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Reliability and validity of an original nurse telephone triage tool for out-of-hours primary care calls: the SALOMON algorithm

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ABSTRACT

Objectives: Due to the persistent primary care physicians shortage and the substantial increase in their workload, the organization of primary care calls during out-of-hours periods has become an everyday challenge. The SALOMON algorithm is an original nurse telephone triage tool allowing to dispatch patients to the best level of care according to their conditions. This study evaluated its reliability and criterion validity in rea-life settings. **Methods:**In this 5-year study, out-of-hours primary care calls were dispatched into four categories: Emergency Medical Services Intervention (EMSI), Emergency Department referred Consultation (EDRC), Primary Care Physician Home visit (PCPH), and Primary Care Physician Delayed visit (PCPD). We included data of patients' triage category, resources, and destination. Patients included into the primary care cohort were classified undertriaged if they had to be redirected to an emergency department (ED). Patients from the ED cohort were considered overtriaged if they did not require at least three diagnostic resources, one emergency-specific treatment or any hospitalization. In the ED cohort, only patients from the University Hospitals were considered. **Results:**10,207 calls were triaged using the SALOMON tool: 19.2% were classified as EMSI, 15.8% as EDRC, 62.8% as PCPH, and 2.2% as PCPD. The triage was appropriate for 85.5% of the calls with a 14.5% overtriage rate. In the PCPD/PCPH cohort, 96.9% of the calls were accurately triaged and 3.1% were undertriaged. SALOMON sensitivity and specificity reached 76.6% and 98.3%, respectively. **Conclusion:**SALOMON algorithm is a valid triage tool that has the potential to improve the organization of out-of-hours primary care work.

KEYWORDS

Primary health care; nurse triage; dispatching; after-hours care; emergency department

Introduction

Due to the persistent primary care physician (PCP) shortage and the increase in their daily workload, the management of the PCP calls during out-of-hours periods has become an everyday challenge for most PCPs in Europe [1]. Out-of-hours primary care has been increasingly provided through large-scale organizations, and the very need to distinguish patients with urgent conditions from those who could wait for a delayed medical consultation has challenged every health-care providers [2].

Triage might have the potential to efficiently alleviate PCP workload, but it should be valid, safe, and lead to appropriate referrals of the patients at the right time, right place, and with the right person. Several concerns have recently been raised about triage safety, advocating the need for efficient tools and standardized educational programs to improve it [3].

Different factors contribute to the efficiency of triage systems but mainly two of them seem to particularly impact the triage's appropriateness: the process of triage and the type of dispatchers. In the past, several groups of health-care providers have been involved in various aspects of telephone triage using either algorithmic or empirical decision-making process. When it comes to triage safety, nurses demonstrate the highest rate of appropriate referrals compared to physicians or other non-clinical dispatchers [4]. However, despite guidelines aiming to improve the balance between safety and efficacy, in the Netherlands, Giesen et al. found that telephone triage by nurses could possibly be unsafe [5,6]. Indeed, telephone triage is a very complex task, often considered as the weakest part of the out-of-hours primary care organization [5]. The absence of visual contact and the, sometimes limited, patient's ability to communicate symptoms or describe signs makes it difficult, with the impending risk of underestimation of the actual urgency due to a suboptimal consultation [7,8].

One important persisting issue remains the scarcity of validated telephone triage tools for primary care calls, enabling the standardization of educational programs for triage nurses. However, a few specific standardized clinical decision supports have recently emerged in order to support triage in terms of safety, efficiency, and appropriate communication skills. Their impact on quality and appropriateness of care are still to be determined [9,10].

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All of the statements aforementioned remind the need of a concrete management of the unscheduled care in the Belgian territory, also called a 'regulation' of care, by strong and valid triage algorithms to provide a safe destination to all patients in need of care. In a criterion-based validity study using simulated clinical case scenarios, we previously demonstrated that the SALOMON algorithm, a French-language triage tool, was robust, valid, and easy to learn [11]. Whether or not this standard still holds true in real-life conditions remained to be further determined. We aimed to evaluate the efficiency and validity of the SALOMON algorithm to triage out-of-hours primary care calls through a retrospective analysis of our 5-year experience in clinical settings.

Material and methods

Context of the study

In 2011, the Belgian Federal Public Service – Health, Food Chain Safety and Environment – decided to launch a pilot experiment in order to find new solutions to the complex management of out-of-hours primary care calls. The SALOMON triage represented an initiative of these services in collaboration with the University Hospital Center of Liège (CHU Liège). The pilot project was supported by the Belgian Order of Physicians and involved emergency and primary care physicians of the Liège area, who worked together to create the SALOMON telephone triage. Researchers only implemented the project in the Liège area and the specific settings of the triage responded to the actual needs of the primary care practice in this region.

SALOMON Telephone Triage

The SALOMON triage is a step-by-step process guiding nurses' decisions concerning the level of care needed and also the most appropriate timing and location [11]. The SALOMON algorithm gathers 54 major flowcharts allowing to deal with most common adult and pediatric calls. These flowcharts are identified on the basis of the main complaints, symptoms, and available signs, using general and specific discriminators. Those algorithms were created by a group of experts composed of emergency department (ED) physicians, primary care physicians (PCP), and triage nurses. By applying these flowcharts, nurses triaged calls and dispatched them into four categories corresponding to decreasing levels of urgency and severity (Table 1).

Triage process

Before the implementation of the SALOMON telephone triage in the Liège region, each PCP on duty was in charge individually of the management of unscheduled urgent care in their concerned areas of care. Since the beginning of the SALOMON telephone dispatching, all primary care calls during out-of-hours periods were dispatched to the SALOMON nurse telephone triage center, where a nurse proceeded to the appropriate regulation with the SALOMON algorithms. The regulation permitted to guide the patients either to the Emergency Department (either directly by calling the European Emergency number or indirectly by their own means) or to the primary care physician (either immediately in a face-to-face consultation at home or on a delayed basis with a scheduled appointment the next day). Table 1 described the four possible destinations advised to the patients.

Table 1. Different levels of the SALOMON algorithm.

Level	Denomination	Severity	Referral Process
Level 1	Emergency Medical Services Intervention (EMSI)	Severe	Triage nurse immediately contacts the 112 dispatching center to send emergency medical services to the scene. The patient is then brought to the closest ED.
Level 2	Non-urgent Emergency Department Consultation (EDRC)	Moderate	Triage nurse advises patients to attend the ED of their choice by their means or to call an ambulance.
Level 3	Primary Care Physician Home visit (PCPH)	Minor	Triage nurse refers the patient to the PCP on duty.
Level 4	Primary Care Physician Delayed visit (PCPD)	Benign	Triage nurse advises the patient to contact their PCP during office hours. Self-care are advised until the PCP consultation.

Study design and settings

We conducted a 5-year (from 2011 to 2016) retrospective study about the out-of-hours primary care calls in different rural, suburban, and urban areas of the Liege Province. Out-of-hours primary care calls to the PCP on duty were directly diverted to the telephone dispatching 7 days a week, from 10 pm to 7 am.

Ten emergency care nurses were in charge of the dispatching with the SALOMON algorithm, after a specific training program for the use of the SALOMON algorithm (24-h theoretical teaching course, 8-h practical skills training, and 8-h residency in the 112 dispatching center). Those nurses were located at the ED of the CHU Liège, where the nurse dispatching center was established. The nurses were responsible of the telephone triage but could benefit from advices from ED physicians if the choice of destination represented several difficulties. The triage nurses were in charge of the primary care calls of the Liège province and dispatched the patients through 8 of the 13 EDs of the region.

Data collection and analysis

Data recorded

From each call, nurses gathered different information (i.e. personal data, complaints, severity criteria, flowchart used, and triage category). Each call was associated with a full report to both patient's and on duty PCP. By convenience and easy availability as concerns, the patients whose triage level imposed ED admission, only the data concerning patients admitted to the University Hospital EDs were gathered for further analysis. Those data were extracted from the hospital electronic patient data file (i.e. resources used, definitive diagnosis, treatments, and outcomes). Data concerning the patients referred to primary care physicians were obtained after a daily debriefing between ED physicians in charge of the study and PCP involved in the care of the patients. Indeed, after the assessment of the triaged patients, PCPs were asked to fulfill a questionnaire regarding the regulation (Table 2). Inappropriate calls (i.e. patients searching for a pharmacy or others information with no relation to a demand of medical care.), or calls with incomplete or missing data, were excluded from the regulation process. Some patients refused to be triaged by the nurse, this was considered as a regulation refusal and the call were directly diverted to the PCP on ward. This process is detailed in Figure 1.

Table 2. Satisfaction questionnaire about the regulation process.

Caller's information			
Name	First Name	Sex	
Qualitative assessment			
Appropriate flowchart used ?		Yes	No
Sufficient information provided by the regulation to appropriately take decision about the patient's care?		Yes	No
Did the call result in a home visit?		Yes	No
Did signs and symptoms provided by the regulation fit with the real patient's condition?		Yes	No
Did you call back Emergency Medical Services? (misdirection of the regulation)		Yes	No
Final diagnosis			
Diagnosis			
Additional comments			
Comments			

Overtriage and undertriage

In the absence of any gold standard to determine the appropriateness of an emergency department visit, the validity of the SALOMON scale has been estimated using standard criteria: the number of diagnostic or therapeutic resources engaged, the need for an hospitalization, and the need for a redirection to another level of care.

Regarding the resources, we considered 'diagnostic tests' (i.e. biological analysis, imaging, etc) and therapeutic procedures (i.e. intravenous drugs, stitches, plasters, etc).

As concerned potential redirections, all patients who were initially referred to primary care and then diverted to the ED were considered as patients who required a redirection because of an inappropriate triage.

Undertriage was considered when a patient categorized as level 3 and level 4 had to be referred secondarily to an ED by the PCP. As for the categories 1 and 2, overtriage was considered when these patients did not require any hospital admission or therapeutic

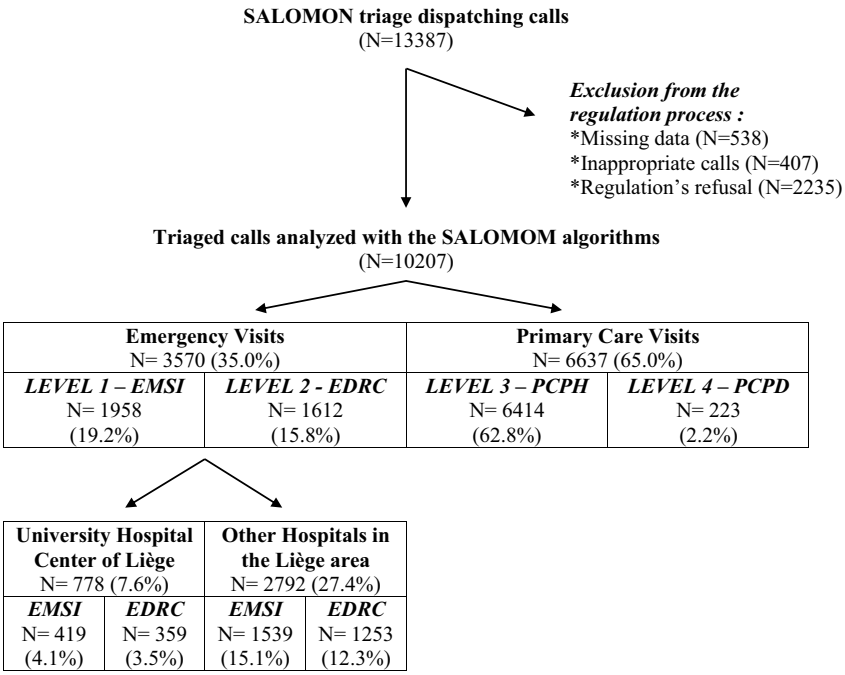

Figure 1. Repartition of the different OOH PCP calls and their final orientation.

resource or less than three diagnostic tests (each test was considered as one test).

Undertriage and overtriage were only considered regarding the level of care and the comparison between the group Emergency Care (EMSI + EDRC) and the group Primary Care (PCPH + PCPD). No analysis were made between PCPH and PCPD nor EMSI and EDRC.

Ethics

All patients gave their informed consent prior to being included in the study, which followed the Declaration of Helsinki principles.

Statistical analysis

Results were expressed as means and standard deviations (±SDs) for quantitative variables with a normal distribution and as medians and interquartile ranges (Q1–Q3) otherwise. Qualitative variables were summarized using numbers and percentages. In order to compare data between the University Hospitals EDs cohort and other hospitals EDs cohort, a Wilcoxon sum rank test was applied for quantitative variables and qualitative variables were compared using a chi-square test. Regarding, the undertriage and overtriage rate, the sensitivity, specificity, positive-predicted value, and negative-predicted value were calculated, with corresponding 95% confidence interval for the need of ED care and the need of primary care. Finally, the error rate of SALOMON tool was calculated as the proportion of wrong classified calls (overtriage and undertriage). This error rate was associated with a 95% confidence interval. All statistical tests were two-sided and results were considered as statistically significant at the 5% critical level ($p < 0.05$). Statistical analysis were carried out using the SAS statistical software package (version 9.4 for Windows) and R (version 3.5).

Results

Out-of-hours primary care calls demography

During the study period, 13,387 calls reached the nurses dispatching. From those, 3180 were excluded because of missing data (n = 538), inappropriate calls (n = 407), or calls with regulation's refusal (n = 2235). Finally, the analysis of complete triage process with SALOMON algorithm was available for 10,207 calls (Figure 1).

Thirty-five percent of the calls were categorized as requiring ED care: 19.2% an EMSI and 15.8% an EDRC. Among the global cohort of calls, 7.6% were dispatched to the University Hospital EDs, 4.1% as EMSI and 3.5% as EDRC patients, and 27.4% were triaged to the other hospitals of the Liège region. PCP visit was considered by triage for 65% of the calls: 62.8% PCP Home visits and 2.2% PCP Delayed visits.

Median age of the patients concerned by these calls was 53-(28–77) year-old [range: 0.015–105 years]. Regarding the sex repartition, there is 5972 (58.5%) women calls. Most calls (86.2% (n = 8797)) originated from the patients' home and 13.8% (n = 1410) from a nursing home. Table 3 presents the characteristics of the calls.

Undertriage

Globally, among the calls triaged as requiring PCP visits (either immediately at home or delayed), the algorithm resulted in undertriage in 3.1%: no PCPD visits resulted in further need for ED consultations but 3.2% of the PCPH visits were further sent to the ED by the PCP.

Median age of all the PCP undertriaged patients was 56-(31–77) year-old [range: 0.025–99 years]. The most frequent flowchart used in this group was: non-traumatic abdominal pain in 45.3%, general trauma complaints in 5.9%, and respiratory distress in 4.4% of the calls. No undertriage was responsible of the death of the patient involved.

Table 3. Different characteristics of the out-of-hours primary care calls.

	TOTAL CALLS N = 10,207			
	PRIMARY CARE N = 6637 (65.0%)		**EMERGENCY CARE N = 3570 (35.0%)**	
	PCPD N = 223 (2.2%)	PCPH N = 6414 (62.8%)	EDRC N = 1612 (15.8%)	EMSI N = 1958 (19.2%)
CHARACTERISTICS				
Mean age ± SD	51.1 ± 24.0	48.87 ± 28.3	41.78 ± 29.4	66.60 ± 22.7
Sex ratio	1.01	0.66	0.88	0.71
Origin of the call				
Home	208 (93.3%)	5747 (89.6%)	1452 (90.1%)	1390 (71%)
Nursing Home	15 (6.7%)	667 (10.4%)	160 (9.9%)	568 (29.0%)
Pediatric case (<16 year-old)	15 (6.7%)	1023 (15.9%)	402 (24.9%)	70 (3.6%)
Elderly (75 year-old)	46 (20.6%)	1621 (25.3%)	312 (19.4%)	966 (49.3%)

Table 4. University EDs cohort.

UNIVERSITY EDs cohort	EMSI N = 419	EDRC N = 359	TOTAL N = 778
Requiring ≥3 diagnostic tests and/or ≥1 therapeutic resource and/or hospitalization	389 (92.8%)	276 (76.9%)	665 (85.5%)
Requiring ≥3 diagnostic tests	340 (81.1%)	191 (53.2%)	531 (68.3%)
Requiring ≥1 therapeutic resource	374 (89.3%)	230 (64.1%)	604 (77.6%)
Requiring hospitalization	290 (69.2%)	107 (29.8%)	397 (51.0%)

Overtriage

The analysis of the University Hospital ED cohort is depicted in Table 4.

Out of the calls identified as requiring either an ED admission through an EMSI or EDRC (n = 3570), 778 patients were admitted in one of the two University Hospital EDs. Regarding the origin of call, the repartition of sex, and the seriousness of case, there was no significant difference between the cohort referred to the University Hospital ED and another hospital ED ($p > 0.05$). However, there was a statistically significant difference between the cohort referred to the University Hospital ED and the cohort referred to another hospital in terms of age ($p < 0.0001$).

Median age of the cohort in another hospital (n = 2792) was 60 (30–80), while median age of the CHU-referred cohort was 66 (41.25–82). This significant difference was reflected in the number of pediatric and geriatric case. Actually, there was a statistically significant difference in terms of pediatric case between the CHU and another hospitals (7.6% vs 14.8%, $p < 0.0001$). Proportions of geriatric case were also significantly different between the CHU and another hospitals (40.1% vs 34.6, $p = 0.0005$). Further analysis was done only on the basis of the cohort referred to the University Hospital EDs.

Following the defined criteria of triage's appropriateness, 85.5% (n = 665) patients beneficiated either from at least three diagnostic and/or one therapeutic procedure and/or were hospitalized, while 14.5% (n = 113) did not, and were considered as overtriaged. According to the same analysis, among the EMSI group, 92.8% (n = 389) were accurately referred to the EDs, while 7.2% (n = 30) were overtriaged. In the EDRC, 76.9% (n = 276) were appropriately triaged, while 23.1% (n = 83) were not.

The median age of the 113 overtriaged patient was 38-(12–69) year-old. Interestingly, 30 of these 113 calls concerned pediatric cases, which represent 26.5% of these overtriaged patients.

Sensitivity and Specificity of the tool

Based on the University Hospitals EDs and PCP cohorts and according to the criterion standards used, we found that the sensitivity and specificity of the SALOMON algorithm to predict the need for ED care was 76.6% (95% CI: 75.6–77.6) and 98.3% (95% CI: 97.9–98.6) respectively, with a 85.5% (95% CI: 85.2–86.3) positive-predictive value and 96.9% (95% CI: 96.6–97.3) negative-predictive value. Those results are depicted in Table 5.

Table 5. Table for cohort referred to the CHU and the cohort referred to PCP.

	Real need	
SALOMON predict	EM	PCP
EM	665	113
PCP	203	6434

Table 6. Table for cohort referred to the CHU and the cohort referred to PCP for pediatric case.

	Real need	
SALOMON predict	EM	PCP
EM	288	24
PCP	54	1613

For the pediatric population, sensitivity and specificity were 56.9% (95% CI: 53.9 – 59.7) and 97.1% (95% CI: 96.1–98.1), respectively. Those results are detailed in Table 6.

Discussion

When it comes to evaluate the need for emergency care according to the resources or hospitalization needs, the analysis of our 5-year clinical experience using the SALOMON triage tool for out-of-hours primary care calls indicates a sensitivity and specificity of 76.6% and 98.3%, respectively. These results confirm that this algorithm is a valid nurse telephone triage system that has the potential to improve the organization of out-of-hours primary care physicians work. Indeed, it efficiently played a role in the Belgian regulation system from 2011 to 2019. During its effective use, the SALOMON algorithms were progressively adapted to new conditions encountered, which probably improved its efficiency over time.

The extreme variety of the out-of-hours primary care calls triage systems used worldwide to categorize patients according to their urgency make the comparison of these systems very complex. Indeed, as previously evoked, the characteristics of these triage systems differ in many ways: the dispatchers involved in the triage process, the location where the triage is performed, the algorithms used and the type of destination advised [9,12–15].

One of the most studied triage system, The Netherlands Triage System (NTS), has been developed by PCP cooperatives in the Netherlands, through the use of the National Telephone Guide (NTG) of the Dutch College of General Practitioners [16]. Van lerland et al. reported the validity of this telephone

triage using surrogate urgency markers, mainly the resources used, hospital admission, and follow-up visits [17]. The design of this study differs from ours for two main reasons. First, they tested the validity of both physical triage in the ED or at PCP facilities and nurses' telephone triage. Then, because the decision flowcharts were also different from the SALOMON ones. Indeed, after telephone triage at PCP cooperatives, the triage nurse could decide to give the patient either a telephone consultation with self-care advices or a physical consultation. As concerns the SALOMON triage, self-care were considered as the need of primary care physician visit the next day because we considered that all triage destinations required a physical assessment. However, our results are similar to theirs in a way that the highest urgency scores were associated with higher ED referrals, resources used or hospital admission rates [17]. What's more, these authors stated that overtriage and undertriage were not properly evaluated in this study and reported that 12.1% of the patients triaged to primary care were referred to the ED afterwards [17]. Using SALOMON algorithms, no PCPD visits resulted in further need for ED consultations, while among all PCPH visits, only 3.2% were further sent to the ED by the PCP.

In Belgium, a new nationwide telephone triage has been implemented recently to standardize the management of out-of-hours primary care calls on the Belgian territory [18]. This triage is similar to the SALOMON triage: those are both using decisional flowcharts related to specific conditions and leading to different severity's criteria. Each level of severity refers to a specific care pathway. The 1733 triage differs from the SALOMON algorithm on two specific points. The main difference is the choice of the telephone dispatchers. Those are represented by nurses for the SALOMON triage, whereas the 1733 is managed by specifically trained non-clinical dispatchers of the emergency telephone dispatching (CS112). Moreover, the destination advised for the patients by the 1733 are also different from the SALOMON ones with the possibility to be referred to the ED by ambulance, or to be referred to the PCP either directly (<2 h), during the on-call duty (<12 h) or during the next opening hours. However, a recent study by Moreel et al. on the efficiency of the 1733 telephone dispatching for out-of-hours primary care calls revealed undertriage and overtriage rates, respectively, of 17% and 12% [18]. This study raised concerns about the undertriage rate which could lead to unsafe triage destinations but the researchers performed the study in a much shorter time frame and those results could potentially improve with time and a real-life experience.

As regards the undertriage, the SALOMON telephone triage is particularly efficient with a very low undertriage rate of 3.2%. Moreover, the analysis of undertriaged cases revealed that most misdirections were related to particular flowcharts protocols. Indeed, the assessment of abdominal pain led to an increased rate of undertriages. Those results might be explained by multiple factors involved in the efficient assessment of patients' complaints such as patient's difficulty to explain precisely their symptoms, the absence of vital parameters or clinical examination. Those factors are known to be determinant to distinguish the urgent versus non-urgent character of the clinical presentation and difficult to point out even with specific clinical decision tools [8,19].

Concerning the overtriage, the rate is relatively moderate for the global population with a value of 14.3%. Significant differences have been demonstrated in telephone and physical triage efficiency and safety between pediatric and global populations, with an increased overtriage rate in children. In that way, further research suggested the need for improvement of those triage protocols for the pediatric population [17,20,21]. In our study, the results concerning this particular population are clearly different from the global population but remain adequate in terms of safety.

Limitations

First, the fact that no comparison was made between the four categories of referrals but only between the two levels of care (Emergency Care and Primary Care) represents a limitation of the study.

A second limitation of the study is the unavailability of all the data of the patients admitted in the different hospitals concerned. Indeed, only the part from the CHU EDs (7.6%) were available and not representative of the complete population.

Finally, the period of the study represents a limitation. Due to the specific primary care organization in the Liège region, researchers developed the SALOMON triage to be available from 10 PM to 7 AM. This period of the day clearly modifies different important variables, such as the availability of diagnostic and therapeutic procedures for PCP.

Perspectives

The SALOMON telephone triage ended in July 2019 to be replaced by the current nationwide telephone triage, 1733. However, these algorithms have shown their efficiency through this 5-year experience but also on a daily basis during 10 years of real-life clinical practice. Different new studies are now in progress to develop new triage systems based on the SALOMON algorithms, such as a patient's self-triage platform or a ED diversion triage to alternative care centers for non-emergency visits [22,23].

Conclusion

The present study made under real-life conditions confirms that SALOMON algorithm is a strong and valid nurse telephone triage tool for both adult and

pediatric populations and has the potential to improve the organization of PCP out-of-hours work.

Disclosure of potential conflicts of interest

No potential conflict of interest was reported by the author(s).

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