Original Article

A decision analysis of the effectiveness of the pediatric telephone triage program in Japan

Kenji Maeda[1,*], Shigeru Okamoto[2], Hiroki Mishina[3], Takeo Nakayama[2]

[1] *Osaka Medical Center for Health Science and Promotion, Osaka, Japan;*
[2] *Department of Health Informatics, Kyoto University School of Public Health, Kyoto, Japan;*
[3] *Department of Epidemiology and Healthcare Research, Kyoto University Graduate School of Medicine and Public Health, Kyoto, Japan.*

Summary **Pediatric telephone triage programs have been initiated to reduce overcrowding of pediatric medical facilities, yet it is unclear what impact these programs have on reducing after hours room visits. This study used a decision analysis model and data from reference literature to investigate the effectiveness of this program and determine the factors that influence the results. The decision analysis model focused on a hypothetical group of children who were not undergoing ongoing treatment but developed symptoms or sustained injuries thought to require a nighttime visit to a medical facility. The model differentiated between urgent, semi-urgent, and non-urgent cases. Model parameters were estimated from the literature whenever possible. We estimated the difference in the number of children who received emergency medical attention, the number of semi-urgent cases in which attention was delayed, and the cases that did not receive medical care, between the telephone triage group and the control group. Telephone triage reduced the number of after hours visits by approximately 4%. There was no change in the number of semi-urgent cases for which medical care was delayed, and the number of semi-urgent cases that did not receive medical attention increased by three. The sensitivity analysis showed that increasing telephone triage use from 10% to 20% would reduce after hours visits by approximately 8%. We conclude that the benefits of this program to the region as a whole would outweigh the harmful effects. However, the effectiveness of telephone triage programs will be limited unless its usage is expanded.**

Keywords: Telephone triage, decision analysis, after-hours care

1. Introduction

In recent years Japan has experienced extreme overcrowding at pediatric medical facilities. There has been a shortage of pediatricians and a decrease in the number of pediatric medical institutions and parents' or guardians' child-care and health anxieties (*1*). The Japan Pediatric Society formulated the Pediatric Care Reform and Emergency Project (*2*) and established a website for parents about emergency pediatric care (*3*) in an attempt to eliminate the disorder of emergency pediatric care and compensate for the lack of manpower. The Ministry of Health, Labor and Welfare, acting in concert with the Japan Pediatric Society, carried out a preliminary survey beginning in 2002, and in 2004 initiated a pediatric emergency telephone triage program (*4*). Under this program, parents whose children are in need of emergency medical attention are instructed to dial the hotline number (#8000), and undergo telephone triage, during which pediatricians and nurses evaluate the need for emergency medical attention (*5*). As of June 2009, almost all prefectures in Japan (45/47 prefectures) had implemented this program.

**Address correspondence to:*
Dr. Kenji Maeda, Osaka Medical Center for Health Science and Promotion, 1-3-2 Nakamichi, Higashinari-ku, Osaka-shi, Osaka 537-0025, Japan.
e-mail: maeken-kyt@umin.ac.jp

Based on reports that callers usually follow the triage pediatrician's instructions, and given the high satisfaction level of those using the program, it seems the pediatric emergency telephone triage program is effective (*6*). It is our hope that Japan will make greater use of this program in the future to further alleviate the overcrowding of pediatric emergency services. It remains unclear, however, to what degree this program contributes to a reduction in after hours visits including trips to emergency rooms. Therefore, to create a system that effectively utilizes the limited number of pediatricians and provides the necessary medical services to the appropriate people, we conducted this study with the following objectives in mind, conceived from the societal perspective of a regional health policy maker (*7*).

(i) In terms of the benefits of the pediatric emergency telephone triage program, we estimated the degree to which this program reduces the number of children visiting the after hours medical facility.

(ii) In terms of the harmful effects of the pediatric emergency telephone triage system, we estimated the degree to which medical attention was delayed as a result of the program.

(iii) In terms of the effectiveness of the program, we assessed the factors related to the pediatric emergency telephone triage system that most influence on reduction in the number of children visiting after hours medical facilities.

2. Methods

We performed decision analysis8 using data from the literature on this subject. The decision analysis model was determined through discussion with two pediatricians and two clinical epidemiologists. The statistical package DATA 3.5 (TreeAge Software, Inc., Williamstown, Massachusetts) was used for the analysis.

2.1. *Target population*

The target population of this study was a hypothetical group of children (age 0-15) who were not currently undergoing treatment and who developed symptoms or sustained injury thought to require emergency medical attention between 7:00-11:00 p.m. Sunday through Thursday, excluding holidays. At the time this study was initiated, these were the operating hours of most telephone consultation programs run at the prefectural level. Fridays and Saturdays were excluded because the time when regular medical attention is available differs on these days.

2.2. *Model parameters*

The model was developed based on the following 6 parameters:

(i) *Degree of urgency of child's symptoms*

The degree of urgency of a child's symptoms was classified as "urgent", "semi-urgent", and "non-urgent" based on the following definitions:

Urgent cases: Those requiring immediate examination and treatment (*i.e.* immediate attention is appropriate).

Semi-urgent cases: Those requiring examination and treatment as swiftly as possible (*i.e.* cases which should get medical attention as soon as possible).

Non-urgent cases: Those for which postponed examination and treatment is appropriate or for which further monitoring is adequate (*i.e.* cases which can be postponed until the following morning).

(ii) *After hours visits based on parents' discretion*

-In urgent cases, all parents will seek medical attention at emergency rooms.

-In semi-urgent and non-urgent cases, some parents will seek after hours medical care for their children, while the remainder wait and observe further.

-In cases that are being monitored and the symptoms worsen, emergency medical attention will be sought immediately.

(iii) *Changes in urgency during monitoring*

-When semi-urgent cases are monitored further, some become urgent or non-urgent.

-When non-urgent cases are monitored further, some become urgent or semi-urgent.

(iv) *Use of the pediatric emergency telephone triage program*

-In urgent cases, all parents will seek medical attention at emergency rooms rather than use the pediatric emergency telephone triage service.

-In semi-urgent and non-urgent cases, some parents will use the pediatric emergency telephone triage service while some will rely on their own judgment.

(v) *Classifying the urgency of symptoms during telephone triage*

-A pediatrician will handle the telephone consultations, and determine the degree of urgency.

-The telephone triage pediatrician will classify some semi-urgent cases as non-urgent, and some as urgent.

-The telephone triage pediatrician will classify some non-urgent cases as semi-urgent, and some as urgent.

(vi) *Compliance with telephone triage pediatrician's recommendation concerning medical care*

-The telephone triage pediatrician will recommend that all cases classified as semi-urgent seek emergency medical attention.

-The telephone triage pediatrician will encourage

all cases classified as non-urgent to follow up by monitoring progress until the next morning (including seeking regular medical attention the next morning).

-Some parents will follow the telephone triage pediatrician's recommendation to seek emergency medical attention while some will choose instead to monitor progress further.

-Some parents will follow the telephone triage pediatrician's recommendation to monitor the child's progress further while some will instead seek emergency medical attention.

2.3. *Outcome*

We used the model to evaluate the following outcomes:

(I): Number of children visiting the after hours medical facility: the number of children who were taken to the after hours medical facility, regardless of the urgency of their symptoms.

(II): Number of children for whom medical treatment was delayed: the number of children who should have received medical attention, but were monitored and worsened before receiving attention.

(III): Lost opportunities for appropriate medical attention: Number of children who should have received medical attention but did not, including semi-urgent cases that were monitored but did not receive treatment.

To determine the potential benefit of the telephone triage program, we compared the difference in (I) between the group using the telephone triage program and the control group (not using the program). To measure the potential harm, we found the difference in (II) and (III) between these two groups.

2.4. *Literature search*

To estimate the parameters in our model, we conducted a search of literature databases, including MEDLINE, the Japan Central Review of Medicine, and the Ministry of Health, Labor and Welfare. We searched each database for the terms "pediatrics," "emergency," "after hours," "out of hours," "nighttime," "telephone," and "triage," occurring together. In addition, for parameters for which it was not possible to find appropriate reference literature, we conducted a search of websites using Google (*http://www.google.co.jp*).

2.5. *Sensitivity analysis*

Each parameter used in the model was subject to sensitivity analysis by multiplying the value used in the basic analysis by 0.5 and 2.0 (for lower and upper limits) or by varying the parameter value within the appropriate range determined from the literature or author discussions

3. Results

3.1. *Decision tree* (Figure 1)

The figure displays a decision tree based on the results of discussion by the authors, taking into consideration the consistency of actions to seek medical attention in actual pediatric emergencies.

3.2. *Parameter estimation* (Table 1)

(i) *Proportion of degree of urgency of child's symptoms*

We could not find any studies directly measuring the proportions of urgent, semi-urgent, and non-urgent emergencies occurring within the region. We therefore made the following estimates based on surveys of residents regarding pediatric emergency treatment (*9*) and a study of the level of urgency of pediatric patients at sites of pediatric emergency care (*10*), which we took as relevant reference literature.

First, based on the survey of area residents (*9*), we divided cases based on the response to the onset of symptoms (including external injury) which were thought to need emergency medical attention at a medical facility into those that received medical attention (62.0%) and those that did not (38.0%). Then, based on the study of the degree of urgency of pediatric patients at emergency treatment facilities (*10*), we divided cases into three categories: urgent cases (62.0% × 4.3% = 2.7%), semi-urgent cases (62.0% × 23.9% = 14.8%), and non-urgent cases (62.0% × 1.8% = 44.5%). Finally, we defined non-urgent cases as the sum of cases that did not receive medical attention and those cases that did receive attention that were classified as non-urgent (38.0% + 44.5% = 82.5%).

The two studies were not limited to cases occurring during night, and the each urgency category described above were assumed to be consistent throughout the whole day. We found no data suggesting that the proportion of each urgency category varied significantly between day and night, so this hypothetical proportion was set.

(ii) *Rate of after hours visits based on parents' discretion*

We were unable to identify any studies reporting this figure. The authors discussed this and assumed the percentage was 90% for semi-urgent cases and 60% for non-urgent cases.

(iii) *Chance of change in urgency during monitoring*

We were unable to identify any studies reporting this figure. The authors discussed and hypothesized that there was a 10% chance of a case changing from one category to the next category, in the order of urgent ↔ semi-urgent ↔ non-urgent. Furthermore, there was a 1% chance of a case changing by two categories.

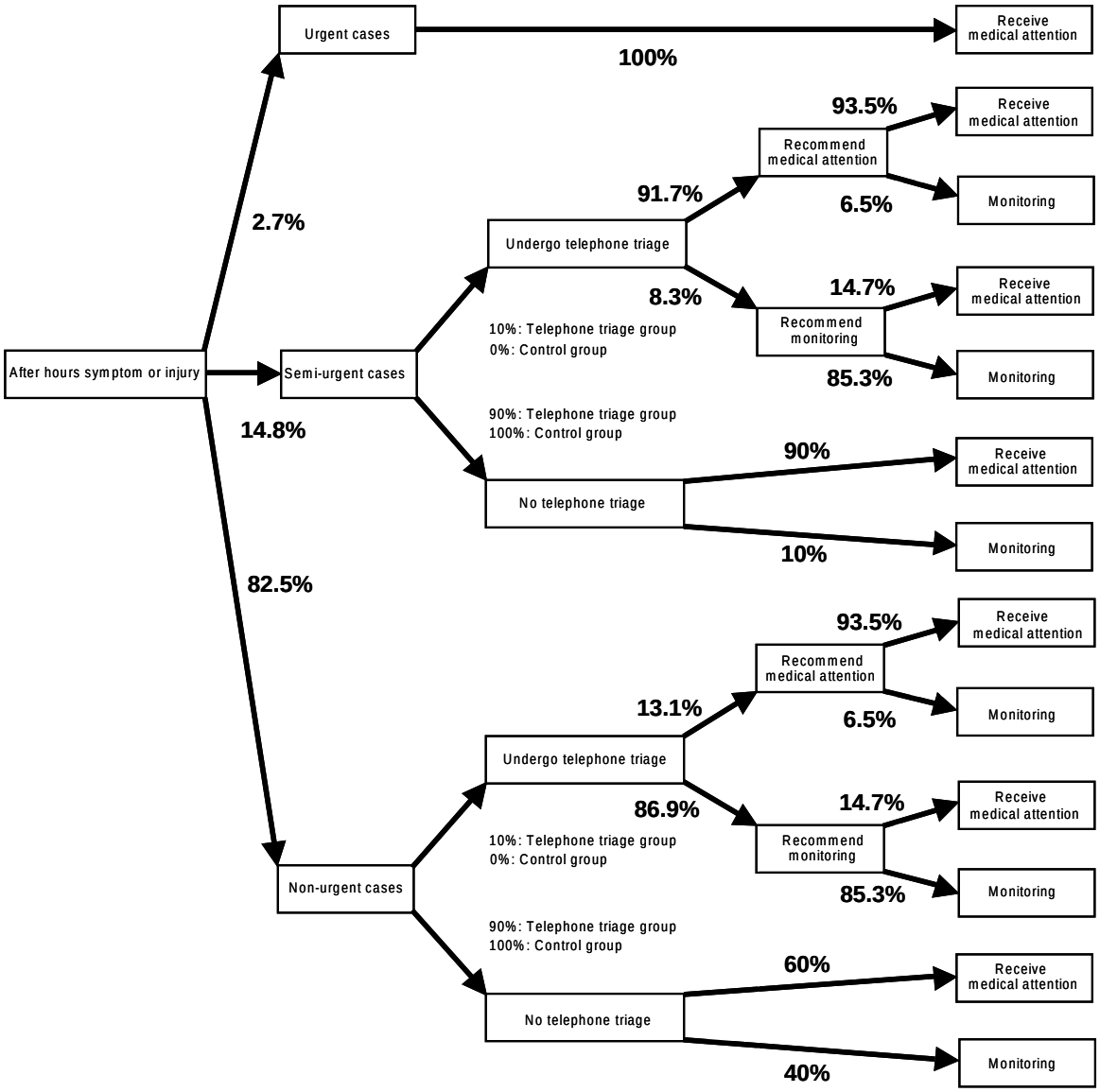

Figure 1. Decision tree.

(iv) *Rate of use of the pediatric emergency telephone triage program*

We were unable to identify any studies reporting this figure. Following discussion among the authors, we set the value at 10% in both semi-urgent and non-urgent cases, as parents who would use it would want to know after hours visit was not only necessary but also unnecessary.

(v) *Accuracy of classification of symptom urgency by telephone triage pediatricians*

We were unable to identify any studies reporting this figure. The authors discussed and hypothesized that 1 out of 10 cases might be misclassified into the next category, in the order of urgent ↔ semi-urgent ↔ non-urgent. Furthermore, 1 case out of 20 may have been misclassified by two categories (*e.g.* an non-urgent case misclassified as urgent).

(vi) *Rate of compliance with telephone triage pediatrician's recommendation concerning medical care*

There were two studies (*11*,*12*) reporting the rate at which parents follow the recommendations given by physicians during telephone triage. One study (*11*) was a randomized clinical trial that compared the results of telephone triage by physicians and nurses, but because over half of the participants dropped out of the study at the stage at which consent was to be obtained, we used the results of the remaining cohort study (*12*). In this study, the advice regarding medical care was divided into three categories: emergency medical attention, examination the following day, and telephone advice alone. The rate at which participants in this study followed recommendations to seek emergency medical treatment was used as the rate of compliance with the recommendation to visit the medical facility in our simulation, and the rates at which participants

followed advice to get an examination the following day or only receive advice on the telephone were collectively taken as the rate at which parents complied with recommendations for further monitoring and follow up.

3.3. *Basic analysis* (Table 2)

Of 10,000 cases arising outside regular hours, we estimated that 8,251 were non-urgent. In the control group, there were 6,757 after hours visits. In the telephone triage group, 973 cases underwent telephone triage, and the number of after hours visits was reduced by 273 compared to the control group, which corresponds to 4% of the control group's after hours visits. There was no increase or decrease in the number of semi-urgent cases for which medical attention was delayed, and the number of semi-urgent cases that did not receive attention increased by three.

3.4. *Sensitivity analysis* (Table 3)

If the rate of use of the telephone triage program varied

Table 1. Basic variable data

Variable	Value	Reference
Urgency of child's symptoms		
Urgent cases	2.7%	References *9*,*10* (See main text)
Semi-urgent cases	14.8%	
Non-urgent cases	82.5%	
Rate of after hours visits based on parents' discretion		
Urgent cases	100.0%	Definition
Semi-urgent cases	90.0%	Hypothesis
Non-urgent cases	60.0%	Hypothesis
Changes in urgency		
Semi-urgent cases		
Change to urgent	5.0%	Hypothesis (See main text)
Remain semi-urgent	90.0%	
Change to non-urgent	5.0%	
Non-urgent cases		
Change to urgent	1.0%	Hypothesis (See main text)
Change to semi-urgent	5.0%	
Remain non-urgent	94.0%	
Usage rate of pediatric emergency telephone triage program	10.0%	Hypothesis
Accuracy of triage pediatrician' classification of symptom urgency		
Semi-urgent cases		
Classified as urgent	8.3%	Hypothesis (See main text)
Classified as semi-urgent	83.4%	
Classified as non-urgent	8.3%	
Non-urgent cases		
Classified as urgent	4.4%	Hypothesis (See main text)
Classified as semi-urgent	8.7%	
Classified as non-urgent	86.9%	
Parents' compliance vis-à-vis recommendation about medical attention		
Recommend medical attention		
Compliance	93.5%	Reference *12*
Non-compliance	6.5%	
Recommend monitoring		
Compliance	85.3%	Reference *12*
Non-compliance	14.7%	

Table 2. Basic analysis (10,000 after hours cases)

Outcome	Telephone triage		Difference
	Yes	No	
No. of cases by urgency			
Urgent cases	267	Same	–
Semi-urgent cases	1,482	Same	–
Non-urgent cases	8,251	Same	–
Telephone triage cases	973	0	+973
After hours visits	6,484	6,757	-273
Urgent cases (reshown)	310	307	+3
Semi-urgent cases (reshown)	1,510	1,499	+11
Non-urgent cases (reshown)	4,664	4,951	-287
No. of semi-urgent cases that became urgent and received medical attention	7	7	+/-0
No. of semi-urgent cases that did not get attention	137	134	+3

Table 3. Sensitivity analysis (10,000 after hours cases)

Parameter	Parameter range of values (Lower limit-basic analysis-upper limit)	Outcome	Lower limit	Basic analysis	Upper limit
Rate of telephone triage usage (%)	5-10-20	# of after hours visits	-137	-273	-546
Rate of medical attention received based on guardian's discretion, non-urgent cases (%)	30-60-90	# of after hours visits	-40	-273	-505
Rate of medical attention received based on guardian's discretion, semi-urgent cases (%)	45-90-100	# of after hours visits	-209	-273	-287
Accuracy of classification of symptom urgency, semi-urgent cases classifi ed as non-urgent (%)	4.5-8.3-14.3	# of after hours visits	-298	-273	-238
Proportion of urgency level, semi-urgent cases (%)	7.4-14.8-29.6	# of after hours visits	-297	-273	-253
Rate of telephone triage usage (%)	5-10-20	# of semi-urgent cases that became urgent and got medical attention	+/-0	+/-0	+/0
Rate of telephone triage usage (%)	5-10-20	# of semi-urgent cases that did not receive medical attention	+/-0	+3	+6

from 5% to 20%, then the reduction in after hours cases would vary widely from approximately 2% (137/6,757 cases) to 8% (546/6,757 cases).

When the percentage of after hours visits for non-urgent cases based on parent discretion is changed from 30% to 90%, the reduction in after hours visits varies from approximately 0.6% (40/6,757 cases) to approximately 7% (505/6,757 cases).

Changing the percentage of after hours visits for semi-urgent cases based on parent discretion changed the number of after hours visits, but that variation was more limited than of the variation for non-urgent cases. On the other hand, the number of semi-urgent cases that did not receive medical attention changed greatly, and the rate of medical visits for semi-urgent cases based on parents' discretion was below 87.0%, which was lower for the telephone triage group than the control group (data not shown).

4. Discussion

By carrying out telephone triage in roughly 1,000 cases, we found that approximately 30% (273 cases) avoided after hours visits. Therefore, the effectiveness of telephone triage in reducing after hours visits was not extremely high. Most of this reduction in after hours visits is attributable to the fact that, as a result of telephone triage, non-urgent cases are directed to monitor developments further, thus avoiding the need for immediate medical attention. The accuracy of urgency classification during telephone triage, compliance with recommendations to continue monitoring the situation, and changes in the degree of urgency during monitoring all had a cumulative impact on the effectiveness of the program. Additionally, some of the monitoring cases received postponed medical attention the following morning, so the overall reduction in medical facility visits, during and outside of regular hours, may be smaller than that shown in the results.

Based on the hypothesis that the rate of use of telephone triage is 10%, only about 4% (273/6,757 cases) of after hours visits were avoided. This result suggests that the impact of this program as a means of easing the overcrowding of emergency medical facilities is slight. If the rate of use is increased, the effect will be greater; for instance, if all after hours cases other than urgent ones first undergo telephone triage, approximately 40% of those currently coming in for emergency attention would not do so, and we could expect emergency medical facility overcrowding to be decreased considerably.

A wide variation in assessment of emergency levels by each triage pediatrician participating in the running program may exist due to a lack of standard telephone triage training required for its participation. Extreme variation in emergency level assessment would therefore lead to a diminution of the effect of reducing after hours visits. However, because there were no figures for accuracy of the assessment, our decision model utilized an estimate of the average figures.

The increase in semi-urgent cases that do not receive attention, which is a negative outcome of telephone triage, was only three cases out of the 1,000 that underwent telephone triage. This is a comparatively small number. In addition, this increase in semi-urgent cases that did not receive medical attention disappeared when the rate of medical visits based on the discretion of parents declined slightly (from 90.0% to 87.5%). Therefore, although it depends on one's perspective in comparing the benefits of the telephone triage program (reduction in after hours visits) with its potential harm (delay in medical attention), we think that the harm remains within an acceptable range and the benefits are greater.

This study is only an estimate based on a hypothetical model, and it is important to do an actual outcome survey. It is important to confirm that life-threatening outcomes will not occur for semi-urgent cases left without medical care until the start of regular hours of operation the following day (at most, 14 hours from 7 p.m. to 9 a.m. the following morning). It is necessary to consider the possibility that such things would cancel telephone triage's potential benefit of reducing the use of

emergency services.

Among the potential benefits of the telephone triage program that we were unable to consider in this study are the enhanced peace of mind that offering the telephone triage program gives to parents and guardians (*6*), and the fact that reducing the number of emergency medical facilities patients makes it possible for pediatricians to give medical care to children with more serious ailments. The peace of mind of parents and guardians is difficult to measure, as are the benefits to the group, but these are important aspects that cannot be ignored.

There are several hurdles that must be cleared before telephone triage can be used more widely. First, there is the issue of finding pediatricians to participate in telephone triage. The results of this study show that to increase the effect of telephone triage on the reduction of emergency medical service use, it is necessary to carry out multiple triages. If pediatricians handle all of these telephone triages, then it will be necessary to hire a very large number of pediatricians, and realistically this is an extremely difficult proposition. In a survey of pediatricians in Hiroshima who took part in telephone triage, some reported that "taking part in telephone triage in addition to our normal work feels like a burden" (*13*). Therefore, rather than having pediatricians handle all telephone triage, there are programs being developed in Japan (*14*) to cultivate trained triage nurses like those in the U.S.(*15*). We think that the use of such triage nurses for telephone triage should be explored.

In addition, current telephone triage programs are run by individual prefectures. However, there is no particular reason why these programs should be provided at the prefectural level, and we think it may be more efficient, in terms of the allocation of triage personnel, to have one or several triage centers nationally.

On the other hand, if the telephone triage program is to be made more widely available, the issue of cost cannot be ignored. It would be best if a study of the telephone triage program's cost effectiveness was carried out swiftly, and the health service provider (the national government, prefecture, *etc.*) used these results as a reference in prioritizing it along with other health services (*12*).

The present study has several limitations. First, there is the great shortage of data estimating the variables used in the model. Therefore, there is the possibility that the absolute values of the reduction of after hours visits through telephone triage will vary widely, as shown in sensitivity analysis. In addition, there is the fact that we were unable to integrate both the beneficial and harmful effects of telephone triage.

In conclusion, we think that the pediatric emergency telephone triage service is a valuable health service with benefits that outweigh the possible harmful effects, but unless the use of the program is expanded, it is likely that the effectiveness in reducing after hours medical visits will be limited.

Acknowledgements

We would like to thank Masahiko Kuwabara, Chairman of the Hiroshima Prefecture Pediatricians Association, who provided us with much valuable information throughout the study.

References

1. Ichikawa K. The problems concerning with actual state of pediatric emergency care system. Sogo Rinsho. 2004; 53 supple:15-20. (in Japanese)
2. Japan Pediatric Society. Syôni -Iryou-kaikaku/ kyûkyû purojekuto. Available at: *http://jpsmodel.umin.jp/*. (accessed September 14, 2007). (in Japanese)
3. Japan Pediatric Society. Kodomo no kyûkyû. Available at: *http://kodomo-qq.jp/*. (accessed September 14, 2007). (in Japanese)
4. Notice No. 0423004 from the Ministry of Health, Labour and Welfare, 2006.
5. Ministry of Health, Labour and Welfare in Japan. Syôni-kyûkyû-dennwa-soudann-jigyô (#8000) ni tsuite. Available at: *http://www.mhlw.go.jp/topics/2006/10/tp1010-3.html*. (accessed September 14, 2007). (in Japanese)
6. Kuwabara M. Syôni-kyûkyû-dennwa-soudann-jigyô. J Emerg Med Serv. 2003; 10:18-22. (in Japanese)
7. Gold MR, Siegel JE, Russell LB, Weinstein MC. Cost-Effectiveness in Health and Medicine. Oxford: Oxford University Press; 1996.
8. Sox HC, Blatt MA, Higgins MC, Marton KI. Medical Decision Making. Massachusetts: Butterworth-Heinemann; 1988.
9. Hyogo Prefecture. Syôni-kyûkyû-iryo ni kannsuru kennminn-annkêto tyousa-kekka Available at: *http://web.pref.hyogo.jp/kenkou/public-comment.htlm*. (accessed March 14, 2006). (in Japanese).
10. Ichikawa K. Kyûkan-sentâ/kyûkyû-byouin syônika ni okeru syôuni-kyûkyû-kannja no juusyoudo-tyosa. Available at: *http://mhlw-grants.niph.go.jp/niph/search/Download.do?nendo=1998&jigyoId=000081&bunkenNo=199800824A&pdf=199800824A0002.pdf*. (accessed September 14, 2007). (in Japanese)
11. Lee TJ, Guzy J, Johnson D, Woo H, Baraff LJ. Caller satisfaction with after-hours telephone advice: nurse advice service versus on-call pediatricians. Pediatrics. 2002; 110:865-872.
12. Crane JD, Benjamin JT. Pediatric residents' telephone triage experience: do parents really follow telephone advice? Arch Pediatr Adolesc Med. 2000; 154:71-74.
13. Kuwabara M. Syôni-kyûkyû-dennwa-soudann-jigyô [Hiroshima no hikari to kage]. J Jap Pediatr Assoc. 2005; 30:159-162. (in Japanese)
14. Katada N. Syôni-kyûkyû-ninntei-kanngoshi no katsuyou to kensyu-puroguramu no kaihatsu. J Child Health. 2005; 64:244-248. (in Japanese)
15. Dale J, Crouch R, Lloyd S. Primary care: nurse-led triage and advice out-of-hours. Nurs Stand. 1998; 12:39-43.

(*Received September 16, 2009; Revised October 21, 2009; Accepted October 22, 2009*)