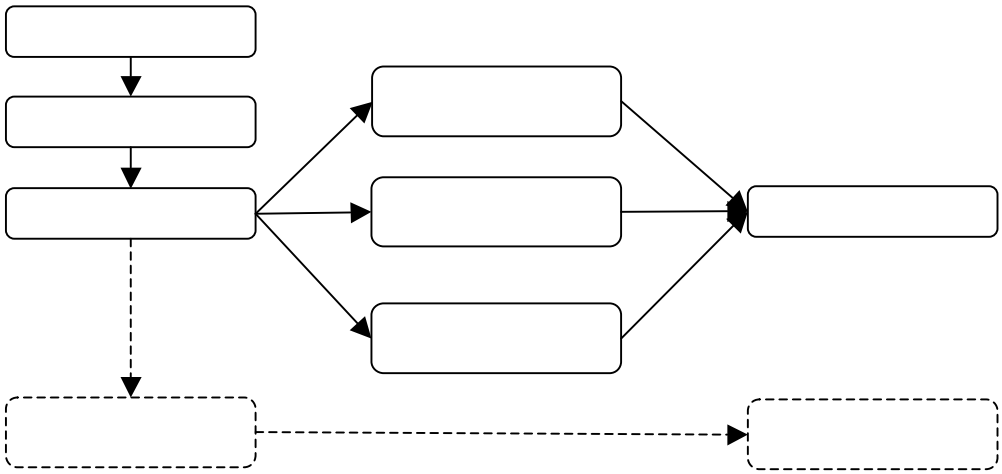
Discharge/Admit

Paediatrics

Primary Care Clinicians

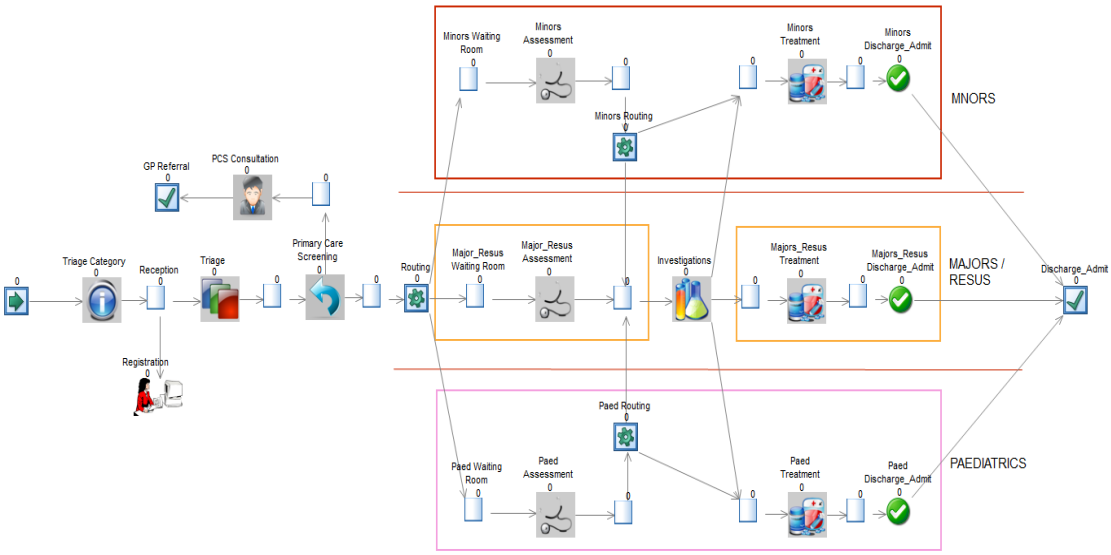
GP Referral / Discharge

Figure 2 - Schematic of patient flows in the simulation model



The schematic of patient flows above was used to develop a DES model of the two schemes. A screen print of the model is given in Figure 3 below. The arrival rates and process times used in this model area again based on HES data. For the patients deflected away from A&E, the consultation times with the primary care clinicians was assumed to take between 5 minutes and 15 minutes.

Figure 3 – Screen print of the DES model



The model was run for each of the seven different values for the proportion of patients in Level 5. The result of interest in our study was the average time spent in A&E by the patients in each the five triage levels. Figures 4.1 to 4.5 show plots of the average time spent in A&E against the proportion of Level 5 patients attending A&E. Separate plots are given for the five triage levels. The results suggest the average times spent in A&E under the proposed scheme are lower than the average times under the Benchmark scheme. The average times under the Benchmark scheme remain roughly the same regardless of the proportion of Level 5 attending A&E. This is not surprising given that, despite the changes in the proportions of Level 4 and Level 5 patients, the total throughput in A&E remains the same under the Benchmark scheme.

In contrast, under the proposed scheme, the average times spent by patients in Levels 1-4 fall as the proportion of Level 5 patients attending A&E increases. Again, this is not surprising since the throughput in A&E falls as more Level 5 patients are deflected. As the proportion of Level 5 patients arriving at A&E increases, the time spent by these patients in A&E increases. Primary care clinician time becomes a limiting factor and Level 5 patients will have to queue longer before they get their consultation with the clinicians. It is worth pointing out that, even though Level 5 patients are denied treatment in A&E under the proposed scheme, they spend considerably less time in A&E than would be the case under the Benchmark scheme. Circumstances may vary from patient to patient but, for some of these patients, a set appointment with their GP at a later time may be preferable to queuing up for treatment in A&E. A survey of the preferences of the Level 5 patients on this question would be helpful.

The results from this study suggest that the proposed scheme may reduce time spent in A&E by patients requiring A&E treatment (i.e. Level 1-4 patients) at the expense of patients with non-urgent needs (Level 5 patients) who are deflected away from A&E. In clinical terms, the benefits of providing treatment more quickly to Level 1-4 patients may outweigh the inconvenience faced by Level 5 patients under the proposed scheme. In the next step of our research, consultations will be held with clinicians to assess the clinical feasibility of the proposed deflection scheme.

Figure 4.1 - Time spent by Level 1 patients in A&E

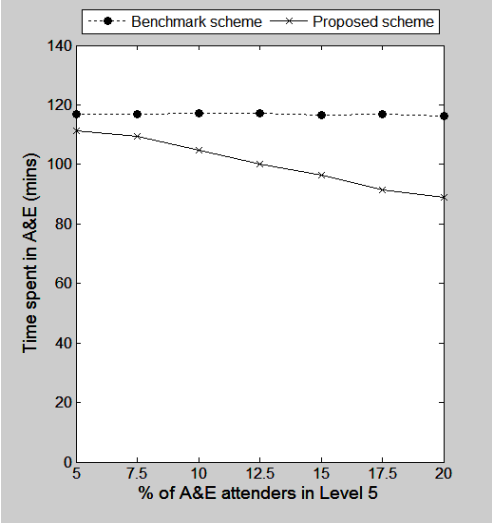


Figure 4.2 - Time spent by Level 2 patients in A&E

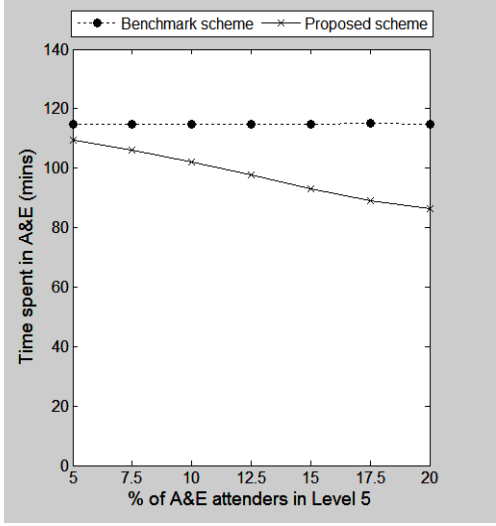


Figure 4.3 - Time spent by Level 3 patients in A&E

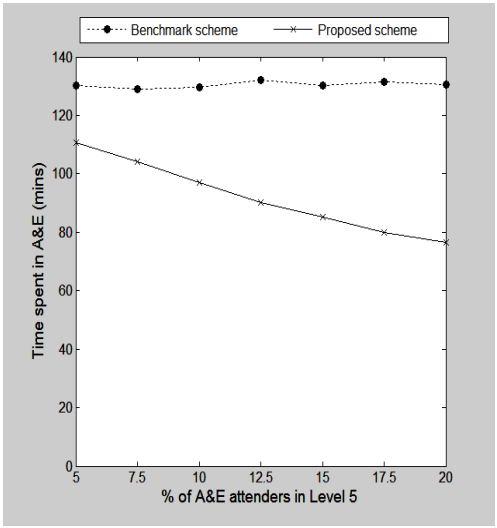


Figure 4.4 - Time spent by Level 4 patients in A&E

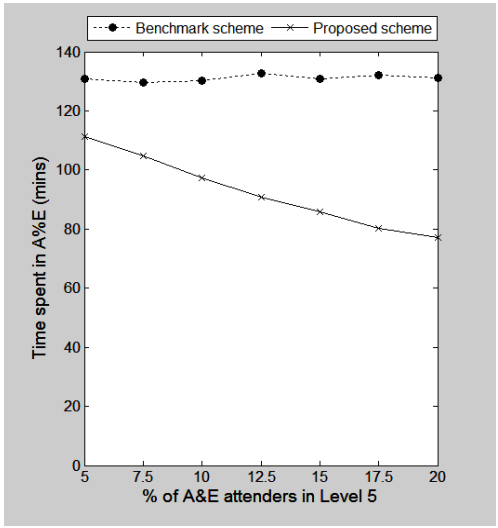
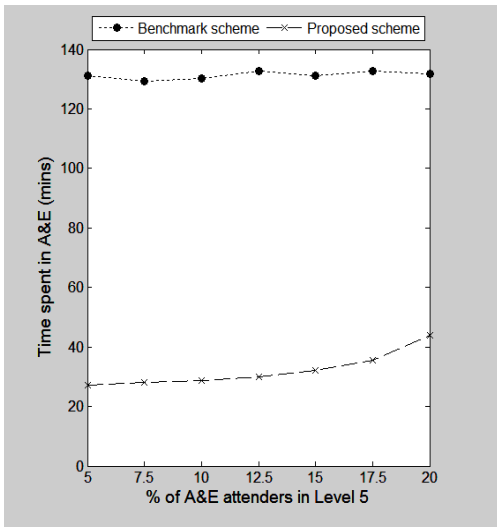


Figure 4.5 - Time spent by Level 5 patients in A&E



CONCLUSIONS

Hospital managers are facing increasing pressure to introduce measures and initiatives in order to ease the problem in of inappropriate attendances at A&E departments. Many health systems have introduced such initiatives. This study uses discrete event simulation to assess one scheme in which inappropriate attendances are deflected, with primary care involvement, away from A&E. The results that such a scheme would reduce the time spent in A&E by patients with urgent needs when compared with an alternative scheme in which all patients, including those with non-urgent needs, are treated within A&E. Further studies will have to carried out to assess the clinical feasibility of the deflection scheme.

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