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Cost effects of nurse led triage at an emergency department with the advice to consult the adjacent general practice cooperative for low-risk patients, a cluster randomised trial

Stefan Morreel [a,1,*], Ines Homburg [b,1], Hilde Philips [a], Diana De Graeve [b], Koenraad G. Monsieurs [c,d], Jasmine Meysman [b], Eva Lefevere [b], Veronique Verhoeven [a]

[a] Department of Family and Population Health, University of Antwerp, Doornstraat 331, Antwerp 2610, Belgium
[b] Department of Economics, University of Antwerp, Prinsstraat 13, Antwerp 2000, Belgium
[c] Department ASTARC, University of Antwerp, Universiteitsplein 1, Antwerp 2610, Belgium
[d] Emergency Department, Antwerp University Hospital, Drie Eikenstraat 655, Edegem 2650, Belgium

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ABSTRACT

Background: During the TRIAGE trial, emergency nurses diverted 13.3% of patients with low-risk complaints from a Belgian emergency department (ED) to the adjacent general practitioner cooperative (GPC). We examined the effects of this diversion on the total cost, insurance costs and patient costs, as charged on the invoice. Changes in the cost composition and the direct impact on revenues of both locations were examined as a secondary objective.

Methods: The differences in costs between intervention and control weekends were tested with two-sample t-tests and Kolmogorov-Smirnov (KS) tests. For the main outcomes an additional generalised linear model was created. Proportions of patients charged with certain costs were examined using Pearson's chi-square tests. Average revenues per weekend were compared using pooled t-tests.

Results: During intervention weekends, total costs increased by 3% (€3.3). The costs decreased by 8% (€2.2) for patients and increased by 6% (€5.5) for insurance, mainly driven by differences in physician fees. More patients were charged a consultation fee only (25% vs. 19%, p-value<0.01). The GPC's revenues increased by 13% (p-value=0.06); no change was found for the ED's revenues.

Conclusion: The intervention reduced costs slightly for patients, while total costs and insurance costs slightly increased. When implementing triage systems with primary care involvement, the effects on the costs and revenues of the stakeholders should be monitored.

1. Introduction

The steady increase in crowding at Emergency Departments (EDs) worldwide raises concerns about inappropriate use of EDs. Particularly during out-of-office hours (OOH), a substantial number of patients present at the ED on their own initiative for non-urgent health problems [1–3]. In Belgium, 70% of ED patients are self-referred and 40–56% are not in direct need of hospital care [4]. This raises the question whether some of these patients could be managed more appropriately in other settings [5]. To improve access to OOH primary care, many European countries are increasingly providing care in General Practitioners Cooperatives (GPCs). Despite the associated increase in primary care utilisation, many patients continue to make unnecessary ED visits [6]. Evaluations have indicated that the rise of GPCs has not necessarily led to a reduction in workload at the ED, but better access to after-hours primary care may reduce non-urgent ED utilisation [7,8]. Unnecessary ED visits result in a high workload for health professionals, decreased patient satisfaction, and reduced quality of care. Some authors argue that inappropriate ED use could lead to unnecessary healthcare spending [9,10]. Therefore, measures should be taken to assist patients in choosing the most appropriate care setting.

One solution is extended triage, the combination of a validated triage

* Corresponding author.
E-mail address: stefan.morreel@uantwerpen.be (S. Morreel).
[1] These authors contributed equally to this work.

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system at the ED with an extension to allow diversion of appropriate patients to the GPC. Classic triage systems, such as the Manchester Triage System (MTS), set treatment priorities, but are as such not suitable for a diversion to primary care [11]. An extended triage tool adds assignment to the most appropriate treatment site (ED for patients in need of urgent or advanced care and GPC for low-risk patients) to the triage system. Previous non-randomised studies have shown promising results but have seldomly included a financial evaluation [12–15].

The Belgian healthcare system is organised into primary (such as GPs), secondary (general hospitals), and tertiary care (specialised hospitals), with open access for patients to all levels. It is mainly organised as a fee-for-service system. The fees for healthcare services are the result of historical negotiations between doctors' unions, semi-private health insurance funds, and the Belgian government. These fees do not necessarily reflect the actual costs to deliver the services. During OOH care, the health insurance's share is charged directly to the health insurance providers [4]. At the GPC, patients pay their share immediately on-site, while at the ED, the invoice is sent a few months later. At the time of the current study, Belgian GPCs were only open during weekends. During weeknights, GPs performed their on-call services at their own practices.

Different mechanisms may generate cost effects of extended triage. First, there are differences between consultation fees of ED physicians and general practitioners (GPs). In Belgium, the magnitude and the direction of these differences depend on the medical speciality of the physician and on the arrival time of the patient [4]. For instance, consultations during the night are more expensive at the GPC than at the ED, while the opposite occurs during daytime. Fees for technical procedures (e.g., sutures for a laceration, or resuscitation in case of cardiac arrest) also differ between physicians and even amongst ED physicians with different professional degrees. Second, different physicians treat similar patients differently in terms of diagnostic procedures, treatments, and hospitalisations which might have an impact on costs. Low-risk ED patients diverted to the GPC might receive a different treatment than they would receive at the ED. This variation has been described between GPs working in a private practice versus an ED [16]. Variation in practice style between GPs and ED physicians has been reported as well [17]. Further, when some patients are referred to the GPC, ED physicians might treat their remaining patients differently leading to changes in costs [18].

To guide Belgian policymakers and further implementation of extended triage, we designed a large, randomised trial to assess whether cost differences arise in practice. Previous studies were insufficient, as few assessed the economic impacts of a reduction in inappropriate ED use and had important methodological limitations [8]. For instance, no studies used a randomised design. Some studies found that the presence of a GP inside the ED led to an improvement in the effectiveness and quality of care and was less expensive than the usual care method, as they used fewer resources than usual ED staff [19–22]. Other studies focused on cost changes when a GPC and ED collaborate. Most of these studies simply compared costs of patients treated at a GPC or in the ED, without considering that patient characteristics might differ between the two settings. Several studies found small cost savings [23,24], while others found an increased cost per patient in the integrated model [25,26]. One study examined the cost savings when diverting self-referred, non-urgent children who present at the ED to the GPC [24]. This prospective observational before-after study found that overall cost benefits of the triage were minimal. The evidence supporting that care models aimed at reducing inappropriate use are financially beneficial remains weak. If savings are realised, this is likely to be overshadowed by the overall cost of introducing an alternative service [27,28]. Finally, although diverting low-severity patients might reduce costs, compared with strategies aimed at reducing admissions, and to a lesser extent improving the efficiency of ED care for intermediate or complex conditions, the potential is small [29].

This article is the first to use a cluster randomised design to investigate the cost effects of diverting ED patients with primary care problems from a Belgian urban general hospital to the adjacent GPC. The clinical results of this trial have been published elsewhere [30]. In this article, we examined whether diverting patients to primary care has an impact on total costs and on the costs for the social insurance and the patients, as charged on the invoice. In addition, we investigated which type of medical treatment drives the changes in costs and how the cost composition of the invoice changes. As a secondary objective, the direct impact of the intervention on the revenues of the ED and GPC was examined.

2. Materials and methods

2.1. The TRIAGE trial

The TRIAGE trial was designed to determine the effects of an extended nurse-led triage system that diverts low-risk patients from a Belgian ED to a GPC. This single-centre, clustered randomised trial ran from 01/03/2019 to 30/12/2019 during OOH care. OOH care is internationally and locally defined as care provided between 7.00 pm and 8 am and during weekends and public holidays. The current study only involves weekends and holidays because the GPC was not open during weeknights [31]. Patients were the units of analysis and weekends (Friday 7 p.m. until Monday 7 a.m.) or bank holidays, hereinafter referred to as weekends, were the units of randomisation. During the trial, a trained nurse performed an extended triage at the ED and assigned patients to the ED or GPC. During intervention weekends, patients with a low risk for hospital care were advised to visit the GPC. Patients had the right to refuse the advice. During control weekends, patients were not informed about the GPC as the advice was recorded in the patient's file but not communicated to the patient. The study was carried out at the ED of an urban general hospital and at the adjacent GPC. The surroundings consist of ethnically diverse middle income and socially deprived neighbourhoods. The ED is staffed by approximately 10 physicians and 25 nurses, who managed 33 027 contacts in 2018. Compared to other Belgian EDs, this workload is on the 75th percentile. The GPC covers a neighbourhood of 145 000 inhabitants and all 110 GPs working in the area are required to work at least one shift per month in the GPC. In 2018, the cooperative handled 10 586 consultations. The GPC moved from a location nearby to a building adjacent to the ED two years prior to this study.

The population of the study site is comparable to other Belgian cities and suburban areas in Europe. Although important national differences exist, the GPC is increasingly the dominant model for organisation of OOH primary care in Europe [32]. More than half of the Organisation for Economic Co-operation and Development member states have established gatekeeping systems (GP referral is required to access secondary care) while in Belgium, ED and GPC are freely accessible [33,34].

For this study, all patients presenting at the ED during the trial were assessed for eligibility ($N = 9964$). Patients arriving in a physician- or nurse-staffed ambulance, patients already admitted to the hospital, and patients referred to the ED by a GP or specialist were excluded because they already underwent a triage. Patients without a social insurance number were excluded as it was not possible to link their data from the ED to the data from the GPC. The final study population consisted of 8158 self-referred patients.

The extended triage was performed using a newly developed extension to the MTS [35]. It consists of 53 flowchart diagrams, each specific to a reason for encounter (e.g., abdominal pain). Every flowchart consists of discriminators (e.g., mild pain), eventually leading to an urgency category ranging from level one (immediate care necessary) to level five (non-urgent) [36]. In the extended version, additional discriminators in the two lowest urgency categories were added to 44 flowcharts to determine the most appropriate caregiver (ED physician or GP).

The TRIAGE trial demonstrated that a sustainable, safe diversion of low-risk ED patients to primary care is possible using the extended MTS.

During intervention weekends, 838/6294 patients (13.3%, 95% CI 12.5 to 14.2) were assigned to visit the GPC, of which 599/6294 (9.5%, 95% CI 8.8 to 10.3) followed the advice and were treated by a GP. Of these, 24 were referred back to the ED and three were admitted. More detailed results on the trial and its methodology are reported elsewhere [30].

2.2. Outcome measures

The primary outcomes of this study are the total cost of all medical services delivered to the patient, the share of these costs for the patient, and the share of these costs reimbursed by the social health insurance. For this study, costs are defined as the prices that appear on the invoice of the patient for the supplied medical services. These costs do not necessarily reflect the opportunity costs of the delivered service. Additional outcomes are the different cost categories (physician fees, medical imaging, technical procedures, medication, and non-refundable items) and whether certain cost categories were charged. The secondary outcomes are the total revenues for the delivered medical services of the GPC and the ED during the trial. Some of the revenues described as 'ED revenues' do not go directly to the ED or ED staff but to other services of the study hospital, such as the radiology department.

2.3. Data collection

The following data were collected using iCAREdata, a database of OOH care medical records [37,38]: patient's age, sex, residence (living within the communities covered by the GPC or not), and socio-economic status (receiving increased reimbursement or not); MTS flowchart (53 flowcharts combined into 15 categories); time period (day, evening, or night); subjective crowding at the ED (quiet, normal, busy). The data from the ED and GPC were linked through their pseudonymised national insurance number.

Patient-level data on the costs of treatment at the ED and GPC were received from the billing department of the hospital and the GPC, respectively. The data consisted of the nomenclature (billing) codes of all provided medical services and their costs. The cost for 87 study patients were not reimbursed by the social health insurance but by a private insurance company or another government institution. Because the paying party does not influence the total costs, these costs have been added to those of the social health insurance (further referenced to as insurance). The nomenclature codes were grouped to construct different cost categories: consultation fees, medical imaging, technical procedures, medication, non-refundable items, and the total billing cost of all medical services. Supplementary fees linked to other costs, such as a night time consultation supplement, have been added to the cost category they are linked to. The category non-refundable items consists of various articles at the request of the patient (e.g., a toothbrush) or necessary for their medical care (e.g., crutches). Costs for medication only include the medication given to the patient during a consultation. The invoices were matched with the medical records based on sex, birth year, postal code, and time. Laboratory tests are in general billed by a separate department and were not routinely available for the study.

Only costs directly related to the care of individual patients and thus appearing on the patient's invoice were studied. The GPC and the ED have additional revenues, such as government funding for staff and infrastructure, which were not analysed. Patient-level data on medical imaging ordered by the GP were unavailable. However, GPs seldomly order medical imaging. During the second semester of 2019, medical imaging was ordered for only 77 out 5747 GPC patients (1.3%, 95%CI 1.1–1.7).

2.4. Study population

For our primary objective (the impact of the intervention on costs), we included all study patients in the TRIAGE-trial. For our secondary objective (the impact of the intervention on the revenues for the study sites) we included all patients who received an invoice from the ED or the GPC during the trial period. This included patients who visited the GPC without a prior ED visit. Patients with a missing invoice were excluded.

For our primary objective, we excluded patients who were hospitalised. Their ambulatory invoice was not representative of their costs at the ED and thus not comparable to ambulatory patients. Further due to the complex reimbursement system in Belgium, some ED costs appear on the invoice for the hospitalisation while others are not reimbursed in case of a hospitalisation.

For the secondary objective (impact of the intervention on the revenues of the ED and GPC), hospitalised patients were not excluded as these analyses did not require comparisons between patient groups. Weekends that include bank holidays and bank holidays in the week were excluded for the secondary outcome as the length of these was more than a standard weekend, naturally leading to different total revenues.

2.5. Statistical analyses

To test whether the randomisation was successful, patients' socio-demographic and medical characteristics were compared between control and intervention weekends using Pearson chi-square tests.

For the primary objective, mean costs were compared using a pooled *t*-test or a *t*-test for unequal variances, depending on which was most appropriate according to an F-test. Although the TRIAGE trial was randomised, a regression analysis could increase statistical power, and thus a generalised linear model (GLM) with a log-gamma link was created for the total costs, the total share for patients, and the total share for the insurance. This model allowed us to estimate mean costs as a function of a set of covariates and is robust to outliers or asymmetries in the data distribution. As the invoice data were highly skewed with a long tail to the right (medcouple = 0.02). It was not suitable to study the composition of the invoices, as these categories contained many zero values [39]. A sensitivity analysis excluding four outliers with very high costs (above €1000) was executed in order to check whether these few records influenced the overall results.

Combined Kolmogorov-Smirnov (KS) two-sample tests were used to examine whether the samples from the intervention and control weekends were from populations with the same distribution. The KS test is an appropriate nonparametric test, as the invoice data were skewed and the direction of the effect was unknown prior to the analysis. Compared to a *t*-test, the KS test is sensitive for all types of differences that may exist between the two distribution functions, including differences in mean, median, or variance [40]. In case of a significant difference in the distributions, a one-sided KS test was used to assess the directions of this (ese) difference(s).

The cumulative density functions of the total cost per patient and the costs for different cost categories were analysed. Such an analysis allows to understand the changes caused by the intervention more precisely. The proportion of patients to whom a certain cost category or a combination of certain categories was billed was compared between intervention and control weekends using Pearson's chi-square tests.

For the secondary objective, the average number of treated patients and average revenues per weekend were compared between intervention and control weekends using a one-sided pooled *t*-test. An increase was expected for the GPC, while a reduction was assumed to occur at the ED.

Data were analysed using JMP Pro® version 15.0 (SAS institute) and Stata 17.0 (StataCorp LLC, College Station, TX USA). The significance level for all tests was set at 0.05.

3. Results

3.1. Study population

During the TRIAGE trial, 8158 patients were assessed for eligibility. The intervention group consisted of 6374 (78.1%) patients and the control group of 1784 (21.9%) patients [30]. Because of subsequent hospitalisation, 1339 (16.4%) patients were excluded for the analysis of our primary objective. Another 338 (4.1%) patients were excluded, as their ED invoice data was missing ($N = 299$) or because no match could be made between invoice and medical data ($N = 39$). Missing invoices were uniformly distributed over time. The mean number of patients with a missing invoice and the mean number of hospitalised patients, as well as their characteristics, did not significantly differ between intervention and control weekends (see Appendix S1 and S2). The resulting sample consisted of 6481 patients, 5069 (78.2%) presented during intervention weekends and 1412 (21.8%) during control weekends. Of these patients, 543 received an invoice from the GPC and 5888 from the ED. Due to a mistake from the billing department ($N = 34$) or due to being referred back to the ED ($N = 16$) by the GPC, 50 patients received an invoice from both care settings.

The sample to analyse the revenues (secondary objective) consisted of 5898 patients with invoices from the ED and 8011 patients with invoices from the GPC, spread over 30 intervention weekends and 9 control weekends.

3.2. Sample characteristics

Appendix S3 compares patient characteristics between intervention and control weekends. The differences in socio-demographic characteristics (age, sex, socio-economic status, and residence) as well as the presenting medical complaint were not significant.

During intervention weekends there was a limited shift from the urgency categories four and five towards more urgent categories (p-value=0.049) (see Appendix S4). The selection of a certain urgency category is thus not independent from the intervention. As a result, comparing costs between control and intervention weekends within urgency categories was not appropriate.

3.3. Comparison of summary statistics

Table 1 provides a comparison of summary statistics for the total cost of care and various cost categories between intervention and control weekends. During control weekends, the mean total cost per patient was

Table 1
Comparison of summary statistics for the total cost of care and various cost categories between intervention and control weekends. All costs are expressed in euro 2019.

		Intervention(n = 5069)	Control(n = 1412)	Total(n = 6481)	p-value combined KS two-samples test	p-value t-test for unequal variances
Total invoice						
Total cost	Mean (SD)	122 (116)	119 (117)	122 (116)	<0.01	0.34*
	Median (IQR)	90 (49–137)	88 (49–135)	90 (49–137)		
Physician fees	Mean	46 (13)	46 (11)	46 (13)	<0.01	0.65
	Median	49 (39–49)	49 (39–49)	49 (39–49)		
Medical imaging	Mean	28 (58)	24 (51)	27 (56)	0.05	0.05
	Median	0 (0–28)	0 (0–28)	0 (0–28)		
Technical procedures	Mean	42 (68)	42 (79)	42 (71)	0.28	0.97
	Median	23 (0–53)	21 (0–48)	23 (0–48)		
Non-refundable items	Mean	3 (7)	3 (6)	3 (7)	0.49	0.70
	Median	0 (0–2)	0 (0–2)	0 (0–2)		
Delivered medication	Mean	3 (14)	2 (6)	3 (13)	0.49	0.28
	Median	0 (0–2)	0 (0–2)	0 (0–2)		
Share for the patient						
Total cost	Mean (SD)	26 (28)	28 (36)	26 (30)	<0.01	0.014
	Median (IQR)	23 (12–31)	23 (15–31)	23 (13–31)		
Physician fees	Mean	16 (10)	18 (9)	17 (10)	<0.01	<0.01
	Median	21 (12–21)	21 (12–21)	21 (12–21)		
Medical imaging	Mean	2 (9)	2 (12)	2 (9)	0.61	0.29
	Median	0 (0–2)	0 (0–2)	0 (0–2)		
Technical procedures	Mean	3 (11)	3 (17)	3 (12)	1.00	0.41
	Median	0 (0–2)	0 (0–2)	0 (0–2)		
Non-refundable items	Mean	3 (7)	3 (6)	3 (7)	0.51	0.68
	Median	0 (0–2)	0 (0–2)	0 (0–2)		
Delivered medication	Mean	1 (4)	1 (4)	1 (4)	0.51	0.72*
	Median	0 (0–1)	0 (0–1)	0 (0–1)		
Share for the insurance						
Total cost	Mean (SD)	97 (108)	91 (109)	95 (109)	<0.01	0.092*
	Median (IQR)	62 (33–107)	57 (28–104)	61 (33–107)		
Physician fees	Mean	30 (14)	28 (11)	30 (13)	<0.01	<0.01
	Median	28 (25–37)	28 (27–37)	28 (25–37)		
Medical imaging	Mean	26 (55)	22 (48)	25 (54)	0.54	0.02
	Median	0 (0–27)	0 (0–27)	0 (0–27)		
Technical procedures	Mean	39 (65)	39 (74)	39 (68)	0.37	0.91
	Median	20 (0–48)	16 (0–46)	20 (0–46)		
Non-refundable items	Mean	0 (1)	0 (1)	0 (1)	1.00	0.86*
	Median	0 (0–0)	0 (0–0)	0 (0–0)		
Delivered medication	Mean	1 (12)	1 (3)	1 (11)	0.96	0.28
	Median	0 (0–0)	0 (0–0)	0 (0–0)		

* Pooled t-test, most appropriate according to F-test for unequal variances.
SD: Standard Deviation.
IQR: Interquartile Range.

€119 (median €90). Costs during intervention weekends were on average 3% more expensive, with an average total cost of €122 (median €90). This difference in mean was not significant according to the to the *t*-test, but in the log-gamma GLM it was significant (see Appendix S5). The KS test indicated that the two samples did not have equal distributions. When examining the various cost categories separately, the KS test was only significant for the physician fees. However, the median (€49) and the mean (€46) were similar during control and intervention weekends. A small difference was also visible in the costs for medical imaging. The average cost for this type of service was higher during intervention weekends (€28 compared to €24).

The second part of Table 1 shows the share of the cost borne by the patient and by the insurance. On average, patients had an invoice of €26 and €28 during intervention and control weekends, respectively. This cost reduction of about 8% was significant both according to the *t*-test and the GLM model (see Appendix S5). The KS test indicated that the distributions differed between both groups. This difference was driven by the physician fees. The mean consultation fee was significantly higher during control weekends. The opposite was found when examining the costs for the insurance. The mean total insurance cost during intervention weekends was around 6% higher than during control weekends, namely €97 compared to €91. This increase was significant at the 0.10 level according to the *t*-test and at the 0.05 level in the GLM (see Appendix S5). The KS test indicated that the two samples had significantly distinct distributions. Again, this was driven by higher consultation fees. In addition, the average cost for medical imaging borne by the insurance was higher during interventions.

A sensitivity analysis excluding four outliers with extremely high costs (above €1000) revealed similar results even though the significance of the difference in patient's share decreased and insurance's share increased (see Appendix S6).

3.4. Cumulative density functions

Fig. 1 plots the cumulative density function of the total cost per patient for both intervention and control weekends. A remarkable difference between weekends can be observed at the lowest percentiles (one-sided KS p-value<0.01). During intervention weekends, a relatively large fraction of patients had a total cost of around €39, indicative of the most common OOH-consultation fee of a GP [41]. Compared to control weekends, a smaller fraction of patients had a cost of approximately €49, which corresponds with the consultation fee of an ED physician.

The cumulative distributions of physician fees (see Fig. 2) show that during intervention weekends, two shifts occurred. First, an additional fraction of patients paid a typical €39 consultation fee of a GP. Therefore, the distribution of costs during intervention weekends contains significantly smaller values than the distribution during control weekends (one-sided KS p-value<0.01). At the higher percentiles, the opposite is observed. During intervention weekends, a small group of patients was charged €52, the typical consultation fee for a GP at night [41]. The intervention group then contains larger values than the control group (one-sided KS p-value<0.01). Thus, the null hypothesis that the distribution of consultation fees is equal in intervention and control weekends is rejected (KS p-value<0.01). The cumulative density functions of the costs for medical imaging, technical procedures, medication, and non-refundable items are similar between intervention and control weekends (see Appendix S7).

3.5. Cost composition of the invoice

Table 2 shows the composition of the invoices. During both intervention and control weekends, 98% of patients were charged a consultation fee. For the remainder, the hospital probably made an administrative mistake.

Regarding the extent to which this consultation fee was combined with other costs, two groups of patients can be described. First, there is a considerable group of patients to whom, apart from the consultation fee, very little or no other costs were charged. During control weekends, almost one fifth of the patients (19%, 95%CI: 17 to 21) paid for a consultation only. For another 10% (95%CI: 9 to 12), a consultation fee was combined with medication. The average cost of medication for these patients was €3. For 5% of the patients (95%CI: 4 to 6), the consultation was combined with non-refundable items. For these, the average cost of items was €3. Finally, 8% (95%CI: 6 to 9) had a consultation combined with medication and non-refundable items. The sum of medication and non-refundable items was on average €8 for these patients. A second group of patients had an invoice consisting of more substantial costs. Technical procedures were carried out for 54% (95%CI: 51 to 56) of patients seen during control weekends, with an average cost of €79 for them. Medical imaging was charged for 39% (95%CI: 36 to 41), costing on average €63 per patient.

A similar trend was observed during intervention weekends. However, significantly more patients were only charged a consultation fee, namely 24% (95%CI: 23 to 26, $p<0.01$). This was paired with a smaller fraction of patients for whom the consultation fee was combined with

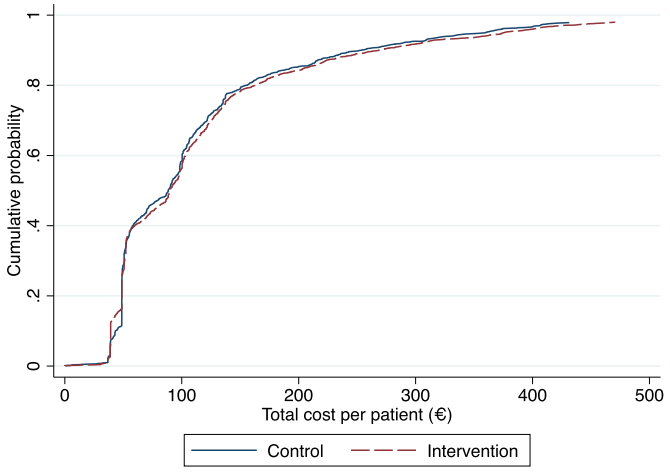

Fig. 1. Cumulative density function of the total cost (in euro 2019) per patient for intervention and control weekends. The x-axis has been restricted to the 98th percentile, otherwise the limited number of patients with a very high cost reduce the readability of the graph.

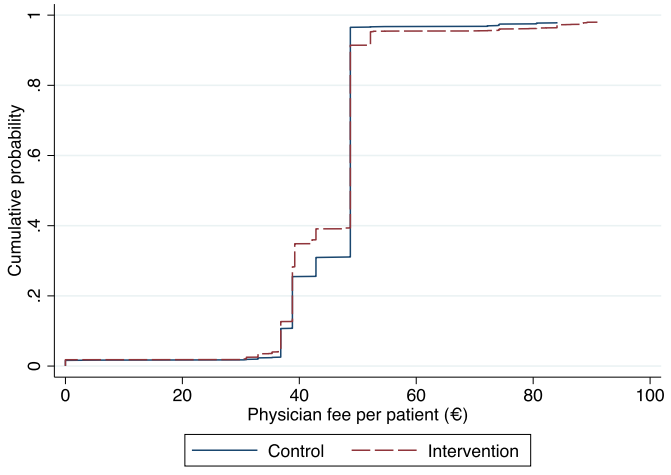

Fig. 2. Cumulative density functions of the physician fee cost (in euro 2019) per patient for intervention and control weekends. The x-axis has been restricted to the 98th percentile, otherwise the limited number of patients with a very high cost reduce the readability of the graph.

Table 2
Composition of the invoice per patient for intervention and control weekends.

	Intervention (%) (n = 5069)	Control (%) (n = 1412)	p-value chi-square test
Consultation fee	4977 (98%)	1389 (98%)	0.64
Medication	2216 (44%)	652 (46%)	0.10
Medical imaging	1983 (39%)	545 (39%)	0.72
Technical procedures	2773 (55%)	760 (54%)	0.56
Non- refundable medication/ items/procedures	2295 (45%)	674 (48%)	0.10
Only consultation fee charged	1239 (24%)	271 (19%)	<0.01
Only consultation fee and medication charged	393 (8%)	147 (10%)	<0.01
Only consultation fee and non-refundable items charged	167 (3%)	64 (5%)	0.03
Only consultation fee, medication, and non-refundable items charged	283 (6%)	110 (8%)	<0.01

either medication or non-refundable items. No differences were observed in the number of patients charged for technical procedures and medical imaging.

3.6. GPC and ED revenues

During intervention weekends, the GPC's revenues were on average 9885€ (13%) higher than during control weekends (€8608 vs. €7619, p-value=0.03). The mean number of patients seen per weekend increased as well, although not significantly (210 vs. 190, p-value=0.06). For the ED, no significant effect was found in the average revenues (€19,228 vs €18,869, p-value=0.65). The number of patients seen per weekend decreased by 6% (149 vs. 159, p-value=0.05). See Appendix S8 for an analysis of the revenues and number of patients per weekend.

4. Discussion

The invoices of 6481 patients, 5069 (78.2%) from intervention weekends and 1412 (21.8%) from control weekends, were analysed. There was a small increase of 3% (€3.3) in the mean total costs per patient. The GPC's revenues increased by 13% during intervention weekends while no reduction was found for the ED's revenues. Average costs decreased 8% (€2.2) for the patient and increased 6% (€5.5) for the insurance during intervention weekends.

An increase in the average cost for medical imaging (€28 vs. €24, p-value=0.05) during intervention weekends was found. A possible explanation for this increase is that need for medical imaging (which was always linked to an ED assignment) was an important item (discriminator) in the extended MTS triage [47]. Diverting a fraction of patients towards the GPC reduced the number of patients with small additional charges, such as medication or non-refundable items. This suggests that apart from cost for medical imaging, cost shifts due to the intervention occurred within the group of patients who would have received a moderate invoice anyway (consisting of a consultation and medication/refundable items).

Our findings are similar to previous findings that the potential cost savings of diverting low acuity patients from ED to GPC are limited [29]. The minor cost differences might be related to the small proportion of diverted patients (10%) as compared to similar studies that reported a diversion of around 20% [42,43]. The total cost increase we found was mainly due to an increase in the cost of medical imaging and has to be monitored closely. We could not detect an increase for the other categories, but the study was not designed to study them, so a small effect on these costs in any direction cannot be excluded. Policy makers should be aware of a possible (small) cost increase when implementing extended triage.

The small increase in total costs does not necessarily mean the intervention was not useful from a clinical perspective. For example, the ED staff considered the triage helpful and found it a positive experience [48]. Given the shortage of specialised ED nurses, a rewarding working environment is important [44]. Additionally, ED crowding is associated with worse quality of care and worse perception of care, the studied intervention might mitigate this effect [45]. There may also be a long-term effect, as patients who were previously introduced to the GPC will visit a GP more readily in the future [46].

On average, the intervention was associated with a lower invoice paid for by the patient (€26 vs. €28) and a higher invoice for the insurance (€97 vs. €91). The share of the invoice borne by the patients decreased, driven by the physician fees. GPC consultations offer higher reimbursements from the insurance, such that only about a quarter is paid by the patient. In the ED, the patient pays almost half of the cost. Extended triage can be used to make emergency healthcare more accessible, especially because more patients with a low socio-economic status were diverted to the GPC [30].

The GPC had a revenue increase of almost 13% (€8608 vs. €7619), while no reduction of the revenues at the ED was found. However, we cannot definitely exclude any loss at the ED, as the standard deviation on its mean revenues per weekend was large, the expected loss was small, and this outcome was a secondary objective only. It is possible that the ED treated the remaining patients during intervention weekends more intensively. The increase in the costs of medical imaging points in this direction. To mitigate shifts in income from ED to GPC, implementation of extended triage should be accompanied by a reform of the funding structure of the entire OOH system. One aim of the TRIAGE trial was to reduce health insurance costs, not to increase the revenues of the GPC so this reform should focus on a financing system that rewards efficient patient care and not the delivery of technical procedures and consultations. Under the intervention, the ED invested in personnel (receptionists and triage nurses) for triage that generated revenues for the GPC. At least partially, GPC and ED should be financed together so they have an incentive to collaborate efficiently. Synergies can be found in the sharing of infrastructure and staff.

In this study, one out of every four patients assigned to the GPC refused the extended triage and remained at the ED [30]. If the proportion of refusers is minimised, which can be achieved by making the advice compulsory or by improving patient-nurse communication, then cost changes may be larger [24,49]. Policy makers should consider an obligation to follow a GPC assignment while taking into account the patient's perspective.

Our study has some limitations. No sample size calculations were made because the size of the convenience sample was determined by the medical outcomes of the TRIAGE trial. Comparing costs between control and intervention weekends by urgency category was not possible since the categories were not independent from the intervention. Such an analysis would capture not only the impact of the intervention, but also the influence of a different and more selective allocation to low urgency categories by the nurses on duty. Doing so would overestimate the savings during intervention weekends giving the higher costs for higher urgency categories. However, when comparing the total cost and various cost categories for only urgency categories four and five, the results were similar (see Appendix S9). Second, there was no full insight into the costs and revenues. Patient level data on medical imaging ordered by the GP and clinical laboratory tests from both settings were not available. We are confident that both imaging and laboratory test are rarely used at the GPC, but do not know the impact on laboratory testing at the ED. We did not study short- and long-term follow-up costs after the ED or GPC consultation. This article analysed only the invoice costs, which do not include all resources used and revenues generated. The GPC and ED have other costs and incomes, such as government funding for staff and infrastructure. Some of these are influenced by the number of patients. Fixed costs (e.g., infrastructure), costs related to the nursing staff or the ED's equipment, additional costs for implementing and executing the triage, and spillover effects, such as a decreased waiting time or patients refusing advice and leaving without care, were also not

considered. Finally, caution is recommended when generalising our results. The study population is representative for other Belgian cities and to a certain extent to other European suburban districts. However, the findings may not be replicable in other settings because they were mainly driven by pricing differences in physician fees, which is country specific. These fees can change after new fee negotiations. Especially the large difference in night-time and day-time fees for the GP as compared to the ED physician is typical for the local healthcare system. Despite this limitation, our results do implicate a clear warning that implementing extend triage does not necessarily lead to a cost reduction, on the contrary, it might lead to an overall cost increase. Our findings support the need for thorough financial evaluation within a specific healthcare system before the implementation of extended triage in that system can be considered.

5. Conclusions

Using a cluster randomised controlled trial on extended triage, we analysed the cost effects of diverting ED patients to the adjacent GPC. Costs decreased significantly for a fraction of patients, mainly due to pricing differences in consultation fees between ED physicians and GPs. The limited cost effects occurred within the group of patients who would have received a moderate invoice anyway. The intervention reduced the patients' share of the total invoice by 5% due to lower co-payment at the GPC, but also increased cost of the social health insurance by 7%, mainly because GPC visits are reimbursed at a higher percentage than ED visits. The GPC's revenues increased with 13% due to the intervention, while no significant decrease was found at the ED. When implementing extended triage systems, the effects on the costs for patients and the government and the effects on the revenues of the involved healthcare services should be closely monitored. Further implementation of extended triage should be embedded in a reform of the funding for the OOH care system.

Data statement

The studied data is available to researchers worldwide after following the application procedures of iCAREdata (see icaredata.eu). Given the privacy policy of the iCAREdata database, the authors are not allowed to share the used data as supporting information or in a public repository. Sharing this database would potentially harm the privacy of the included patients. The Belgian Data Protection Authority does not allow the authors to share the raw data. The authors are, however, able to deliver a selection of variables and the outputs of their statistical software upon reasonable request. Such a request should be directed towards the authors or icaredata@uantwerpen.be.

CRediT authorship contribution statement

Stefan Morreel: Conceptualization, Methodology, Funding acquisition, Formal analysis, Data curation, Validation, Writing – original draft, Writing – review & editing. **Ines Homburg:** Formal analysis, Data curation, Validation, Writing – original draft, Writing – review & editing, Visualization. **Hilde Philips:** Conceptualization, Methodology, Funding acquisition, Supervision, Project administration. **Diana De Graeve:** Conceptualization, Methodology, Funding acquisition, Formal analysis, Data curation, Validation. **Koenraad G. Monsieurs:** Conceptualization, Methodology, Funding acquisition, Supervision, Project administration. **Jasmine Meysman:** Conceptualization, Methodology, Funding acquisition. **Eva Lefevere:** Conceptualization, Methodology, Funding acquisition. **Veronique Verhoeven:** Conceptualization, Methodology, Funding acquisition, Supervision, Project administration.

Declaration of Competing Interest

SM is a general practitioner working in the surroundings of the study site, and as such, he performed on call shifts at the study site and treated some of the studied patients. Due to the anonymity of the studied data, the exact number of study patients seen by him cannot be determined, but it was below ten. He is also a board member of the studied general practice cooperative receiving meeting fees. HP is coordinator of the iCAREdata project. She had an appointment at the University of Antwerp for this project until September 2020. The authors declare no other relationships or activities that could have influenced the submitted work.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.healthpol.2022.08.002.

References

[1] Carret ML, Fassa AG, Kawachi I. Demand for emergency health service: factors associated with inappropriate use. BMC Health Serv Res 2007;7(1):1–9. Artn 13110.1186/1472-6963-7-131.

[2] Durand AC, Gentile S, Devictor B, Palazzolo S, Vignally P, Gerbeaux P, et al. ED patients: how nonurgent are they? Systematic review of the emergency medicine literature. Am J Emerg Med 2011;29(3):333–45. https://doi.org/10.1016/j.ajem.2010.01.003.

[3] Kraaijvanger N, Rijpsma D, van Leeuwen H, van Dijk N, Edwards M. Self-referrals in a Dutch emergency department: how appropriate are they? Eur J Emerg Med 2016;23(3):194–202. https://doi.org/10.1097/MEJ.0000000000000216.

[4] Van den Heede K, Dubois C, Devriese S, Baier N, Camaly O, Depuijdt E, et al. Organisation and payment of emergency care services in Belgium: Current situation and options for reform. Belgian Health Care Knowledge Centre (KCE); 2016.

[5] Cooper A, Carson-Stevens A, Hughes T, Edwards A. Is streaming patients in emergency departments to primary care services effective and safe? BMJ 2020;368:m462. https://doi.org/10.1136/bmj.m462.

[6] Colliers A, Remmen R, Streffer ML, Michiels B, Bartholomeeusen S, Monsieurs KG, et al. Implementation of a general practitioner cooperative adjacent to the emergency department of a hospital increases the caseload for the GPC but not for the emergency department. Acta Clin Belg 2017;72(1):49–54. https://doi.org/10.1080/17843286.2016.1245936.

[7] Goncalves-Bradley D, Khangura JK, Flodgren G, Perera R, Rowe BH, Shepperd S. Primary care professionals providing non-urgent care in hospital emergency departments. Cochrane Database Syst Rev 2018;2:CD002097. https://doi.org/10.1002/14651858.CD002097.pub4.

[8] Hong M, Thind A, Zaric GS, Sarma S. The impact of improved access to after-hours primary care on emergency department and primary care utilization: a systematic review. Health Policy 2020;124(8):812–8. https://doi.org/10.1016/j.healthpol.2020.05.015.

[9] Berchet C. Emergency care services: trends, drivers and interventions to manage the demand. OECD Health Working Papers. 2021. doi:10.1787/18152015.

[10] Uscher-Pines L, Pines J, Kellermann A, Gillen E, Mehrotra A. Deciding to visit the emergency department for non-urgent conditions: a systematic review of the literature. Am J Manag Care 2013;19(1):47.

[11] Slagman A, Greiner F, Searle J, Harriss L, Thompson F, Frick J, et al. Suitability of the German version of the Manchester Triage System to redirect emergency department patients to general practitioner care: a prospective cohort study. BMJ Open 2019;9(5):e024896. https://doi.org/10.1136/bmjopen-2018-024896.

[12] Dias RD, Rios IC, Canhada CL, Fernandes MD, Letaif LS, Bonfa E, et al. Using the Manchester triage system for refusing nonurgent patients in the emergency department: a 30-day outcome study. J Emerg Manag 2016;14(5):349–64. https://doi.org/10.5055/jem.2016.0300 (Weston, Mass).

[13] Gilbert A, Brasseur E, Petit M, Donneau AF, D'Orio V, Ghuysen A. Advanced triage to redirect non-urgent Emergency Department visits to alternative care centers: the PERSEE algorithm. Acta Clin Belg 2021:1–8. https://doi.org/10.1080/17843286.2021.1914948.

[14] van der Straten LM, van Stel HF, Spee FJ, Vreeburg ME, Schrijvers AJ, Sturms LM. Safety and efficiency of triaging low urgent self-referred patients to a general practitioner at an acute care post: an observational study. Emerg Med J 2012;29 (11):877–81. https://doi.org/10.1136/emermed-2011-200539.
[15] van Veen M, Steyerberg EW, Lettinga L, Ruige M, van Meurs AH, van der Lei J, et al. Safety of the Manchester Triage System to identify less urgent patients in paediatric emergence care: a prospective observational study. Arch Dis Child 2011; 96(6):513–8. https://doi.org/10.1136/adc.2010.199018.
[16] Brekke KR, Holmås TH, Monstad K, Straume OR. Competition and physician behaviour: does the competitive environment affect the propensity to issue sickness certificates? J Health Econ 2019;66:117–35. https://doi.org/10.1016/j.jhealeco.2019.05.007.
[17] Bösner S, Abushi J, Feufel M, Donner-Banzhoff N. Diagnostic strategies in general practice and the emergency department: a comparative qualitative analysis. BMJ Open 2019;9(5):e026222. https://doi.org/10.1136/bmjopen-2018-026222.
[18] Léonard C, Stordeur S, Roberfroid D. Association between physician density and health care consumption: a systematic review of the evidence. Health Policy 2009; 91(2):121–34. https://doi.org/10.1016/j.healthpol.2008.11.013.
[19] Bosmans JE, Boeke AJ, van Randwijck-Jacobze ME, Grol SM, Kramer MH, van der Horst HE, et al. Addition of a general practitioner to the accident and emergency department: a cost-effective innovation in emergency care. Emerg Med J 2012;29 (3):192–6. https://doi.org/10.1136/emj.2010.101949.
[20] Dale J, Lang H, Roberts JA, Green J, Glucksman E. Cost effectiveness of treating primary care patients in accident and emergency: a comparison between general practitioners, senior house officers, and registrars. BMJ 1996;312(7042):1340–4.
[21] Jimenez S, de la Red G, Miro O, Bragulat E, Coll-Vinent B, Senar E, et al. Effect of the incorporation of a general practitioner on emergency department effectiveness. Med Clin (Barc) 2005;125(4):132–7. https://doi.org/10.1157/13076941.
[22] Murphy AW, Bury G, Plunkett PK, Gibney D, Smith M, Mullan E, et al. Randomised controlled trial of general practitioner versus usual medical care in an urban accident and emergency department: process, outcome, and comparative cost. BMJ 1996;312(7039):1135–42. https://doi.org/10.1136/bmj.312.7039.1135.
[23] Weinick RM, Burns RM, Mehrotra A. Many emergency department visits could be managed at urgent care centers and retail clinics. Health Aff (Millwood) 2010;29 (9):1630–6. https://doi.org/10.1377/hlthaff.2009.0748.
[24] van Veen M, ten Wolde F, Poley MJ, Ruige M, van Meurs AH, Hable C, et al. Referral of nonurgent children from the emergency department to general practice: compliance and cost savings. Eur J Emerg Med 2012;19(1):14–9. https://doi.org/10.1097/MEJ.0b013e32834727d4.
[25] Broekman S, Van Gils-Van Rooij E, Meijboom B, De Bakker D, Yzermans C. Do out-of-hours general practitioner services and emergency departments cost more by collaborating or by working separately? A cost analysis. J Prim Health Care 2017;9 (3):212–9. https://doi.org/10.1071/Hc17015.
[26] van Uden CJ, Ament AJ, Voss GB, Wesseling G, Winkens RA, van Schayck OC, et al. Out-of-hours primary care. Implications of organisation on costs. BMC Fam Pract 2006;7(1):29. https://doi.org/10.1186/1471-2296-7-29.
[27] Goncalves-Bradley D, Khangura JK, Flodgren G, Perera R, Rowe BH, Shepperd S. Primary care professionals providing non-urgent care in hospital emergency departments. Cochrane Database Syst Rev 2018;2(2):CD002097. https://doi.org/10.1002/14651858.CD002097.pub4.
[28] Ramlakhan S, Mason S, O'Keeffe C, Ramtahal A, Ablard S. Primary care services located with EDs: a review of effectiveness. Emerg Med J 2016;33(7):495–503. https://doi.org/10.1136/emermed-2015-204900.
[29] Smulowitz PB, Honigman L, Landon BE. A novel approach to identifying targets for cost reduction in the emergency department. Ann Emerg Med 2013;61(3): 293–300. https://doi.org/10.1016/j.annemergmed.2012.05.042.
[30] Morreel S, Philips H, De Graeve D, Monsieurs KG, Kampen JK, Meysman J, et al. Triaging and referring in adjacent general and emergency departments (the TRIAGE trial): a cluster randomised controlled trial. PLoS ONE 2021;16(11): e0258561. https://doi.org/10.1371/journal.pone.0258561.
[31] O'Malley J. Out of hours and primary care: closer and closer apart. Br J Gen Pract 2012;62(597):176–7. https://doi.org/10.3399/bjgp12X635976.
[32] Steeman L, Uijen M, Plat E, Huibers L, Smits M, Giesen P. Out-of-hours primary care in 26 European countries: an overview of organizational models. Fam Pract 2020;37(6):744–50. https://doi.org/10.1093/fampra/cmaa064.
[33] Smits M, Colliers A, Jansen T, Remmen R, Bartholomeeusen S, Verheij R. Examining differences in out-of-hours primary care use in Belgium and the Netherlands: a cross-sectional study. Eur J Public Health 2019;29(6):1018–24. https://doi.org/10.1093/eurpub/ckz083.
[34] Reibling N, Wendt C. Gatekeeping and provider choice in OECD healthcare systems. Curr Sociol 2012;60(4):489–505. https://doi.org/10.1177/0011392112438333.
[35] Parenti N, Reggiani ML, Iannone P, Percudani D, Dowding D. A systematic review on the validity and reliability of an emergency department triage scale, the Manchester Triage System. Int J Nurs Stud 2014;51(7):1062–9. https://doi.org/10.1016/j.ijnurstu.2014.01.013.
[36] Manchester Triage Group. Emergency triage. 3rd ed. John Wiley & Sons, Ltd; 2014. ed:.
[37] Bartholomeeusen S., Philips H., Van Royen P., Remmen R., Coenen S. iCAREdata: improving care and research electronic data trust Antwerp. Dataset Zenodo. 2017.
[38] Colliers A, Bartholomeeusen S, Remmen R, Coenen S, Michiels B, Bastiaens H, et al. Improving Care And Research Electronic Data Trust Antwerp (iCAREdata): a research database of linked data on out-of-hours primary care. BMC Res Notes 2016;9(1):259. https://doi.org/10.1186/s13104-016-2055-x.
[39] Gregori D, Petrinco M, Bo S, Desideri A, Merletti F, Pagano E. Regression models for analyzing costs and their determinants in health care: an introductory review. Int J Qual Health Care 2011;23(3):331–41.
[40] Kolassa JE. An introduction to nonparametric statistics. Chapman and Hall/CRC; 2020.
[41] Rijksinstituut voor Ziekte- en Invaliditeitsverzekering. Tarieven; artsen - raadplegingen en bezoeken; 01-01-2019. 2018.
[42] van Gils-van Rooij ES, Yzermans CJ, Broekman SM, Meijboom BR, Welling GP, de Bakker DH. Out-of-hours care collaboration between general practitioners and hospital emergency departments in the Netherlands. J Am Board Fam Med 2015;28 (6):807–15. https://doi.org/10.3122/jabfm.2015.06.140261.
[43] van Veelen MJ, van den Brand CL, Reijnen R, van der Linden MC. Effects of a general practitioner cooperative co-located with an emergency department on patient throughput. World J Emerg Med 2016;7(4):270–3. https://doi.org/10.5847/wjem.j.1920-8642.2016.04.005.
[44] Bruyneel A, Smith P, Tack J, Pirson M. Prevalence of burnout risk and factors associated with burnout risk among ICU nurses during the COVID-19 outbreak in French speaking Belgium. Intensive Crit Care Nurs 2021;65:103059. https://doi.org/10.1016/j.iccn.2021.103059.
[45] Badr S, Nyce A, Awan T, Cortes D, Mowdawalla C, Rachoin JS. Measures of emergency department crowding, a systematic review. How to make sense of a long list. Open Access Emerg Med 2022;14:5–14. https://doi.org/10.2147/oaem.S338079.
[46] Doran KM, Colucci AC, Hessler RA, Ngai CK, Williams ND, Wallach AB, et al. An intervention connecting low-acuity emergency department patients with primary care: effect on future primary care linkage. Ann Emerg Med 2013;61(3):312–21. https://doi.org/10.1016/j.annemergmed.2012.10.021. e7.
[47] Morreel S, Verhoeven V, Philips H, Meysman J, Homburg I, De Graeve D, Monsieurs KG. Differences in emergency nurse triage between a simulated setting and the real world, post hoc analysis of a cluster randomised trial. BMJ Open. 2022;12(7):e059173. doi:10.1136/bmjopen-2021-059173. PMID: 35777880; PMCID: PMC9252194.
[48] Meysman J, Morreel S, Lefevere E, Verhoeven V, De Graeve D, Monsieurs KG, Philips H. Triaging and referring in adjacent general and emergency departments (the TRIAGE-trial): A process evaluation of medical staff experiences in a nurse-led triage system. Int Emerg Nurs. 2022;63:101191. doi:10.1016/j.ienj.2022.101191. Epub 2022 Jul 8. PMID: 35810679.
[49] Homburg I, Morreel S, Verhoeven V, Monsieurs KG, Meysman J, Philips H, et al. Non-compliance with a nurse's advice to visit the primary care provider: an exploratory secondary analysis of the TRIAGE-trial. BMC health services research 2022;22(1):1-1. doi: 0.1186/s12913-022-07904-8.