A Quantitative Analysis of Integrated Emergency Posts

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Abstract As a solution to overcrowding, emergency departments (ED) in the Netherlands start to collaborate with general practitioner cooperatives (GPC) in so-called integrated emergency posts (IEP) to make sure that self-referring patients receive the right treatment by the right care provider. The underlying assumption is that this collaboration will increase effectiveness of care and efficiency. This chapter describes two case studies: for one case study the IEP has already been opened upon the start of this research, whereas for the other case study the decision to open an IEP was not made yet. Furthermore, the two case studies differ in several ED and GPC characteristics, like the percentage of self-referring patients. For both case studies, we compare the situation before integration, the so-called non-integrated post (NIP), with the IEP. The analysis is done using a discrete-event simulation model, which is set up in a generic way to enable analysing different NIPs and IEPs without drastically changing the model. We illustrate the latter using the two case studies. We furthermore show that integration without considering capacitive or organizational changes might lead to an increase in length of stay (LOS) for patients at the GPC as well as at the ED. However, when the capacities and responsibilities are changed accordingly, the introduction of an IEP has a positive impact towards patients and leads to less overcrowding at the ED. These results led to the decision to also open the IEP in the second case study.

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1 Introduction

Overcrowding in the emergency department (ED) has been a problem for years [5, 22]. Overcrowding might result in higher mortality, increased time to treatment, and an increased probability of leaving the ED against medical advice or without being seen [1]. One of the causes of overcrowding is the fact that many patients who do not need the ED for their care visit the ED anyway [4]. We refer to these patients as self-referrals. Part of these self-referrals could be treated by their own general practitioner (GP) during the day or by a GP from a GP cooperative (GPC) during out-of-hours (in the evening, night, or in the weekend).

Throughout the Netherlands, integrated emergency posts (IEP) have been created to solve the problem of self-referrals [28]. An IEP is a collaboration between an ED and a GPC, with the purpose "to provide appropriate treatment within one organization with complex, specialized care being provided by accident and emergency doctors and less complex care being provided by GPs or specially trained nurses, such as nurse practitioners or physician assistants" [14]. During out of hours, patients call a single regional telephone number, and triage is done by a nurse supervised by a GP [27]. Patients receive nurse-led telephone advice, are visited at home by a GP, receive an appointment for a consult by a GP in the GPC for less urgent problems, or are sent to the ED specialist for more complex high urgent care. This reduces the number of unnecessary self-referrals to the ED and, as there is one access point to medical care, reduces confusion among patients for choosing the right care provider [10].

In case of an IEP, the ED and GPC are located at the same site and share one front office with two back offices. Without integration, the ED and GPC are not necessarily located at the same site, and travel time might be required to go from a GPC to an ED. Within the Netherlands, there are 95 EDs, of which 71 have a GPC located at the same site, of which 51 share the same entrance, of which 31 are fully integrated into an IEP [16].

The underlying assumption for collaboration between an ED and a GPC is that this will increase effectiveness of care and efficiency. However, only a few studies are available that study these effects. [26] study the proportion of all out-of-hour patients seen by GPs, and [25] study differences in patient characteristics and presented complaints and ED discharge diagnoses, both comparing three regions without an IEP and three regions with an IEP. Furthermore, [12] show that an IEP is a promising option to improve job satisfaction. Focusing on the processes and process times before and after the integration for an IEP in Switzerland, [29] report large improvements for self-referrals but do not show effects on other patients. Thijssen et al. [24] compare ED utilization and patient flows before and after IEP implementation. However, due to other changes happening around the time of implementation, conclusive evidence on the effects of the IEP cannot be given. Summarizing, a complete quantitative analysis of the effects of this integration on processes and process times is currently missing. In this chapter, we perform such an analysis using two case studies. In these case studies, we focus on processes

and length of stay of patients, and leave out financial consequences and preferences of stakeholders involved. In the first case study, the IEP in Almelo, the integration took place in 2011, but similar to [24], the effect of this integration could not be studied directly from available data, due to other changes happening at the time of integration. One of these changes was a change in policy, leading to an increase in number of patients of a specific patient type. This case study is further referred to as case Almelo. In the second case study, the ED of the hospital Medisch Spectrum Twente (MST) and the GPC of Enschede were considering integrating into an IEP and needed to gain insight into the effects and changes needed prospectively. This case study is further referred to as case Enschede. Besides the differences in the status of the integration, the two case studies also differ on other important characteristics, like the percentage of self-referring patients and the fact that the hospital in Enschede is a regional trauma centre, whereas the hospital in Almelo is not. For both case studies, we use simulation to compare the situation before the integration, referred to as the non-integrated post (NIP), with the situation after the integration, the IEP. This way, the before and after comparison can be made under stationary conditions. The simulation model used is set up in a generic and flexible way, such that it can easily be used in both (and other) cases, as we will show in this chapter.

Using simulation as a tool to analyse and improve healthcare processes is not new. Several literature reviews about the use of simulation in healthcare have been conducted [3, 11, 21], also discussing the usage of simulation within EDs. For the vast majority of simulation studies on EDs, the presentation is limited to a specific hospital or situation, and the results are often hard to generalize to other EDs, let alone to other departments within a hospital. We mention a few exceptions. For a hospital in Arizona, [8] use a semi-reusable product, EDsim, to quickly model and test alternative design scenarios for existing and proposed hospital emergency departments. Also aiming at reusability, [23] present a flexible simulation model that could be used in different ED settings. Fletcher et al. [9] report the use of a generic simulation model for EDs. Their model, implemented in Simul8, has been used at various EDs within the UK. Facchin et al. [7] presented a flexible model of an ED based on common structural and functional characteristics of every actual emergency room. Despite these examples, the actual reuse of proposed ED simulation models is limited [11].

Other papers focus on using simulation models to evaluate interventions for specific case studies, e.g., regarding staff and room availability [6], bed availability [15], and other frequently proposed interventions [22]. Jahangirian et al. [13] performed an extensive literature review and showed that only 8% of the reviewed papers were real problem-solving articles, using real-life data. Brailsford et al. [3] conclude from a literature review of healthcare simulation and modelling that for only 5.3% of the papers the solution was actually implemented. Madhavi et al. [19] confirm these small implementation rates.

For simulation modelling of IEPs, similar contributions have been made. Mes and Bruens [20] present a generic simulation model for an IEP. Borgman et al. [2] use this model to evaluate interventions to improve the performance of a specific IEP.

The comparison between the NIP and IEP, however, has not been made, and the effects of the integration are not studied. Also, the claim by [20] that the proposed simulation model is generic has not been tested. This chapter closes that gap.

The aim of this chapter thus is threefold. First, we extend the simulation model of the IEP as proposed by [20] to model the NIP. Second, we show that the simulation model is generic by not only using it for modelling the NIP and IEP but also by applying it to two different case studies. Third, we show the effects of the integration for case Almelo as well as for case Enschede. For case Almelo, the IEP already existed at the time of this study, and we retrospectively study the added value of the integration. For case Enschede, the two organizations were not integrated yet (NIP), and we perform a prospective analysis of the situation after integration and possible scenarios to improve the performance.

This chapter is organized as follows. Section 2 describes the context of this study, followed by the simulation model in Sect. 3. In Sect. 4, we provide the experimental design of our simulation study. Section 5 gives the results for both case studies. We end with conclusions in Sect. 6.

2 Context

We perform two case studies, case Almelo and case Enschede. For both case studies, we study the non-integrated post (NIP) as well as the integrated emergency post (IEP), which we describe in Sect. 2.1, followed by the case studies in Sect. 2.2.

2.1 NIP and IEP

In the NIP, the GPC and ED are separate organizations with their own entrance, their own employees, and their own resources. A patient entering the ED is treated at the ED, even if the treatment could have been provided at the GPC. In the IEP, the two organizations share the same entrance, and a triage nurse decides whether the patient is seen at the GPC or at the ED. In both cases, patients might be referred to the ED after having a consultation at the GPC, typically resulting in travel time for the patients in case of a NIP.

Figure 1 shows a generic overview of the processes at both the NIP and the IEP. There are several ways in which patients enter the system: (i) by calling the IEP or GPC, (ii) by going to the IEP, GPC or ED as a self-referral, and (iii) by being referred to the ED by an external care provider; we denote these arrival types by callers, self-referrals, and external arrivals, respectively. The detailed processes shown in Fig. 1 are explained in more detail in Sects. 3.2 and 3.3. Here we limit ourselves to describing the differences between the NIP and IEP case.

The lines denoted with the numbers 2 and 3 are specific for the NIP case and reflect the two main differences between the NIP and the IEP. First, in the IEP the

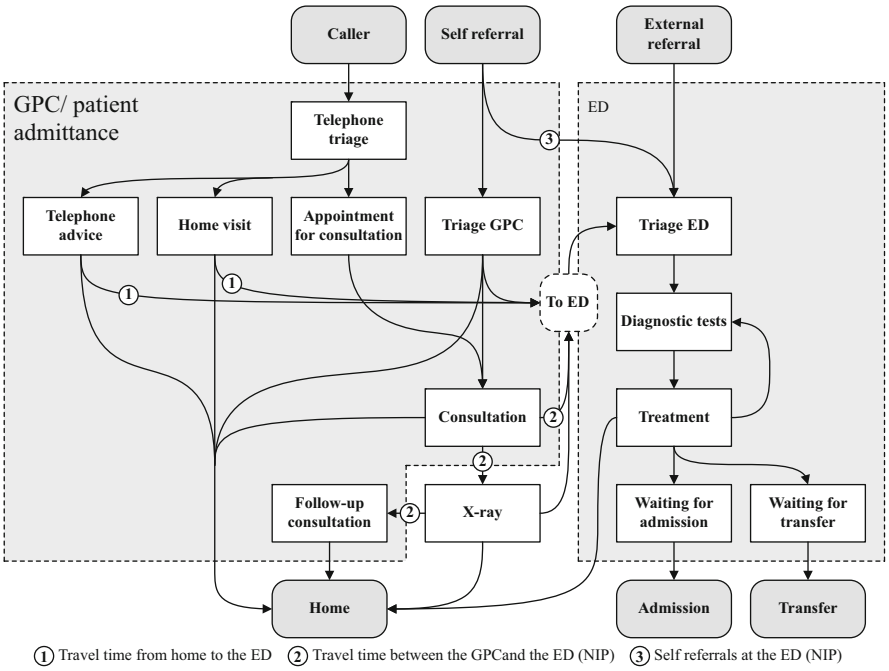

Fig. 1 Processes at the NIP and IEP. (Adapted from [20])

two organizations collaborate with regard to self-referrals. Self-referrals are triaged in one dedicated room (triage GPC) at the moment they enter the IEP, removing the choice of patients to go to the GPC or to the ED (number 3 in Fig. 1). Second, at the IEP, the GPC and the ED are situated at one location; thus, no travel time is required. This holds both for patients that need to go to the ED and patients that need more diagnostics (number 2 in Fig. 1).

2.2 Case Studies

In case Almelo, we study an existing IEP that consists of a collaboration between the GPC of Almelo and the ED of the hospital "Ziekenhuisgroep Twente" in Almelo. This collaboration started in 2011. In that year, around 60,000 patients visited the IEP. Approximately 2% of these patients had urgency code U1 (very urgent), 6% U2, 30% U3, and 62% U4 (non-urgent). Approximately 5% of all patients were self-referrals. In the situation before the integration, 95% of the self-referrals went directly to the ED, and 5% visited the GPC. The travel time between the two organizations was approximately 10 min. The hospital and the IEP in Almelo are located at the border of the city in a rural area. At the time of integration, several

other changes took place. One of these changes was the concentration of specialities pulmonary and neurology at the hospital location in Almelo and directing patients of these specialities from a partner hospital to the ED in Almelo, leading to an increase in the number of patients and a change of patient population seen at the ED. Therefore, it is impossible to directly compare the historical data before and after the integration. An analysis of the effects of the integration therefore was missing.

In case Enschede, the GPC and ED of the hospital "Medisch Spectrum Twente" were considering integrating towards an IEP. Both organizations wondered what the effect would be for their organization and whether changes were necessary. In 2013, around 48,000 patients visited the GPC, and around 15,000 patients visited the ED. Approximately 2% of the GPC patients had urgency code U1 (very urgent), 11% U2, 34% U3, 26% U4, and 27% U5 (non-urgent). Of the ED patients, 2% had urgency code Red (very urgent), 14% Orange, 43% Yellow, 40% Green, and less than 1% Blue (non-urgent). Approximately 40% of all ED patients were self-referrals. The GPC in the non-integrated situation is adjacent to the ED, so there is no travel time. The hospital and proposed IEP in Enschede are located in the city centre of an urban area. The locations of the two hospitals likely explain the large difference in percentage of self-referrals.

3 Simulation Models

In this study, we compare two situations, reflecting the non-integrated post (NIP) and the integrated emergency post (IEP). To make a fair comparison between the two models, we need to keep most of these characteristics the same and only change the characteristics that we want to study. The easiest way to do this is by using one model as a basis. For that purpose, we use the discrete-event simulation model developed by [20] for the IEP in Almelo as the starting point of our research. We extend this model to also represent the NIP situation in case Almelo, as well as the IEP and NIP situations in case Enschede.

We start with a general description of the set-up of the model in Sect. 3.1, followed by a description of the NIP and the IEP for case Almelo in Sects. 3.2 and 3.3, respectively. Then, we give an overview of the changes needed to use the model for case Enschede in Sect. 3.4. Afterwards, we describe the implementation of the model in Sect. 3.5, followed by a description of the performance measures in Sect. 3.6.

3.1 General Set-Up

The NIP and the IEP are characterized by the arrivals of patients, available resources (personnel, rooms, etc.), processes, dependencies, and prioritization, all with specific characteristics. The simulation starts with the generation of patient

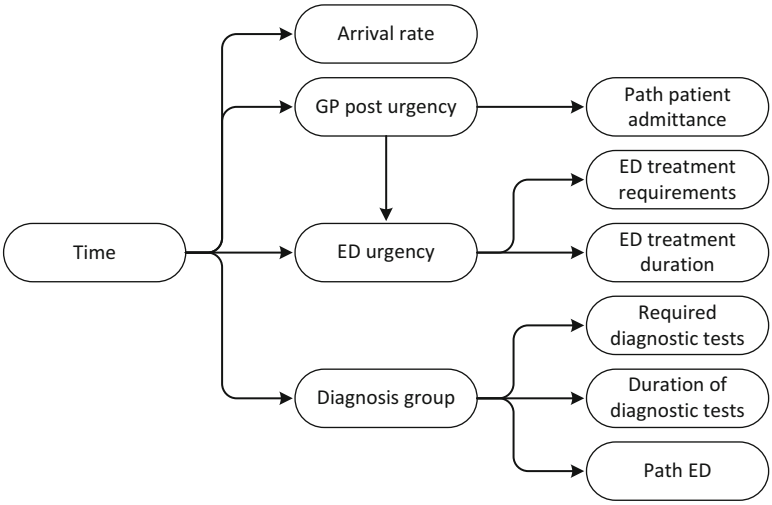

Fig. 2 Dependencies in patient characteristics

arrivals and patient characteristics (age, gender, diagnosis-related group, and triage urgency). Patient arrivals are modelled following a time-dependent Poisson process, with arrival rate $\lambda_{h,d,w}$, being the average number of patients arriving in hour h on the day of the week d in a week of the year w. Depending on the time of arrival, we determine the diagnosis-related group (DRG) and urgency, since these relations are seen in the data. A summary of the dependencies between the involved variables can be found in Fig. 2. Depending on these characteristics, the care pathway is determined, after which it becomes clear which processes the patient needs to go through and what resources and processes are needed.

We distinguish between three types of resources: staff, rooms, and equipment. With respect to staff, we distinguish between regular staff and external staff. The regular staff is included in the shift schedule. The external staff is the staff that has to be called in; they either come from within the hospital or from externally. Several rooms are taken into account in the model, where we distinguish between rooms directly related to the processing steps (triage rooms, GP Rooms, ED Rooms, X-ray rooms, CT rooms, and plaster rooms) and rooms mainly used for animation purposes (call centre, patient waiting areas at the GPC and the ED, and "waiting areas" for staff members at the GPC and the ED). Regarding medical equipment, we include ECG and ultrasound equipment, which are portable so that the tests take place at the ED room of the patients.

We distinguish between three types of processes: regular tasks, parallel tasks, and delay tasks. Here, we assume that all tasks are initiated by a particular patient. A regular task is a treatment required by a patient. For most of the regular tasks, a patient and staff member come together in a room. This is not the case with parallel tasks, for which the patient does not need to be present. As a result, the

patient might undergo another task while the parallel task is still in progress, e.g., the reviewing of test results from an X-ray, ultrasound, or CT scan. A delay task is a task that might forego a regular task. With a delay task, the patient has to wait before the next treatment can be started. Examples of delays are required travel time of a staff member (e.g., a GP making a home visit), the cleaning of a room or medical equipment, etc. For all three types of tasks, several resources might be required such as staff (multiple staff members might be possible), rooms (e.g., a treatment room), and medical equipment (e.g., ECG). For all three types of tasks, we have a list with processing time distributions. The processing times depend on the task involved but might also depend on other factors, such as the staff member performing the task and the diagnosis group of the patient.

Tasks in the model are prioritized depending on the triage category and the waiting time of the patient. In this way, a patient becomes more urgent when its waiting time is close to the maximum waiting time. A calling patient that needs an appointment at the GPC gets an appointment when a GP is available. The main triggers in our simulation are the start and end of a task. In our case, one task might require multiple resources, and completion of a single task might initiate the simultaneous start of multiple other tasks. The way we handle the events in our simulation is similar as in [20].

In both models (NIP and IEP), we use the same patient arrivals and characteristics and the same resources to allow for a fair comparison between the NIP and IEP. The care pathway a certain patient follows, however, depends on the situation. Below, we therefore discuss the possible care pathways for the NIP and IEP, respectively.

3.2 NIP Case Almelo

To distinguish between the different care pathways, the NIP model is split into three parts: patient admittance, GPC, and ED. We describe these three parts below. In the first part, patient admittance, patients can contact the NIP in four different ways: (i) the patient calls the GPC, (ii) the patient arrives at the GPC as a so-called self-referral, (iii) the patient arrives at the ED as a self-referral, and (iv) the patient arrives at the ED after an external referral by, e.g., the call centre of the national alarm number 112, a GP, or the hospital. Patients that call the NIP are triaged by phone, while self-referrals are triaged at the GPC or ED, respectively. When triaged by phone, several things can happen: (i) medical advice is given during the call, and the patient leaves the system, (ii) an ambulance is sent to bring the patient to the ED, (iii) the patient receives an appointment time for a consultation at the GPC, and (iv) a GP is sent to the home of the patient for a visit, after which the patient either leaves the system or an ambulance brings the patient to the ED for further examination or treatment.

At the second part, the GPC, the most important process step is the GPC consultation, after which most patients can go home. However, some patients need an X-ray, which is located in the hospital, so the patient has to travel to the hospital.

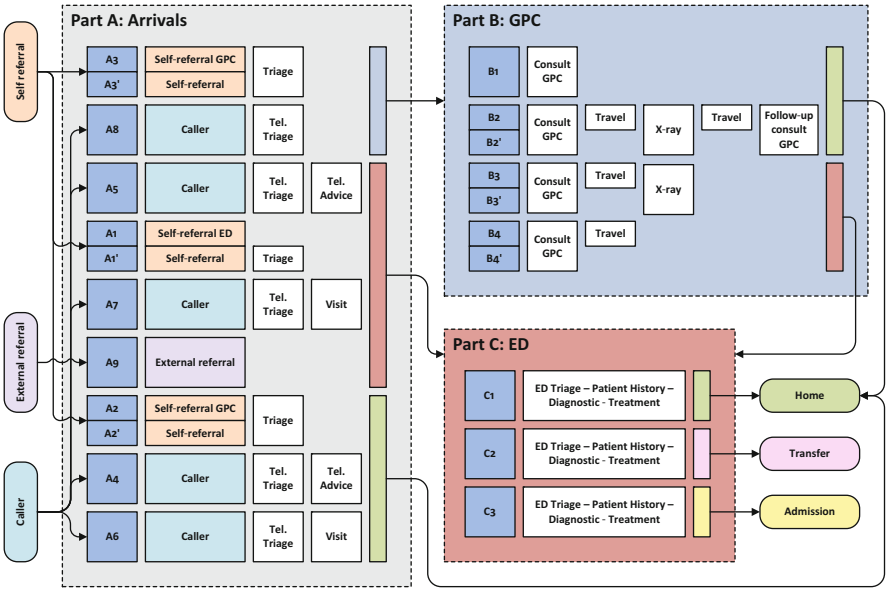

Fig. 3 Care pathways NIP/IEP case Almelo

After the X-ray, depending on the results, the patient is discharged, needs to go back to the GPC for follow-up consultation, or is referred to the ED. Also, patients that cannot be treated at the GPC are referred to the ED.

At the third part, the ED, all arriving patients are triaged, since the GPC and the ED have different triage systems. After the patient history has been registered, a patient might undergo several diagnostic tests, after which treatment can start. This might be repeated several times, before the patient is discharged home, ready to be admitted to a department within the hospital, or transferred to another hospital or psychiatric institution. For the simulation model, the destination of the patient is relevant since patients that need to be admitted might have to wait for a bed at a ward to become available. Also, patients that need a transfer have to wait for an ambulance. These patients stay in their ED room while waiting to move along and exit the IEP.

Combining these three parts leads to nine paths that patients can take to enter the NIP (A1 to A9), four paths through the GPC (B1 to B4), and three paths through the ED (C1 to C3); see Fig. 3.

We assume that the decision of self-referring patients whether to go to the GPC or to the ED is independent of their urgency. There are several reasons why a patient might decide to go to the ED directly, such as (i) perception of a need to receive immediate care, (ii) preferences, (iii) difficulty of assessing primary care services, and (iv) defensive medicine behaviours or wrong diagnoses. Although perceived urgency might be a reason to make this decision, it is questionable whether the perception of the patient is right [18].

3.3 IEP Case Almelo

The model for the IEP also consists of three parts, largely overlapping with those of the NIP. The crucial differences between the NIP and IEP are that with the IEP, (i) self-referrals at the ED are not possible, and (ii) travel times between the GPC and the ED are negligible. Because of the first difference, all self-referring patients are triaged at the GPC, where it is decided whether the patients receive an appointment at the GPC, at the ED, or can go home. These changes lead to a new model with also nine paths to enter the IEP, four paths through the GPC, and three paths through the ED. However, some of these paths differ from the paths in the NIP model; see Fig. 3 (paths A1', A2', A3', B2', and B3' replace paths A1, A2, A3, B2, and B3). Path A1 is changed to A1' since in the IEP, it is not possible to enter the ED without triage at the IEP. Path A2 and A3 are changed towards A2' and A3', since these paths in the IEP can be taken by all self-referrals. Paths A4 to A9 remain unchanged. Paths B2 and B3 change into B2' and B3' since, due to the integration, the GPC has direct access to an X-ray. Paths B1 and B4 remain the same, as well as paths C1 through C3.

3.4 Changes and Additions Needed for Case Enschede

As mentioned before, the simulation model has been developed specifically for the IEP in case Almelo. To use the model for case Enschede, some changes and additions are needed. The first set of changes is related to the fact that the hospital in Enschede is a regional trauma centre, whereas the hospital in Almelo is not. The data of case Enschede shows a relation between the type of arrival to the system (self-referral, ambulance, etc.) and the urgency of the patient, whereas this relation is not present in the data of case Almelo and therefore is not included as an option in the simulation. The model is extended to include these relations.

Some additional changes to the model are needed. First, the specialized car used by GPs to visit patients is included as an extra resource in the model for case Enschede. This is not included in the model for case Almelo because it was not a limiting resource in that case. Second, in Enschede a difference is made between so-called labelled and unlabelled patients, a distinction that is not made in Almelo. Unlabelled patients, patients for which the urgency and the speciality are not known yet, can be seen by an ED physician, whereas labelled patients cannot. Therefore, a new patient attribute, called "labelled", is added. Third, the data of case Enschede shows a dependency between the urgency of the patients and the duration of diagnostic tests, which requires changes to the model.

Finally, changes are needed that could be handled by only changing the input tables. First, changes are needed since the available data in case Enschede and case Almelo are different, since in Almelo the IEP was already implemented, whereas in Enschede the GPC and ED were still separate organizations at the time of

performing this simulation study. Second, a new map had to be created since each hospital has a unique layout.

From this, we conclude that the model developed is generic. Most differences between the NIP and IEP, and between the two case studies, could be taken into account by only changing the input tables, while the handling of all events, i.e. the core of the simulation model, stays the same. The changes we have made to also apply this model to case Enschede resulted in a model that can be used at other organizations even easier.

3.5 Implementation

The models are implemented in the discrete-event simulation software package Tecnomatix Plant Simulation from Siemens. The basis for the simulation is the map of the GPC and ED in both case studies, Almelo and Enschede, as shown in Figs. 4 and 5, respectively. We choose to use the exact layout of the organizations to increase recognizability for the stakeholders and future users. The patients are shown as small figures that move over the map. Patients as well as staff members have different colours based on their characteristics. Also, tiny coloured markers are placed at the patients to indicate their urgency.

We first give a general overview of the verification and validation methods used, followed by more detailed information for both case studies. The models are

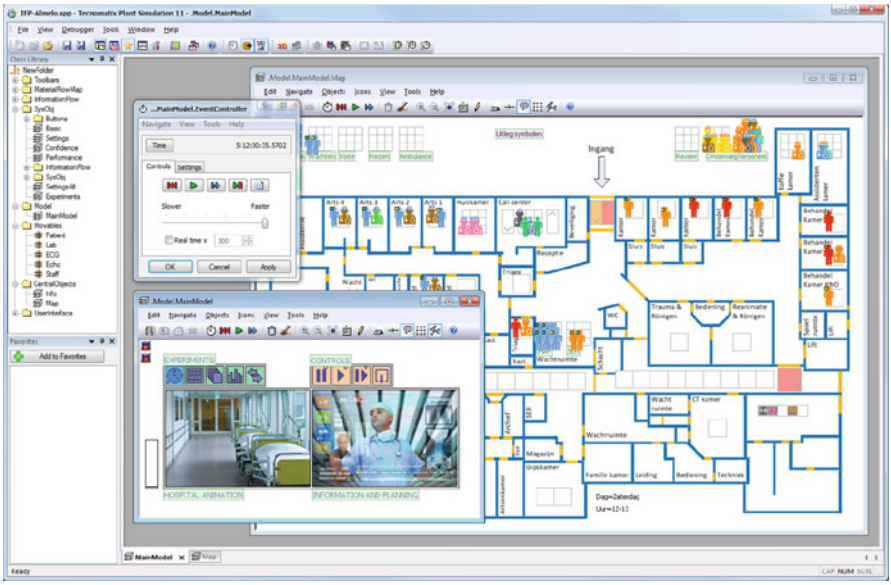

Fig. 4 Map of the IEP in Almelo

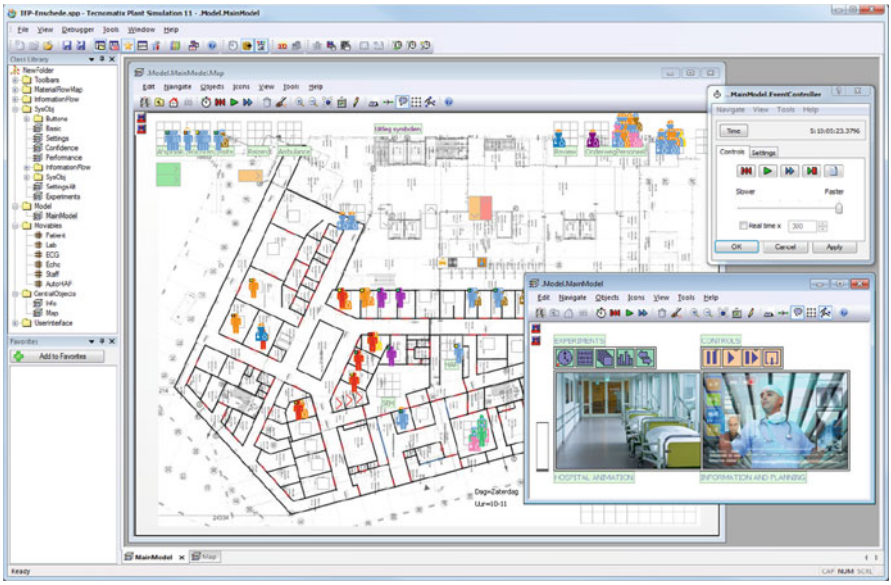

Fig. 5 Map of the proposed IEP in Enschede

verified and validated, following the procedures as described in [17]. Verification of the models is done by (i) writing and debugging the computer program in modules and subprograms, (ii) reviewing the program by other persons than the writer, (iii) running the simulation and checking the outcomes with the inputs, (iv) providing demonstrations to the stakeholders at our monthly meetings, and (v) watching the animations of patients, staff, and equipment. From this analysis, we conclude that both models are good representations of the situations that we modelled. Validation of the models is done by (i) collecting high-quality information and data on the system; (ii) interacting with the manager on a regular basis; (iii) maintaining a written assumptions document and performing a structured walk-through; (iv) validating components of the model by using quantitative techniques; (v) validating the output of the overall simulation model; and (vi) animation. In addition, we organized computer sessions where the healthcare managers worked with the simulation model.

In case Almelo, data for the years 2009–2011 has been collected from available computer systems from the GPC, the ED, and the IEP. Besides this, we held an extra 2-week measuring period in February 2012 to collect more detailed data on treatment times and length of stay. During the development, monthly sessions were organized with important stakeholders like the manager of the GPC and the ED to discuss changes and assumptions in the model, and all assumptions were kept in an assumptions document. Furthermore, animation was used to see whether patients take the right paths through the system, and staff and resources are deployed as expected. Regarding the validation of the overall simulation output, we compared

the output of the simulation with historical data for five indicators (waiting time for diagnostics, waiting time for triage of self-referrals, waiting time for consultation at the GPC, length of stay at the ED, medical specialist waiting and treatment time) and concluded together with the stakeholders that the model was valid.

In case Enschede, data has been collected from available computer systems from the GPC (2012 and 2013) and the ED (September–December 2013). Monthly meetings were held where the assumptions made were presented to the stakeholders of both the GPC and the ED. Finally, the output of the model was validated with real-life data. We compared the simulation with historical data on three indicators (waiting time till triage at the ED, length of stay at the ED, length of stay at the GPC) and concluded together with the stakeholders that the model was valid.

3.6 Performance Measures

In this chapter, we study the differences between the NIP and IEP under various scenarios. We consider the length of stay (LOS) of patients as our primary performance indicator, which we define as the time between entering the NIP or IEP (in person) and discharge. The LOS depends on whether the patient is treated in the GPC or in the ED. Therefore, we also distinguish between the length of stay at the GPC (LOS GPC) and the length of stay at the ED (LOS ED). For most experiments, we focus on the average LOS over all patients. For one experiment we zoom in at several patients groups as well, such as self-referrals versus non-self-referrals and different urgency classes.

We are interested in the LOS at the sites of the NIP and IEP, since this is the part that is effected by the integration. Therefore, we do not include the duration and waiting time for telephonic triage, telephonic consultation, and home visits in the performance measures. These processes, however, are included in the capacity usage of GPC physicians and nurses, and standard priorities for assigning capacities to these processes are applied.

4 Experimental Design

We first describe the experiments for the case Almelo in Sect. 4.1, followed by the experiments for case Enschede in Sect. 4.2. We conclude this section with the general simulation settings in Sect. 4.3.

4.1 Case Almelo

For case Almelo, we first compare the situation before the collaboration started (NIP) with the situation after the collaboration (IEP). At the introduction of the IEP, three changes occurred at the same time, namely, the freedom for patients to self-refer to the ED was removed, the location of the GPC changed (no travel times in the IEP), and an extra nurse practitioner (NP) was hired, working in both the GPC and the ED to relieve the GPs from the expected increase in workload. In this first comparison all three changes are included. For the comparison, we use aggregate performance measures as well as detailed performance measures for different patient groups.

Next, we study the effects of each of the three changes separately. Therefore, in this second set of comparisons, we study different configurations for the NIP as well as for the IEP. For the NIP, we have four alternative configurations (Table 1). First, we study the NIP with (+NP) and without the extra NP. Second, we study the situation in which the GPC and the ED are located next to each other, i.e. no travel time (−TT), and the situation in which both organizations are at different locations representing the situation before the integration. For the IEP, two different configurations are included: an IEP with and without (−NP) the extra NP.

Finally, we perform a sensitivity analysis on:

1. *The number of arrivals.* The before-after comparison as studied is case-specific. Some areas in the Netherlands might receive more patients at the GPC and the ED, whereas other areas receive fewer patients. Therefore, we multiply the number of arrivals of the current situation (as used in the experiments) with an arrival factor that we vary between 0.5 and 1.6.
2. *The percentage of self-referrals where 5% of the self-referrals go to the GPC.* The IEP in Almelo faces a relatively low percentage of self-referrals (5%) compared to the total number of patients visiting the IEP. In more densely populated areas, self-referral percentages of 80% have been reported (of which the majority directly goes to the ED). Therefore, in this sensitivity analysis, we study the impact of the percentage of self-referrals, referred to as the self-referral factor, and vary this factor between 5% and 70%. Approximately 5% of these self-

Table 1 Alternative configurations and experiments case Almelo

Configuration	Choice self-referrals?	Travel times (TT)?	Extra capacity (NP)?
NIP	Yes	Yes	No
NIP + NP	Yes	Yes	Yes
NIP − TT	Yes	No	No
NIP + NP − TT	Yes	No	Yes
IEP	No	No	Yes
IEP − NP	No	No	No

referrals go to the GPC, whereas 95% enter the ED immediately. This percentage is assumed to be quite common in the Netherlands.

3. *The percentage of self-referrals where 50% of the self-referrals go to the GPC.* The effect of the percentage of self-referrals is directly linked to whether in the NIP these self-referrals would go to the GPC or the ED. If all self-referrals would go the GPC, the effect of the integration would be limited. At case Almelo, before the integration only 5% of the self-referrals visited the GPC. A new policy has been proposed in the Netherlands that states that self-referred patients that visit the ED for care that could have been given by their GP get a financial penalty, likely resulting in less self-referrals at the ED. We therefore also study the effect of the self-referral factor for the situation that 50% of all self-referrals go the GPC.

To provide a fair comparison, we perform this sensitivity analysis using the NIP without travel time and the IEP without the extra NP as base case.

4.2 Case Enschede

For case Enschede, we first compare the current situation (NIP) with the expected situation after the integration (IEP). Afterwards, we compare the following process and capacity interventions that might improve the impact of the integration:

1. *Extend authority of ED physicians.* In the NIP, ED physicians were only allowed to see unlabelled patients. In the first process change, we allow ED physicians to see all patients.
2. *Add more staff to the GPC.* In the IEP, all self-referring patients will visit the GPC, leading to an increase in workload. This can be offset by increasing the number of staff at the GPC. Three staff types are considered, adding one at all times:
   a. An extra triage nurse (+TN).
   b. An extra nurse practitioner (+NP).
   c. An extra GP (+GP).
3. *Use the same triage system.* In the current situation, the GPC and ED use a different triage system, due to which patients visiting both the GPC and the ED (i.e. referred to the ED by the GPC) need to be triaged twice. By using the same triage system, GPC referrals do not have to be triaged again.
4. *Share rooms.* Since in the IEP, the ED and GPC are located next to each other, the possibility arises to share each other's rooms.

These interventions have been derived from discussions with the stakeholders of both the GPC and the ED. The impact of each of these interventions is studied separately. See Table 2 for an overview of the experiments.

Table 2 Alternative configurations and experiments case Enschede

Configuration	Choice self-referrals	Extended ED authority?	Extra capacity?	Same triage system?	Share rooms?
NIP	Yes	No	No	No	No
IEP	No	No	No	No	No
IEP + Authority	No	Yes	No	No	No
IEP + TN	No	No	Yes, +TN	No	No
IEP + NP	No	No	Yes, +NP	No	No
IEP + GP	No	No	Yes, +GP	No	No
IEP + Triage	No	No	No	Yes	No
IEP + Rooms	No	No	No	No	Yes

After studying the interventions separately, we combine the most promising interventions in a 2^k factorial design.

4.3 Simulation Settings

We simulate the out of hours, which are between 5:00 pm and 8:00 am on weekdays and during the weekends. Since the ED is open 24/7, we randomly generate an initial filling of patients in the ED upon the start of the out of hours (5:00 pm at weekdays). To determine the distribution of the number of patients at 5:00 pm, we collect data of patient arrivals, together with their urgency classes, and use this to generate the initial filling. For all patients present at 5:00 pm, we randomly decide which part of their care pathway they already finished. Given this set-up, we do not require a warm-up period for our simulation. Furthermore, since the time-dependent arrival process is defined in a yearly cycle, we use 1 year as simulation run length. We use five replications for each experiment, which is sufficient to reach a relative error of 0.05 with a confidence level of 95% for our key performance indicators.

5 Results

We start this section with the results for case Almelo in Sect. 5.1, followed by the results for case Enschede in Sect. 5.2.

5.1 Case Almelo

For case Almelo, we perform three different analyses. We describe the before-after analysis including all changes mentioned in Sect. 5.1.1, followed by the analysis of the changes separately in Sect. 5.1.2. Finally, we show the results of the sensitivity analysis in Sect. 5.1.3.

5.1.1 Before-After Analysis

We first compare the situation before the integration with the situation after the integration in case Almelo. In this comparison, all changes that occurred at the time of the integration as discussed in Sect. 4.1 are taken into account. See Table 3 for the aggregate results of this comparison. Due to the integration, the average LOS (in total, for the GPC, and for the ED) decreases with 15.0, 4.5 and 15.5 min, respectively. One reason for this decrease in LOS is that the treatment times decrease. A patient who visits the ED, even when this visit is not necessary, takes more time to be treated than a similar patient visiting the GPC. A second reason can be found in the increase in capacity as in the new situation an extra NP is hired. The third reason is the presence of travel times in the NIP, which causes patients that visit both organizations to have a longer LOS. Finally, the integration leads to fewer patients in the ED, resulting in a less busy system, leading to a lower LOS at the ED. The opposite holds for the GPC, due to which the LOS for GPC patients is expected to increase. However, since the integration also included hiring an extra NP, the effect of the increasing number of patients at the GPC is levelled out.

The overall results show a decrease in LOS over all patients. We now zoom in on some subgroups of patients, also for the before-after comparison including all changes. We first look at self-referring patients versus non-self-referring patients. Afterwards, we zoom in on different urgency categories.

Self-referrals versus non-self-referrals Figure 6 shows the LOS (total, GPC, and ED) for the NIP and the IEP, making a distinction between self-referring patients and non-self-referring patients. The left part of the figure shows the performance over all patients; the right part only includes patients that visit the ED. From Fig. 6, it is clear that both self-referrals and non-self-referrals benefit from the integration, since the total LOS is lower for the IEP than for all patient groups in the NIP. Looking at all patients (left side), we see a large decrease in the total LOS for self-referring patients. This is due to the fact that most self-referring patients to the ED do not

Table 3 Effect of integration for case Almelo

Configuration	LOS (min)	LOS GPC (min)	LOS ED (min)
NIP	60.8	28.3	117.8
IEP	45.8	23.8	102.3

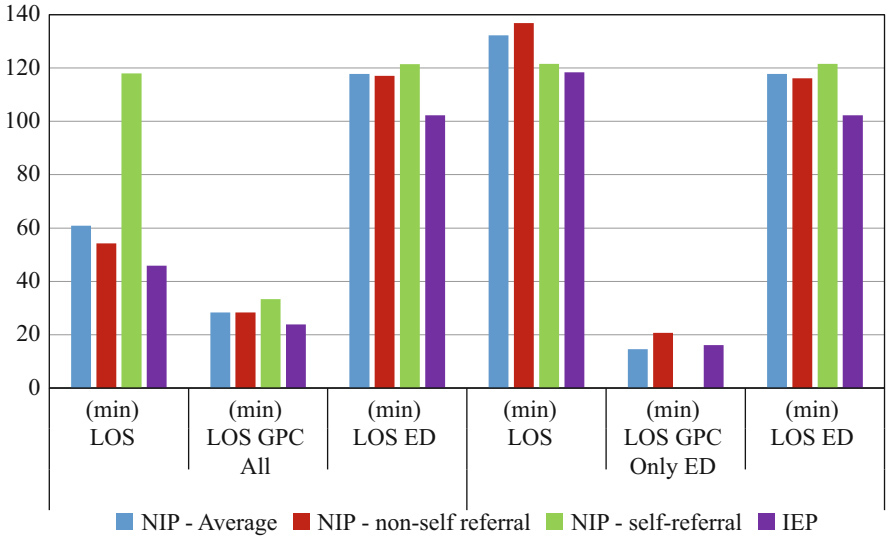

Fig. 6 LOS for self-referring versus non-self-referring patients for case Almelo

need treatment in the ED. In the IEP, these patients can leave after consultation at the GPC, which saves a long process in the ED. Before the integration, self-referring patients at the ED had a lower total LOS than non-self-referring ED patients (4th green versus 4th red bar in Fig. 6); in other words, for patients that actually needed ED treatment, it was faster to self-refer to the ED than to follow the official guidelines and first visit the GPC. This is caused by the GPC consultation time that is skipped by ED self-referrals (LOS GPC). In the IEP, this distinction is gone, and both groups have an equal and lower total LOS. Note that although for the self-referring ED patients the LOS in the GPC increases due to the integration (from zero to the height of the 5th purple bar), the LOS at the ED is much lower (last green versus purple bar), which leads to a lower overall LOS (4th green versus 4th purple bar).

ED urgency Since the main goal of integration into an IEP is to reduce overcrowding at the ED and to increase the service level towards urgent patients, we also look at the differences between the performance of patients with different ED urgency classes. Table 4 shows the LOS (total, GPC, and ED) for the different urgency classes and the percentage of patients for each of the classes compared to the number of ED patients in the NIP situation. From this it is clear that fewer patients indeed visit the ED (73.9% of the NIP ED patients, given by the sum of the percentages in the last column). Furthermore, when looking at the total LOS, we see that almost all patients benefit from the integration, except for a non-significant difference for the urgent patients (red). Note that the LOS GPC for non-urgent (blue) patients is zero. This results from the fact that no non-urgent patients will be sent from the GPC to the ED. All patients in this category are external arrivals, who enter the ED directly

Table 4 LOS for different ED urgency classes for case Almelo

	NIP				IEP			
ED urgency	LOS (min)	LOS GPC (min)	LOS ED (min)	% patients	LOS (min)	LOS GPC (min)	LOS ED (min)	% patients
Blue	145.8	0.0	145.8	0.5%	88.9	0.0	88.9	0.2%
Yellow	135.2	12.2	123.0	43.7%	128.5	16.0	112.5	27.6%
Green	138.4	22.2	116.2	37.1%	113.9	20.6	93.3	32.7%
Orange	113.6	5.0	108.5	18.0%	109.5	5.6	103.9	12.9%
Red	99.8	5.1	94.7	0.6%	101.2	4.9	96.3	0.5%
Average	**132.3**	**14.5**	**117.8**		**118.4**	**16.1**	**102.3**	

Table 5 Aggregate results of different configurations for case Almelo

Configuration	LOS (min)	LOS GPC (min)	LOS ED (min)
NIP	60.8	28.3	117.8
NIP + NP	58.3	24.9	118.2
NIP − TT	58.5	25.4	117.7
NIP + NP − TT	55.9	21.8	118.4
IEP	45.8	23.8	102.3
IEP − NP	50.0	28.6	102.1

without a GPC visit. Looking at the LOS GPC, we see that this increases for some patient groups and on average. This is due to the fact that in the IEP, all patients first visit the GPC and self-referring to the ED is not possible anymore.

Summary Concluding, we can state that the integration in case Almelo was beneficial for all patients, self-referring and non-self-referring, and for all urgency classes. For some patient groups, the LOS at the GPC increases, but this is offset by the lower LOS at the ED. Especially, for patients that receive treatment in the ED, we see a large improvement in the total LOS. Furthermore, at the ED, the large difference in LOS between self-referring and non-self-referring patients is gone, resulting in a lower and equal LOS for both groups.

5.1.2 Different Configurations

The comparison as described in Sect. 5.1.1 is based on three changes when integrating into an IEP (capacity, travel time, choice of patients). We now analyse each change separately by looking at all possible configurations; see Table 5 for the results.

With equal capacity (IEP − NP versus NIP), the LOS at the GPC is almost equal (NIP, 28.3 min; IEP, 28.6 min), but the LOS at the ED and in total decreases with 15.7 and 10.8 min, respectively. When an extra NP is hired in both organizations (IEP versus NIP + NP), the LOS for the GPC is again comparable (NIP, 24.9 min;

IEP, 23.8 min), but the LOS at the ED is improved with 15.9 min and the average total LOS with 12.5 min.

After excluding the travel time of patients (comparisons IEP-NP versus NIP − TT and IEP versus NIP + NP − TT), we only see the effect of self-referrals not able to directly enter the ED anymore. Because of this, the average LOS in the GPC increases, with 3.2 min (without NP) and 2.0 min (with NP), whereas the average LOS in the ED decreases with 15.6 min (without NP) and 16.1 min (with NP), and the total LOS decreases with 8.5 min (without NP) and 10.1 min (with NP). Just looking at the influence of the travel times (NIP versus NIP − TT and NIP + NP versus NIP + NP − TT), only improvements in the LOS of the GPC (2.9 and 3.1 min), and therefore also in the overall LOS (2.3 and 2.4 min), are found.

Summary From these comparisons, we draw the following conclusions. First, due to the integration, self-referrals do not have a choice anymore where to go to. This leads to more patients at the GPC and less patients at the ED. If there is no extra capacity to deal with this increased number of patients at the GPC, the LOS at the GPC increases slightly. For the ED the opposite holds: the number of patients at the ED decreases, and thus the LOS at the ED decreases. Furthermore, patients that visit the ED have longer treatment times than patients visiting the GPC, and a patient that is treated at the ED that could have been treated at the GPC would have a shorter treatment time at the GPC. Combining these two effects, we see a large decrease in total LOS, so we can conclude that even with equal capacity, it is beneficial to integrate the two organizations from a patient perspective. Since resources at the ED are generally more expensive than resources at the GPC, also from an economical point of view, the integration is beneficial. Second, the integration abolishes the travel time between the two organizations, which lowers the LOS of patients visiting both locations. Travel time could also be excluded by moving the GPC close to the ED, without integrating their services; however, even in this situation it is beneficial to integrate into an IEP.

5.1.3 Sensitivity Analysis

The results from Sects. 5.1.1 and 5.1.2 are specific for case Almelo. In this section, we generalize the results by performing a sensitivity analysis. To make a fair comparison, we study the NIP without travel time and assume the same capacity (no extra NP) for both the NIP and IEP, so we take configuration NIP − TT and IEP − NP as starting point.

Number of arrivals Figure 7 shows the average LOS for the IEP and NIP for different arrival factors, in total and for the GPC and ED separately. When looking at the total LOS, we see that for a small number of patients, it is better to integrate the GPC with the ED than to have two separate organizations. However, when the number of patients increases, the difference becomes smaller, and an indifference point for the total LOS is reached at approximately an arrival factor of 1.6. The reason for this is that in these experiments, we kept the personnel capacity the same

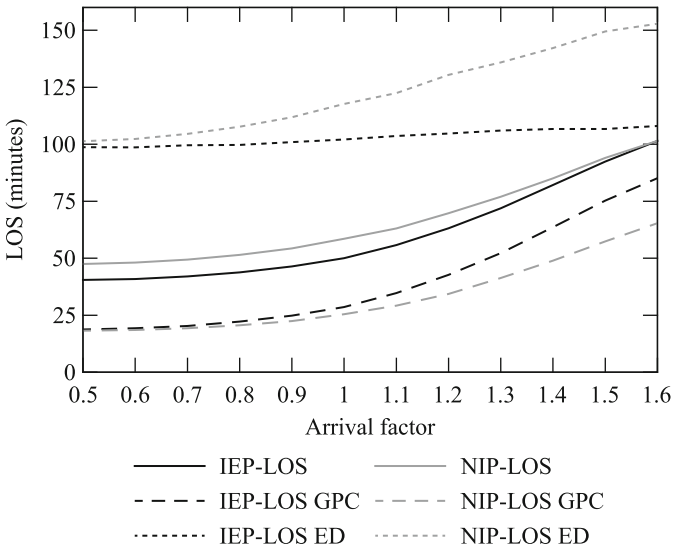

Fig. 7 LOS depending on the arrival factor (% of arrivals for case Almelo)

with increasing number of patients. Since all patients arriving at the IEP are first seen at the GPC, the utilization at the GPC increases with the number of patients and therefore also the LOS of the GPC. Looking at the ED, the LOS in the IEP increases only slightly with more arrivals, whereas the LOS at the NIP increases significantly more. However, since all patients are seen at the GPC, the resulting increase in LOS at the GPC in the IEP influences all patients and thus has a large negative impact on the average LOS in the overall system.

Percentage of self-referrals Figure 8 shows the average LOS for the IEP and NIP for different percentages of self-referrals (self-referral factor varying between 0.05 and 0.7). The self-referral factor of 0.05 is the situation for case Almelo. Obviously, if there would be no self-referrals, it would make no difference whether or not the GPC and the ED are integrated. However, as soon as more self-referrals are entering the system, it is clear that the two systems behave totally different. In the NIP, an increase in self-referrals entering the ED leads to a higher LOS. Since at some point a utilization of close to (or more than) 100% is reached, the system explodes, and the waiting times cannot be measured anymore. The GPC in the NIP will perform better when the number of self-referrals to the ED increases, since fewer patients arrive at the GPC. However, the effect seen at the ED is large, and therefore the overall performance is reduced heavily. In the IEP, all self-referrals are seen at the GPC, while part of the non-self-referrals only have a telephonic consult. As a result, the average LOS at the GPC increases with the number of self-referrals. However, since the GPC acts as a gatekeeper for the ED, the increase in self-referrals does not have any influence on the ED. Overall the performance deteriorates with increasing

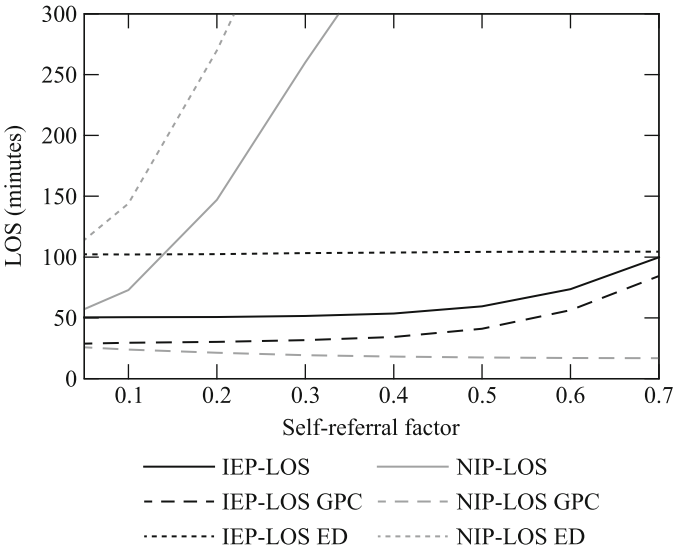

Fig. 8 LOS for different self-referral factors (% of total number of patients for case Almelo)

percentage of self-referrals, but the total increase in LOS in the IEP is not as high as in the NIP.

Percentage of self-referrals, when 50% of the self-referrals visit the GPC The situation at our partner organization might not be representative for other hospitals when it comes to the distribution of self-referrals over the GPC and the ED. Furthermore, new policies might influence self-referrals to the ED. Therefore, we varied the percentage of self-referrals (self-referral factor) for a situation in which 50% of the self-referrals choose to go to the ED and 50% choose to go to the GPC. The results are shown in Fig. 9. A similar effect is visible as in Fig. 8, i.e. the LOS in both the NIP and the IEP increases with a higher self-referral factor, but the difference is smaller compared to the situation in which only 5% of the self-referrals go to the GPC. The underlying reason is that the increase in number of self-referrals to the ED in the NIP, with increasing self-referral factor, is smaller, since 50% of all self-referrals visit the GPC.

Summary Concluding, our sensitivity analysis shows that (i) integrating the GPC with the ED without reconsidering the capacity usage might lead to a higher total LOS than in the NIP, (ii) integration is more beneficial for hospitals with a large number of self-referrals, and (iii) a financial or other incentive for patients to not directly go to the ED, but first visit a GPC, can limit (but not remove) the benefits of integrating the two organizations.

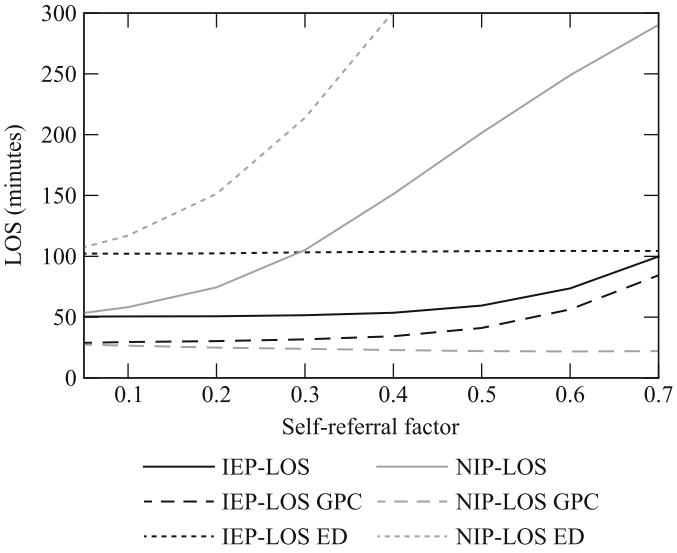

Fig. 9 LOS for different self-referral factors (% of total number of patients for case Almelo), given that 50% of all self-referrals go to the GPC

5.2 Case Enschede

For case Enschede, we perform two different analyses: a before-after analysis in Sect. 5.2.1, followed by an analysis of various process and capacity changes in Sect. 5.2.2.

5.2.1 Before-After Analysis

In the first experiment for case Enschede, we compare the current situation (NIP) with the proposed situation after the integration (IEP); see Table 6. Due to the integration, the average LOS in the GPC and the ED increases with 3.5 and 36.8 min, respectively, and the total LOS with 7.8 min. For the GPC, this can be explained by an increase in the number of patients, since due to the integration all self-referrals will visit the GPC leading to a higher utilization and thus a longer LOS. For the ED, this result is surprising, since less patients visit the ED, and thus a lower LOS can be expected. The increase in LOS, however, can be explained by the fact that the ED physicians at the hospital in Enschede are only allowed to see unlabelled patients (patients for which the urgency and the speciality are not known yet). In the integrated situation, less patients enter the ED, but all patients do have a label, which leaves the ED physicians without work.

From this comparison, we draw the following conclusions. Due to the integration, patients do not have a choice anymore where to go to. This leads to more patients

Table 6 Aggregate results of before-after comparison for case Enschede

Configuration	LOS (min)	LOS GPC (min)	LOS ED (min)
NIP	41.9	12.3	117.7
IEP	49.7	15.8	154.5

Table 7 Aggregate results of different configurations for case Enschede

Configuration	LOS (min)	LOS GPC (min)	LOS ED (min)
NIP	41.9	12.3	117.7
IEP	49.7	15.8	154.5
IEP + authority	40.0	15.9	111.7
IEP + TN	49.3	15.5	153.7
IEP + NP	44.7	9.7	157.0
IEP + GP	43.8	8.6	157.4
IEP + triage	48.6	16.2	148.0
IEP + rooms	49.3	15.6	153.5

in the GPC and less patients in the ED. If there is no extra capacity to deal with this increased number of patients at the GPC, the LOS increases. For the ED, the decrease in patients does not directly lead to a decrease in LOS due to the fact that the ED physicians are only allowed to treat non-labelled patients. Hence, in case Enschede, integrating the GPC and ED without making any process and capacity changes is not beneficial.

5.2.2 Process and Capacity Changes

The analysis in Sect. 5.2.1 shows results for a situation in which the integration takes place without changing the processes or capacities. We now analyse other configurations where the possibilities of the IEP are further explored. We first perform a one to one comparison of several interventions, followed by a 2^k factorial design of the most promising interventions.

The results for each experimental factor are shown in Table 7. For the situation where ED physicians are allowed to treat a broad spectrum of patients (authority), we see an increase in the LOS at the GPC (12.3 in the NIP to 15.9 in the IEP) and a decrease in the LOS at the ED (117.7 in the NIP to 111.7 in the IEP). The total LOS decreases with 1.9 min. Compared to the IEP without the broadened authority, we see a small (non-significant) increase in the LOS at the GPC (15.8 versus 15.9), a large decrease in LOS ED (154.5 versus 111.7), and a decrease in the total LOS (49.7 versus 40.0).

When an extra triage nurse (TN) is hired, we see an increase in LOS in the IEP compared to the NIP (total LOS +7.4, LOS GPC +3.2, LOS ED +36.0) and a small (non-significant) decrease compared to the IEP without extra interventions. An extra nurse practitioner (NP) and an extra general practitioner (GP) lead to a decrease of

the LOS GPC and an increase of the LOS ED and the total LOS compared to the NIP. Compared to the IEP, both interventions lead to a significant lower LOS GPC, a slightly higher LOS ED, and a lower total LOS.

When the same triage system is used (triage), a decrease of LOS is seen at the ED compared to the IEP with two different triage systems (154.5 to 148.0). Compared to the NIP, this intervention leads to a higher LOS for the GPC, the ED, as well as in total. Sharing rooms (rooms) has a small but non-significant effect compared to the IEP without sharing rooms for the GPC as well as the ED. Compared to the NIP, the total LOS as well as the LOS GPC and LOS ED is higher in the IEP with sharing rooms.

From these comparisons, we conclude that broadening the authority of the ED physicians has a positive influence on the LOS of the ED, compared to the NIP as well as the IEP without this intervention. Without this intervention, the LOS in the ED increases significantly due to the integration, leading to an unacceptable situation. Therefore, we take the IEP with broadened authorities as our base case for our further analysis. We further refer to this situation as IEP*. Looking at the other interventions, we see that hiring an extra NP and hiring an extra GP have a significant influence on the LOS at the GPC, where using the same triage system has a significant influence on the LOS at the ED. We therefore take these interventions into account in a further analysis, by performing a 2^k factorial design experiment. Summarizing, we take the IEP with broadened authority (IEP*) as base case and study the influence of the three other promising interventions.

Figure 10 shows the differences in LOS between the different experiments and the IEP*. From this figure, we see that using the same triage system is the

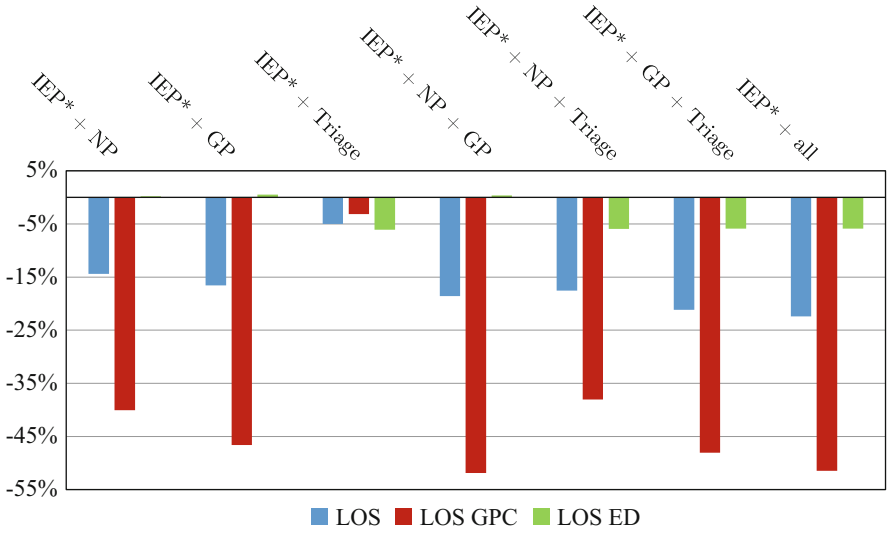

Fig. 10 LOS of various IEP settings compared to LOS IEP with broadened authority (IEP*)

only intervention changing the LOS at the ED, without interacting with the other interventions. In all experiments in which the triage system was changed, the LOS ED decreased with 6% (6.8 min). Hiring an extra NP and hiring an extra GP have a similar effect on the LOS at the GPC; the LOS GPC decreases with, 40% (6.4 min) and 47% (7.4 min) respectively. Hiring both an NP and a GP leads to a decrease of 52% (8.3 min). If all interventions are combined, the LOS GPC, ED, and total LOS decrease with, 51% (8.2 min), 6% (6.8 min), and 22% (9.0 min) compared to the IEP*, respectively. Compared to the NIP, we see a decrease of 37% (4.6 min) for the GPC, 11% (12.6 min) for the ED, and 26% (10.9 min) in total.

Summary We conclude that broadening the authority of the ED physician is needed for the integration to have a positive effect on the LOS ED. An extra decrease in LOS ED can be established by using the same triage system in the GPC and ED. To decrease the LOS GPC, it is possible to hire an extra NP, extra GP, or both. The added value of hiring them both, however, is low. Following these results, the ED and GPC in case Enschede decided to integrate into an IEP. Since the costs for hiring an extra GP are higher than for hiring an extra NP, the stakeholders decided to hire an extra NP to lower the LOS at the GPC. The total expected improvement compared to the NIP is a decrease in LOS GPC of 20% (2.5 min), a decrease in LOS ED of 11% (12.7 min), and a decrease in total LOS of 21% (8.9 min).

6 Conclusions

In this chapter, we studied the impact of integrating a general practitioner cooperative (GPC) with an emergency department (ED) into one integrated emergency post (IEP). To compare an IEP with a non-integrated post (NIP), we used simulation, since this allowed us to keep external factors the same for both situations. We used a model of an IEP developed by [20] and extended it to represent both the NIP and IEP for two case studies: case Almelo in a rural area and case Enschede in an urban area. By applying the simulation model to the NIP and IEP in both case studies, we showed the generic applicability of the proposed simulation model. Most differences between the NIP and IEP, and between the two case studies, could be taken into account by only changing the input parameters. For some case-specific differences, only small additions to the model were needed, resulting in a model that can be used at other organizations even easier. We used the model to perform various experiments, with the IEP and NIP under similar conditions, to analyse the effects of integrating the GPC and ED for both case studies.

For case Almelo, we conclude that integration turns out to be beneficial, given the performance measures used in this chapter. The length of stay (LOS) for both the GPC and the ED decreased due to the integration. The improvement in the LOS at the GPC is caused by the increase in capacity and the absence of travel times. Another advantage is that an IEP is more fair, since self-referrals at the ED in the NIP are treated faster than non-self-referring patients in the ED, while in the

IEP both have the same and lower LOS. Only limiting self-referrals to go to the GPC also has a positive impact on the ED but leads to a higher LOS at the GPC. This means that less urgent patients have higher waiting times, but the more urgent patients (those that actually need to be at the ED) are treated sooner. Overall, this is a preferable situation since patients at the ED are more urgent than patients at the GPC, and resources at the ED are more costly.

For case Enschede, we see that integration without any further changes will lead to a higher LOS for all patients. However, when some organizational changes are made, such as allowing the physicians to treat more patient types and using the same triage system in both organizations, we see a positive effect of the integration for the urgent ED patients. No extra investments are needed for these changes. However, with a relatively small investment in additional capacity, a reduction in LOS for all patient types can be achieved. After finishing our study, the GPC and the ED in Enschede decided to start collaborating and integrated into an IEP.

Concluding, we see that integrating a GPC and an ED into an IEP does not automatically mean that the LOS of all patients will be improved. However, when the authorities and the capacities in both organizations are aligned, a situation will occur that is beneficial for all patient groups.

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