BMJ Open

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Journal:	*BMJ Open*
Manuscript ID	bmjopen-2017-016423
Article Type:	Research
Date Submitted by the Author:	20-Feb-2017
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Primary Subject Heading:	Health services research
Secondary Subject Heading:	Public health
Keywords:	Triage, Task shifting, Health Service Supply and Distribution, PRIMARY CARE, Prevention, School Health Services

Triage in Preventive Child Health Care: a Prospective Cohort Study of Care Use and Referral Rates for Children at Risk

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Word count (manuscript): 4,402

ABSTRACT

Objectives

A novel approach involving the use of triage in routine assessments was introduced to improve the efficiency of Preventive Child Health care (PCH). Assistants carried out pre-assessments of all children to select children for follow-up assessments by a physician or nurse. In the usual approach, physicians or nurses assessed all children. We aimed to study the potential opportunities for PCH physicians and nurses to pay more attention to children at risk. We explored the impact of triage and task shifting on extra PCH care and referral by PCH.

Design, participants

An observational prospective cohort design was used with an analysis of the basic registration data from the preventive health assessments for 1897 children aged 5 to 6, and 10 to 11 years.

Setting

A comparison was made between two PCH services in the Netherlands using the novel triage approach and two PCH services providing the usual approach.

Main outcome measures

The primary outcome measures were the referral rates to either additional PCH assessments or to external services. The secondary outcome measures were the rates of PCH assessments made at the request of parties such as parents and school professionals.

Results

Overall, more children were referred to additional PCH assessments (OR 1.3, 95%-C.I. 1.0-1.6), mainly in the 5 to 6 years age group (OR 1.9, 95%-C.I. 1.3-2.7). Fewer children from the two age groups were referred to external services in the triage approach than in the usual approach (OR 0.4, 95%-C.I. 0.3-0.7). More PCH assessments were performed on request in the triage approach (OR=4.6, 95%-C.I. (3.0-7.0)).

Conclusions

Targeted assessments in the triage approach to PCH provide extra opportunities to devote extra PCH care to vulnerable children with specific health needs.

Keywords

Triage. Task shifting. Health service supply and distribution. Primary care. Prevention. School health services. Children. Screening.

ARTICLE SUMMARY

Strengths and limitations of this study

- The inclusion of four PCH services from urban and rural areas, improving the external validity of the study.
- The inclusion of a random sample of schools stratified by socio-economic status.
- We selected groups of children that were homogeneous in terms of gender and age and controlled for differences in socio-economic status.
- We were not allowed to analyse the individual details of the children referred to additional PCH assessments or to external services because of the absence of informed consent.

BACKGROUND

Changes in the prevalence of disorders such as mental health problems, the need to prevent violence, increases in lifestyle-related problems and apparent health inequities between subgroups of children all mean that improvements are needed in the system of community preventive services for children[1-6]. These preventive services face several challenges, such as accessibility to care, programme quality and the efficient use of professionals[7, 8]. Changes and improvements to health care systems could be accomplished by means of the introduction of triage and the shifting of tasks between health care professionals, possibly producing the following benefits: the optimal use of the skills and expertise of health care professionals, reduced workloads for physicians and nurses, improvements to the accessibility of health care, and greater patient satisfaction[9, 10]. Research in primary care shows that task-shifting from physicians to nurses dealing with chronic disorders results in more return consultations by nurses but that the number of referrals to secondary care is similar for nurses and physicians. Nevertheless, this type of task-shifting has a clear positive impact on patient satisfaction[11-14].

Preventive Child Health care (PCH) services usually provide vaccinations and routine health assessments using a pre-defined age schedule. The aim is to monitor child growth and development and to prevent child health problems[8, 15]. In the Dutch PCH programmes, all children receive 17 routine assessments: 13 in the first 3 years (in well-child clinics) and 4 in the age group 4 to 18 years (in school health services). Routine assessments are conducted by community-based physicians and nurses who have studied specifically to do this work. The Dutch PCH services are free of charge and attendance rates can be more than 85%[16, 17]. When problems are identified, PCH physicians and nurses decide whether there is any need for advice, additional assessments by PCH, or referral to external services such as a general practitioner or a specialist. The referral of children to the appropriate services according to their needs, which is also a feature of primary care is an essential component of the health screening programmes delivered by PCH[18].

The PCH programme needs to be more flexible and demand driven than in the current pre-defined schedule, in which there are only four assessments during a school career, in order to follow the

changing care needs of the children. A two-step triage procedure has been developed based on task-shifting from PCH physicians and nurses to PCH assistants for children aged 4 to 18 years[19]. A PCH assistant first assesses children with a strict pre-assessment protocol based on questionnaires completed by parents and schoolteachers and face-to-face screening. The PCH assistant refers only the children with suspected health concerns to a follow-up assessment by a PCH physician or nurse. The nature and complexity of the suspected health problems determines whether the follow-up assessment should be conducted by a physician or a nurse: physicians attend to medical and developmental disorders and nurses attend mostly to psychosocial problems and lifestyle issues. The pre-assessment by the PCH assistants is conducted in the schools in the absence of parents but with parental consent. Follow-up assessments by a physician or nurse are made in the presence of the child's parent in order to allow for interaction with the PCH professional about the potential health problems detected by the PCH assistant. In the usual approach, all children are assessed by a PCH physician or nurse, who will sometimes receive support from PCH assistants. In both approaches, the PCH professionals can provide additional PCH assessments or refer children to external services appropriate to children's specific needs, as is the case in primary care. In addition, PCH professionals may assess children at the request of, for example, parents or school professionals. The triage approach results in less involvement of physicians and nurses in the routine assessments.

We conducted a pilot study of the triage approach that compared attendance and referral rates in the triage and the usual approach. We found equal attendance levels and fewer children being referred for additional PCH assessments or to external services in the triage approach than in the usual approach[19]. Another study showed that routine health assessments in a triage approach detect health concerns as well as the usual approach[20]. In the present cohort study, we looked at whether the triage approach provides more opportunities for PCH professionals to devote extra attention to children at risk of health problems in terms of additional PCH assessments and PCH assessments on request. This study aimed to investigate the effect on PCH referrals of a redesign of routine child health assessments to include triage and task-shifting. We addressed the following research questions:

- What are the rates of referral for additional PCH assessments and to external services resulting from routine assessments in the triage approach as compared with the usual PCH approach?
- What are the rates of PCH assessments requested by parties such as parents and school professionals, including the referral rates resulting from these assessments, when a triage approach is used rather than the usual approach?

METHODS

An observational prospective cohort design was used to study the research questions.

Study sample

The study was conducted with routine and administrative data from four PCH services in the Netherlands. Two services used the triage approach and two services the usual approach. A sample of primary schools, stratified for socio-economic status (low, middle and high status) and urban or rural area was randomly selected: 20 schools that used the triage approach were matched with 21 schools that used the usual approach. The socio-economic status of the schools was determined using national census statistics. Routine health assessments were conducted by PCH services in Dutch primary schools for two age groups: 5 to 6 years, and 10 to 11 years. To study the referral rates, the study included all the children from the selected schools aged 5 to 6 and 10 to 11 years who were offered a routine assessment. A sample of 1008 children who received the triage approach was compared with a sample of 986 children who received the usual approach. In addition to routine PCH assessments, we also investigated PCH assessments of children at the request of parties such as parents, school professionals and professionals working in well-child care (we refer to these assessments hereinafter as 'PCH assessments on request'). To address this research question, we included all children attending the schools selected for this study in a period of 12 months. This resulted in a sample of 4050 children in the schools where the triage approach was used and 4611 children in the schools where the usual approach was adopted. Since there were no vital changes or interventions in health care, and all the data were fully anonymised and coded, and since the data did not include medical

details that could be linked to individuals before inclusion in this study on a population level, no informed consent was needed.

Data collection

This study drew on routinely registered digital PCH records to collect data on rates of referral to additional PCH assessments and to external services following the detection of health problems during routine PCH assessments. In addition, data were registered for the PCH assessments on request. The assessment procedures were described in uniform protocols for all PCH services covered by this study and the participating PCH professionals were informed about these protocols. For the sake of completeness, a random sample of the dataset from the PCH records was checked manually. Children in the study sample who received triage pre-assessments or assessments as usual were included from January to April 2012. Data relating to children requiring triage follow-up assessment and PCH assessments on request were included until December 2012.

Procedures

When weight problems, visual disorders and/or psychosocial problems were identified by PCH physicians and nurses, the children were referred to additional PCH assessments or external services. We chose these three health indicators because the relevant procedures are established and known to be valid[17, 21].

Children were referred for these indications after the follow-up assessment in the triage approach, and after the routine assessment in the usual approach. When school professionals or parents suspected the presence of risk factors in children, they were allowed to request an assessment by PCH for further identification. After problems were identified by a PCH physician or nurse, these children could also be referred for additional assessments or to external services (Figure 1).

Insert Figure 1 about here

PCH professionals registered and coded socio-demographic variables in digital PCH records that included gender and age, weight, visual and psychosocial health status and referrals to additional PCH assessments and to external services. The socio-economic status of the children was established using national census statistics and on the basis of postal codes for their home addresses using education, income and employment status of the local population.

Weight, visual and psychosocial health status were assessed and recorded in the digital PCH records as usual. Problems with weight (both overweight and underweight) were determined using the body mass index and assessment by the professional. The thresholds used by the international obesity task force were adopted as the BMI cut-off points for overweight and obesity[22]. Standard deviation (SD) scores for BMI were based on the Dutch general population[23]. Visual disorders, including amblyopia and impaired vision, were determined using a visual acuity test: the Snellen chart with SD scores based on the Dutch general population[21]. Psychosocial problems included behaviour and emotional problems of the child, social interaction problems and child abuse. The identification of these psychosocial problems was based on the assessment made by the PCH professional, and it also included the child's scores on the Strengths and Difficulties Questionnaire[24, 25].

All referrals to additional PCH assessments or to external services were registered and coded by the PCH professionals.

Finally, records were kept of whether requests for PCH assessments were made by parents, school professionals or professionals in well-child care. The referrals to additional PCH assessments and to external services subsequent to these assessments were also registered.

Study outcomes

The primary outcomes of this study were the rates of referral to additional PCH assessment and to external services as a result of the routine assessments. The secondary outcomes were the number of children receiving assessments on request, including the party requesting the assessment and rates of referral to further PCH assessment or to external services.

Statistical analyses

Our first step was to assess differences in background characteristics between the two cohorts using chi-square tests. Secondly, we assessed the referral rates from pre-assessment to follow-up assessment in the triage approach. We also assessed the referral rates in general (additional PCH assessment and to external services combined) for the two approaches and separately for additional PCH assessment and external services. All referral rates were assessed using the total sample of children participating in the study as the index population. We tested differences in rates of referral between the two approaches using three separate logistic regression analyses with the outcome variables general referral, referral to additional PCH assessment and referral to external services. In all logistic regression analyses we adjusted for socio-economic status. These analyses were repeated for the subgroups of children referred for weight problems, visual disorders and psychosocial problems. Because routine PCH assessments were made in the 5 to 6 and 10 to 11 years age groups, the interaction effects of child age and the type of approach on the outcome measures were studied. When we found interaction effects associated with child age, the analyses were repeated separately for the 5 to 6 and 10 to 11 years age groups.

Thirdly, we compared the rates of assessments on request for the two approaches using Fisher's exact test. In this analysis, the total sample of children of the schools participating in this study was used as the index population. We also assessed whether children were referred by different parties (school, parents, well-child care, other) in the two approaches using chi-square and Fisher's exact tests (categories were tested separately). In these analyses, the sample of the group of children who received a PCH assessment on request was used as the index population.

Furthermore, we assessed differences between the two approaches in rates of referral for the group of children who received a PCH assessment on request. This involved the use of chi-square testing and the sample of the group of children who received a PCH assessment on request was used as the index population.

Effects were considered to be statistically significant when the p-value was ≤ 0.05 (2-sided). SPSS Statistics was used to analyse the data (SPSS 22.0 for Windows, SPSS Inc., Chicago, IL).

RESULTS

Study sample

We found no differences in the ages or genders of the children receiving routine assessments in the triage and usual approaches. However, the socio-economic status of the children did differ: the triage sample included more children with lower socio-economic status (Table 1). No differences were found in the ages or socio-economic status of the group of children receiving PCH assessments on request. There was a gender difference in the group of children receiving assessments on request: more boys received an assessment on request in the triage approach than in the usual approach (Table 1).

Table 1. Characteristics of children assessed using the triage and usual approaches to PCH.

Characteristics	Triage approach n (%)	Usual approach n (%)
Children receiving routine assessment	N=974	N=923
Gender		
Boy	485 (49.8)	455 (49.3)
Girl	489 (50.2)	468 (50.7)
Age (years)		
≤8	480 (49.3)	468 (51.8)
≥9	494 (50.7)	436 (48.2)
Socio-economic status		
Low	415 (42.9)	342 (37.1) **
Middle	304 (31.4)	372 (40.4)
High	249 (25.7)	207 (22.5)
Children receiving assessment on request	N=107	N=27
Gender		
Boy	67 (62.6)	10 (40.0) *
Girl	40 (37.4)	15 (60.0)
Age (years)		
≤8	78 (72.9)	21 (77.8)
≥9	29 (27.1)	6 (22.2)
Socio-economic status		
Low	68 (65.4)	17 (70.8)
Middle	22 (21.2)	2 (8.3)
High	14 (13.5)	5 (20.8)

*p<0.05; **p<0.01

Referral to additional PCH assessments or to external services

The percentage of children referred from pre-assessment to a follow-up assessment in the first step of the triage approach was 45.6%. We did not find differences between the total numbers of children

referred to extra care (in other words, the children referred to additional PCH assessments and/or to external services) in the two approaches: 18.1% of the children in the triage group were referred to extra care after the follow-up assessments, and 19.2% of the children were referred from usual group (OR=0.9, 95%-C.I. (0.7-1.1)) (Figure 1, Table 2). A closer look at these referrals indicates that there were more referrals to additional PCH assessments (OR 1.3, 95%-C.I. 1.0-1.6) and fewer referrals to external services in the triage approach than in the usual approach (OR 0.4, 95%-C.I. 0.3-0.7).

The percentage of children referred to extra care was also different in the group of children assessed as having a weight problem. In the triage group, 4.5% of the children were referred to extra care for a weight problem after 15.4% had been referred to a follow-up assessment by a PCH physician or nurse. In the usual group, 5.2% of the children were referred to extra care. The lower proportion of referral by triage PCH for a weight problem was particularly striking in referral to external services: 0.3% of the children, as opposed to 1.4% in the usual PCH group (OR=0.2, 95%-C.I. 0.1-0.7).

We found no difference between the triage and usual groups in terms of the total number of referrals of children with psychosocial problems to extra care. However, we found a difference in the percentage of referrals to external services: 1.2% of the children in the triage group were referred to external health services; the rate of referral was 2.5% in the usual group (OR=0.5, 95%-C.I. 0.2-1.0).

No differences were found between the triage and usual approaches in referral to extra care for the health indicator ‘visual disorder’.

Interaction effects were found for child age. In the 10 to 11 years age group, fewer children in the triage group were referred to extra care (in other words, additional PCH assessments and/or referrals to external services) than in the usual group (OR=0.6, 95%-C.I. 0.4-0.9). This effect was found for additional PCH assessments in particular (OR=0.5, 95%-C.I. 0.3-1.0). In the 10 to 11 years age group, fewer children were referred to extra care for weight problems (OR=0.6, 95%-C.I. 0.3-1.0) and for psychosocial problems (OR=0.5, 95%-C.I. 0.3-0.8) when the triage approach was used. No differences were found between the two approaches in the referral rates to extra care (in other words, to PCH and/or to an external service) for the 5 to 6 years age group. When looking closer at the type of extra care to which children were referred, we find that more children in the 5 to 6 years age group were

referred to additional PCH assessments in the triage approach (OR=1.9, 95%-C.I. 1.3-2.7). This interaction effect was found for children with psychosocial problems (OR=2.2, 95%-C.I. 1.0-4.5).

Table 2. Association between referral to additional PCH assessment or to external services and the PCH approach (triage versus usual care).

	Triage approach N=974		Usual approach N=923		
	Referral rate after pre-assessment by PCH assistant	Referral rate after having received a follow-up assessment by PCH physician or nurse	Referral rate after assessment by PCH physician or nurse		
	n (%)	n (%)	n (%)	Odds ratio^	95% CI
All referrals					
Number of children referred to follow-up assessment by PCH	444 (45.6)	-	-	-	-
Number of children referred to additional PCH assessment and/or external services	-	176 (18.1)~	177 (19.2)	0.9	0.7-1.1
additional PCH assessment	-	152 (15.6)	116 (12.6)	1.3	1.0-1.6
external services	-	35 (3.6)	73 (7.9)	0.4	0.3-0.7
Indication for referral: weight problem					
Number of children referred to follow-up assessment by PCH	150 (15.4)	-	-	-	-
Number of children referred to additional PCH assessment and/or external services	-	44 (4.5)	48 (5.2)	0.8	0.5-1.3
additional PCH assessment	-	43 (4.4)	38 (4.1)	1.0	0.7-1.6
external services	-	3 (0.3)	13 (1.4)	0.2	0.1-0.7
Indication for referral: visual disorder					
Number of children referred to follow-up assessment by PCH	47 (4.8)	-	-	-	-
Number of children referred to additional PCH assessment and/or external services	-	16 (1.6)	22 (2.4)	0.7	0.3-1.3
additional PCH assessment	-	10 (1.0)	10 (1.1)	1.0	0.4-2.4
external services	-	8 (0.8)	14 (1.5)	0.5	0.2-1.3
Indication for referral: psychosocial problem					
Number of children referred to follow-up assessment by PCH	152 (15.6)	-	-	-	-
Number of children referred to additional PCH assessment and/or external health services	-	48 (4.9)	57 (6.2)	0.8	0.5-1.1
additional PCH assessment	-	38 (3.9)	36 (3.9)	0.9	0.6-1.5
external services	-	12 (1.2)	23 (2.5)	0.5	0.2-1.0

^Logistic regression analyses with referral by PCH as the outcome variable, the approach (triage follow-up assessment or usual assessment) as the independent variable, and socio-economic status as co-variate
~Some children were referred to both additional PCH assessment and external health services.

PCH assessments on request

More children were referred to PCH assessments at the request of school professionals and parents in the triage approach than in the usual approach (p<0.01) (Table 3). In particular, more children in the triage approach than in the usual approach were referred to PCH assessments at the request of school professionals and of well-child care. Well-child care professionals referred children aged 4 years old when they entered primary school and care was transferred to PCH. Furthermore, we found differences between the two approaches for the rates of children who were referred to additional PCH assessments as a result of the PCH assessments on request. Half of the children seen on request were referred to additional PCH assessments and one out of five to external services in the triage approach. No children in the usual approach were referred to additional PCH assessments and two children (7.4 %) were referred to external services.

Table 3. Association between PCH approach (triage versus usual care) and children referred to PCH assessments on request and referral of these children to additional PCH assessment or to external services.

	Triage approach	Usual approach
	n (%)	n (%)
	N=4050#	N=4611#
Number of children receiving PCH assessment on request	107 (2.6)	27 (0.6)**
	N=107	N=27
Referring parties~		
School	18 (16.8)	0 (0.0) *
Parents	18 (16.8)	5 (18.5)
Well-child care	33 (30.8)	0 (0.0) **
Other	1 (0.9)	1 (3.7)
Unknown	37 (34.6)	21 (77.8) **
Referral to additional PCH assessment and/or external services	62 (57.9)	2 (7.4) **
additional PCH assessment	54 (50.5))	0 (0.0) **
external services	23 (21.5)	2 (7.4)

*p<0.05; **p<0.01
#All children (4-12 years) at the schools included
^ Chi-square test / Fisher's exact test
~The five categories were tested separately. For example, the school as the referring party was tested relative to all categories as a reference to analyse differences between the triage and usual approaches.

DISCUSSION

This study aimed to investigate the effects on care delivery and referral by PCH after a redesign of routine child health assessments based on triage and a shifting of tasks between health care professionals. We compared the rates of referral to additional PCH assessments or external services after the identification of health concerns during routine assessments with either the triage approach or the usual approach and explored whether this could improve the targeting of PCH care. We did not find any differences between the total numbers of children referred to extra care in the two approaches. However, more children aged 5 to 6 years and fewer children aged 10 to 11 years were referred to additional PCH assessments. Fewer children from both age groups were referred to external services when triage was used rather than the usual approach. The differences between the referral rates can be attributed to the different processes used to identify health problems in the two approaches. In the two-step triage approach, children requiring follow-up (in other words, children with suspected health problems) are assessed twice. After the pre-assessment by the assistant, the PCH physician or nurse and the parents need to focus only on the suspected health problems. In this follow-up assessment, more time is available to provide advice, recommendations and reassurance. This can reduce the need for referral to external services. Because the routine assessments in the usual approach are intended to cover all different screening items, little time is available for a further investigation of the problems identified. This could explain why the referral rate to external services is higher in the usual approach than in the triage approach. In particular, the lower referral rates to external services for weight problems and psychosocial problems as indicators of health problems, when the triage approach is used, could be explained by the positive fact that more time is available to investigate the problems during the follow-up assessment. Children with visual problems are usually referred directly to external services in both approaches and this could explain the equal referral rates to external services for these problems. The lower referral rate to external services in the triage approach may also be explained by the fact that problems – minor psychosocial problems, for example – are solved in the period between the pre-assessment and the follow-up assessment. On the other hand, parents may seek care in the period between the pre-assessment and the follow-up assessment and this may reduce the referral rates to external services in the triage approach.

In addition, the discipline conducting the assessment may also explain the differences found between the two approaches. The aim of pre-assessment by assistants and task-shifting is to save time for additional PCH assessments by physicians and nurses so that more attention can be paid to the care needs of children at risk. And indeed, we found that there were more additional PCH assessments for the 5 to 6 years age group when the triage approach was used. However, in the 10 to 11 years age group, there were fewer additional PCH assessments in the triage approach. This can be explained by the fact that all children aged 10 to 11 years are assessed by a nurse in the usual approach and children aged 5 to 6 years are assessed by a physician. When medical problems are suspected, nurses are required to refer the child for an additional PCH assessment by a physician. This leads to extra referrals to additional PCH assessments. In the triage approach, the PCH assistant preselects the children with suspected medical problems and refers them immediately for a follow-up assessment by a PCH physician. This is routine care in the triage procedure and it is not yet described as an additional assessment. It is also possible that PCH nurses have more return consultations than PCH physicians and that this leads to more additional PCH assessments for the 10 to 11 years age group in the usual approach.

A pilot study with the triage approach showed that referral rates to additional PCH assessments or to external services were lower than in the usual approach[19]. This has been confirmed in our study looking at referral to external services. Our results of referral rates of additional assessments for the shifting of tasks from physicians and nurses to assistants for the 10 to 11 years age group are in line with studies of task-shifting in primary care, which found more return consultations when nurses took over tasks from physicians, even though the number of referrals did not change[12, 13].

We examined the results of the PCH assessments (made with the aim of devoting more attention to children at risk) requested by parties such as parents, school professionals and professionals of well-child care. More PCH assessments at the request of these parties were found in the triage approach but these findings must be treated with caution because of the low numbers involved. The referrals for these children came from school professionals in particular. It could be hypothesised that differences in PCH assessments on request between the triage and usual approach can be attributed to the fact that

the triage approach results in a greater awareness among school professionals of the abilities of physicians and nurses to assess children on request. This explanation is in line with findings of our earlier study of school professionals, who responded that PCH services with the triage approach contribute more to support for children with specific needs than the usual approach[26].

Finally, the outcomes of the triage approach in PCH as measured in this study may have been affected by its relatively recent introduction by comparison with the usual approach. It can reasonably be expected that the triage approach will have a stronger impact on the number of PCH assessments on request when this approach has been in place for a longer period of time. It takes time to establish a relationship with parties such as school professionals.

Strengths and limitations of the study

The strengths of this study are that it is a "real-life" observational comparison that included four PCH regional services and random samples of schools stratified by socio-economic status and urbanity. We were able to use data from a homogeneous group of children with regard to gender and age range and controlled for differences in socio-economic status. The sample in the current study was selected from the general Dutch population from urban and rural areas, making generalisation of the findings to other PCH organizations possible. All four PCH services in this study used the same guidelines and registration procedures, reducing the possibility of identification and reporting bias. A limitation is that we were not allowed to use and analyse the individual details of the children referred to additional PCH assessments or to external services without informed consent.

Implications for practice

Economic circumstances and changing health demands require the development of new ways of delivering care. More efficiency and flexibility in the delivery of the PCH programme is needed to address challenges such as reduced budgets, workforce shortages, the growing need for optimal use of expertise of professionals, and the wish to provide customised care. PCH services in the Netherlands introduced more flexible PCH care delivery, with triage and task-shifting.[27] The triage approach is

intended to create more customised care in response to health issues that arise in the life cycle of children. It ensures a basic package of care for all children while preserving the strengths of the preventive health service: a low threshold and the wide reach necessary for the early identification of health problems. The costs required to assess all children have to be in balance with the extra care for children with specific needs. Our study of the costs of triage showed that this approach to routine PCH assessments, with the shifting of tasks from physicians to PCH assistants, resulted in a cost reduction of about one-third for the 5 to 6 years age group while providing basic care for all children. A minimal cost reduction was found for the 10 to 11 years age group[28]. We found that physicians and nurses working with a triage approach delivered extra PCH care in terms of additional PCH assessments for the 5 to 6 years age group and more PCH assessments at the request of parents, school professionals or professionals of well-child care targeting children with specific needs. Our study provides further insight into the possibilities of a more flexible and demand-driven delivery of preventive health services for children.

Future research

Further research is needed to assess the satisfaction of the children, young people and their parents with a triage approach to routine PCH assessment and the resulting care. Research is also needed to determine the actual quality of detection and referrals using a triage approach. This would allow us to determine the accuracy of referral to extra care (in other words, to determine whether a referral is justified or not) and to enhance our understanding of the equity of care distribution to the children needing health care. Moreover, research into the impact of the triage approach on the long-term need for care is advised.

Conclusions

Targeted assessments in the triage approach to PCH provide opportunities to devote extra PCH care to vulnerable children with specific health needs. The triage approach leads to fewer referrals to external care. More research into the outcomes of referral to extra care is needed.

Funding statement

This study was financially supported by grants 156511002 and 156520007 from ZonMw-the Netherlands Organization for Health Research and Development. The funding source had no role in the study design, data collection, data interpretation, data analysis or writing of the report.

Ethical approval

The Medical Ethics Committee of Leiden University Medical Centre approved this study (reference P11.161/NV/nv).

Availability of data

Anonymised data can be provided by TNO to researchers on request.

List of abbreviations

BMI Body Mass Index

PCH Preventive Child Health care

Competing interests

The authors declare they have no competing interests.

Authors' contributions

JB had the original idea, contributed to the development of the triage protocols, acquisition and interpretation of data and drafting of this article.

MN contributed to the revision of the drafts and the intellectual content of this article.

SB contributed to the revision of the drafts and the intellectual content of this article.

MK contributed to the data collection, and to the analysis and interpretation of the data. She was involved in revising the article.

MT contributed to the conception and design, analysis and interpretation of data. She was involved in revising the article.

PK contributed to the conception and design, analysis and interpretation of data and drafting of the article. He supervised the execution of the study.

Finally, all authors read and approved the final article.

Acknowledgements

We thank the personnel of the PCH services Municipal Health Service Noord- en Oost- Gelderland, Municipal Health Service Hollands Noorden, Municipal Health Service Drenthe and Municipal Health Service Gelderland-Midden for participating in this study and D. Heinen M.Sc. for statistical advice.

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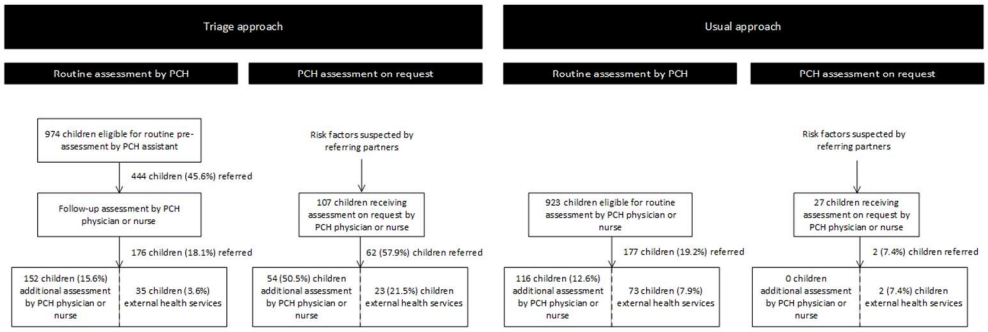
List of Figures

Figure 1. Flow chart for the PCH routine assessment and assessment on request in the triage and usual approaches.

PCH: Preventive child health care



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STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1, 3
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	6, 7
Objectives	3	State specific objectives, including any prespecified hypotheses	7, 8
Methods			
Study design	4	Present key elements of study design early in the paper	8
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	8, 9
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	8
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	8
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	9, 10
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	10
Bias	9	Describe any efforts to address potential sources of bias	8, 11
Study size	10	Explain how the study size was arrived at	8
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	10, 11
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	11
		(*b*) Describe any methods used to examine subgroups and interactions	11
		(*c*) Explain how missing data were addressed	n/a
		(*d*) If applicable, explain how loss to follow-up was addressed	n/a
		(*e*) Describe any sensitivity analyses	n/a
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8, 9
		(b) Give reasons for non-participation at each stage	n/a
		(c) Consider use of a flow diagram	9
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	12
		(b) Indicate number of participants with missing data for each variable of interest	n/a
		(c) Summarise follow-up time (eg, average and total amount)	n/a
Outcome data	15*	Report numbers of outcome events or summary measures over time	12, 13, 14, 15
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	12, 13, 14, 15
		(*b*) Report category boundaries when continuous variables were categorized	12
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	13, 14
Discussion			
Key results	18	Summarise key results with reference to study objectives	16, 17
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	16, 17, 18
Generalisability	21	Discuss the generalisability (external validity) of the study results	18, 19
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	20

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Triage in Preventive Child Health Care: a Prospective Cohort Study of Care Use and Referral Rates for Children at Risk

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2017-016423.R1
Article Type:	Research
Date Submitted by the Author:	06-Jul-2017
Complete List of Authors:	Bezem, Janine; Municipal Health Service Gelderland-Midden, Preventive partners Health Care Department Kocken, Paul; Netherlands organization for applied scientific research (TNO), Child health Kamphuis, Mascha; JGZ Zuid Holland West Theunissen, Meinou; TNO, Department of Child Health Buitendijk, Simone; Imperial College London, Education Office Numans, Mattijs; Leiden University Medical Centre, 4Department of Public Health and Primary Care
Primary Subject Heading:	Health services research
Secondary Subject Heading:	Public health
Keywords:	Triage, Task shifting, Health Service Supply and Distribution, PRIMARY CARE, Prevention, School Health Services

Triage in Preventive Child Health Care: a Prospective Cohort Study of Care Use and Referral Rates for Children at Risk

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Word count (manuscript): 4,802

ABSTRACT

Objectives

A novel triage approach to routine assessments was introduced to improve the efficiency of Preventive Child Health care (PCH): PCH assistants carried out pre-assessments of all children and sent the children with suspected health problems to follow-up assessments conducted by a physician or nurse. This two-step approach differed from the usual approach, in which physicians or nurses assessed all children The objective of this study was to examine the impact of triage and task-shifting on care for children at risk, identified by PCH or parents and schools.

Design, participants

An observational prospective cohort design was used, with an analysis of the basic registration data from the preventive health assessments for 1897 children aged 5 to 6, and 10 to 11, years from a sample of 41 schools stratified by socio-economic status, region of PCH service and urbanisation.

Setting

A comparison was made between two PCH services in the Netherlands that used the triage approach and two PCH services that provided the usual approach.

Main outcome measures

The primary outcome measures were the referral rates to either additional PCH assessments or external services. The secondary outcome measures were the rates of PCH assessments requested by, for example, parents and schools.

Results

Overall, a higher referral rate to additional PCH assessments was found for the triage approach than for the usual approach (OR 1.3, 95%-C.I. 1.0-1.6), mainly in the age group of 5 to 6 years (OR 1.9, 95%-C.I. 1.3-2.7). We found a lower rate of referral to external services in the triage approach (OR 0.4, 95%-C.I. 0.3-0.7) and a higher referral rate to PCH assessments on request (OR=4.6, 95%-C.I. 3.0-7.0).

Conclusions

The triage approach provides extra opportunities to deliver PCH assessments and PCH assessments on request for children at risk, and it also results in fewer referrals to external services.

Keywords

Triage. Task-shifting. Health service supply and distribution. Primary care. Prevention. School health services. Children. Screening.

ARTICLE SUMMARY

Strengths and limitations of this study

- The inclusion of four PCH services from urban and rural areas, improving the external validity of the study.
- The inclusion of a random sample of schools stratified by socio-economic status, region of PCH service and urbanisation.
- We selected groups of children that were homogeneous in terms of gender and age and controlled in the analyses for differences in socio-economic status.
- We were not able to monitor the outcome of the referrals to additional PCH assessments or to external services because we were not allowed to analyse the individual details of the children in the absence of informed consent.

BACKGROUND

Changes in the prevalence of disorders such as mental health problems, the need to prevent violence, increases in lifestyle-related problems and apparent health inequities between subgroups of children all mean that improvements are needed in the system of community preventive services for children[1-6]. These preventive services face several challenges, such as accessibility to care, programme quality and the efficient use of professionals[7,8]. Changes and improvements to health care systems could be accomplished by introducing triage and the shifting of tasks between health care professionals. Task-shifting is defined as the delegation of existing tasks to current or new professionals who have less and/or more specific training[9]. Triage and the task-shifting may result in the more optimal use of the skills and expertise of health care professionals and reduce workloads for physicians and nurses. This could improve the quality of care and result in greater patient satisfaction[9,10]. Research in primary care shows that shifting tasks from physicians to nurses dealing with chronic disorders results in more additional assessments by nurses after the initial visit of the patient and that the number of referrals to secondary care is similar for nurses and physicians. Nevertheless, this type of task-shifting has a clearly positive impact on patient satisfaction[11-14].

Preventive Child Health care (PCH) services in several countries provide vaccinations and routine assessments using a pre-defined age schedule (see Figure 1 for a glossary of terms used for PCH care). The aim is to monitor child growth and development and to prevent child health problems[8,15]. In the Dutch PCH programmes, all children receive 17 unsolicited routine assessments: 13 in the first 3 years of life (in well-child clinics) and 4 in the age group 4 to 18 years (in school health services).

Insert Figure 1 about here

The routine assessments consist of standardised screening procedures targeting several health-related topics. Specially trained community-based physicians, nurses and assistants ('PCH professionals') work separately from specialised clinical care-providers such as paediatricians or other clinical health professionals. In the usual approach in PCH all children are initially assessed by a PCH physician or

nurse, who will sometimes receive support from PCH assistants who have been trained at the secondary vocational level that focuses specifically on medical issues The Dutch PCH services are free of charge and attendance rates can be more than 85%[16,17].When problems are identified, PCH physicians and nurses decide whether there is any need for advice, additional assessments by PCH, or referral to external services such as a general practitioner or a specialist. The referral to the services appropriate to the needs of the children is an essential component of the health screening programmes delivered by PCH[18].

The PCH programme needs to be more flexible and demand-driven than in the current pre-defined schedule, in which there are only four assessments during a school career, in order to respond to the changing care needs of the children. PCH assessments traditionally provide snapshots of the dynamic process of development and growth of children at isolated points in time, even though most children will have no problems at those times. PCH needs to improve its accessibility, be more available for children and parents throughout the school period, and offer care when it is needed.

To achieve a more flexible provision of care, a two-step triage approach was developed for children aged 4 to 18 years involving triage and the shifting of tasks from PCH physicians and nurses to PCH assistants[19]. In the triage approach, children are pre-assessed by a PCH assistant using a strict protocol which includes the completion of questionnaires by parents and teachers, and face-to-face screening (that covers areas such as growth, hearing and vision). Only children with suspected health concerns are selected by the PCH assistant for follow-up assessment by a PCH physician or nurse. The triage approach results in less involvement of physicians and nurses in routine assessment. When children are referred for follow-up assessment, the nature and complexity of the suspected health problems determines whether that assessment should be conducted by a physician or a nurse: physicians attend to medical and developmental disorders and nurses attend mostly to psychosocial problems and lifestyle issues. Pre-assessments at schools by PCH assistants are conducted in the absence of parents but with parental consent. Follow-up assessments by a physician or nurse take place in the presence of a parent in order to allow for interaction with the PCH professional about the potential health concerns detected by the PCH assistant. In both the usual and the triage approaches,

children in whom health concerns have been identified in the routine assessments may be referred to extra care, in other words additional PCH assessments or external services appropriate to the children's specific needs. In both approaches, children may be assessed at the request of, for example, parents or school professionals, we will refer to these assessments as PCH assessments on request).

A pilot study of the triage approach that compared appointment attendance and referral rates in the triage and the usual approach was conducted before the present study. We found that attendance levels were the same, and that the referral rate to additional PCH assessments or external services was lower, in the triage approach by comparison with the usual approach[19]. Another study showed that routine assessments in a triage approach detect health concerns as well as the usual approach[20]. The present study examined the impact of triage and task-shifting on care for children at risk, identified by PCH or by external parties such as parents and schools. It addresses the following research questions:

- What are the rates of referral to additional PCH assessments and external services resulting from routine assessments in the triage approach as compared with the usual PCH approach?
- What are the rates of PCH assessments on request, including the referral rates resulting from these assessments, when a triage approach is used rather than the usual approach?

METHODS

An observational prospective cohort design was used to study the research questions.

Study sample

The study was conducted with routine and administrative data from four PCH services active in four separate regions in the Netherlands. Two services used the triage approach and two services the usual approach. Each PCH service covers a population of around 125,000 children from birth to the age of 18 years. A sample of primary schools, stratified for socio-economic status (low, middle and high status), region of the PCH service, and urban or rural area was randomly selected from these four services. To obtain sufficient and equal numbers of children for both study groups (in other words, the triage and usual approach), 20 schools that used the triage approach were matched with 21 schools that

used the usual approach. The socio-economic status of the schools was determined using national census statistics. Routine assessments were conducted by PCH services in Dutch primary schools for two age groups: 5 to 6 years, and 10 to 11 years. To study the referral rates to additional PCH assessments and external services, the study included all the children from the selected schools aged 5 to 6 and 10 to 11 years who were offered a routine assessment. A sample of 1008 children who received the triage approach was compared with a sample of 986 children who received the usual approach. In the usual approach, all children aged 5 to 6 years are assessed by a physician and children aged 10 to 11 years are assessed by a nurse. When medical problems are suspected, nurses are required to refer the child for an additional PCH assessment by a physician. In the triage approach, all children are pre-assessed by a PCH assistant and follow-up assessments are conducted by PCH physicians and nurses. In addition to routine PCH assessments, we also investigated PCH assessments on request. To study the referral rates to PCH assessments on request, we followed all children attending the schools selected for this study for a maximum of 12 months (the reference population). This resulted in a sample of 4050 children in the schools where the triage approach was used and 4611 children in the schools where the usual approach was adopted. Since there were no vital changes or interventions in health care, and all the data were fully anonymised and coded, and since the data did not include medical details that could be linked to individuals before inclusion in this study on a population level, no informed consent was needed.

Data collection

Study data were registered in digital PCH records during the study period. In addition, data were registered for the PCH assessments on request. The assessment procedures were described in uniform protocols for all PCH services covered by this study and the participating PCH professionals were informed about these protocols. For the sake of completeness, we compared a random sample from the analysis data file with the data in the PCH records. Children in the study sample who received triage pre-assessments or assessments as usual were included from January to April 2012. Data relating to

children requiring triage follow-up assessment and PCH assessments on request were included and the children were followed until December 2012.

Procedures

When weight problems, visual disorders and/or psychosocial problems were identified by PCH physicians and nurses, the children were referred to additional PCH assessments or external services. We chose these three health indicators because the relevant procedures are established and known to be valid[17,21].

Children were referred for these indications after the follow-up assessment in the triage approach, and after the routine assessment in the usual approach. When school professionals or parents suspected the presence of risk factors in children, they were allowed to request an assessment by PCH for further identification. After problems were identified by a PCH physician or nurse, these children could also be referred for additional PCH assessments or to external services (Figure 2).

Insert Figure 2 about here

PCH professionals registered and coded socio-demographic variables in digital PCH records that included gender and age, weight, visual and psychosocial health status, and referrals to additional PCH assessments and to external services. The socio-economic status of the children was established using national census statistics and on the basis of postal codes for their home addresses using education, income and employment status of the local population[22].

Weight, visual and psychosocial health status were assessed and recorded in the digital PCH records as usual. Problems with weight (both overweight and underweight) were determined using the body mass index and assessment by the professional. The thresholds used by the international obesity task force were adopted as the BMI cut-off points for overweight and obesity[23]. Standard deviation (SD) scores for BMI were based on the Dutch general population[24].Visual disorders, including amblyopia and impaired vision, were determined using a visual acuity test: the Snellen chart with SD scores

based on the Dutch general population[21]. Psychosocial problems included behaviour and emotional problems of the child, social interaction problems and child abuse. The identification of these psychosocial problems was based on the assessment made by the PCH professional, and it also included the child's scores on the Strengths and Difficulties Questionnaire[25,26].

All referrals to additional PCH assessments or to external services were registered and coded by the PCH professionals.

Finally, records were kept of whether requests for PCH assessments were made by parents, school professionals or professionals in well-child care. The referrals to additional PCH assessments and to external services subsequent to these assessments were also registered.

Study outcomes

The primary outcomes of this study were the rates of referral to additional PCH assessment and to external services as a result of the routine assessments. The secondary outcomes were the rates of PCH assessments on request, and rates of referral to additional PCH assessment and to external services resulting from these assessments.

Statistical analyses

Our first step was to look at differences in background characteristics such as gender, age and socio-economic status between the two cohorts using chi-square tests. Secondly, we studied the rates of referral to follow-up assessments in the triage approach. We also made separate analyses of the referral rates to additional PCH assessment and external services, and the sum of referrals to additional PCH assessments and to external services. We tested differences in rates of referral between the two approaches using three separate logistic regression analyses with the outcome variables 'referral to additional PCH assessment', 'referral to external services' and 'sum of referrals to additional PCH assessments and external services'. Adjusted Odd Ratios (OR) were calculated in all logistic regressions analyses. We adjusted for socio-economic status. Missing data were excluded from the

regression analyses. These analyses were repeated for the subgroups of children referred for weight problems, visual disorders and psychosocial problems.

Because routine PCH assessments were conducted in the age groups of 5 to 6 and 10 to 11 years, the interaction effects of child age and the type of approach (in other words, the triage and usual approaches) on the outcome measures were studied. When we found interaction effects associated with child age, the analyses were repeated separately for the age groups of 5 to 6 and 10 to 11 years.

Thirdly, we compared the rates of PCH assessments on request in the two approaches using Fisher's exact test. In this analyses, the total sample of children of the schools participating in this study was used as reference population. We also assessed whether children were referred by different parties (school, parents, well-child care, other) in the two approaches. Furthermore, we assessed differences between the two approaches in rates of referral for the group of children who received a PCH assessment on request. Due to the small number of children referred to PCH assessment on request in the usual approach it was not possible to adjust for background characteristics. We therefore used Chi-square and Fisher's exact tests (categories were tested separately). In these analyses, the sample of the group of children who received a PCH assessment on request was used as the reference population. Effects were considered to be statistically significant when the p-value was ≤ 0.05 (2-sided). SPSS Statistics was used to analyse the data (SPSS 22.0 for Windows, SPSS Inc., Chicago, IL).

RESULTS

Study sample

To study the rates of referral to additional PCH assessments and external services, we compared a sample of 1008 children who were eligible for a pre-assessment in the triage approach with a sample of 986 children who were eligible for an assessment in the usual approach (Figure 2). To investigate the rates of PCH assessments on request a sample of 4050 children in the schools where the triage approach was used was compared with a sample of 4611 children in the schools where the usual approach was adopted.

We found no differences in the ages or genders of the children receiving routine assessments in the triage and usual approaches. However, the socio-economic status of the children did differ: the triage sample included more children with a lower socio-economic status (Table 1). No differences were found in the ages or socio-economic status of the group of children receiving PCH assessments on request. There was a gender difference in the group of children receiving assessments on request: more boys received an assessment on request in the triage approach than in the usual approach (Table 1).

Table 1. Characteristics of children assessed using the triage and usual approaches to PCH

Characteristics	Triage approach n (%)	Usual approach n (%)	p-value
Children receiving routine assessment*	N=974	N=923	
Gender			
Boy	485 (49.8)	455 (49.3)	0.83
Girl	489 (50.2)	468 (50.7)	
Age (years)			
≤8	480 (49.3)	468 (51.8)	0.28
≥9	494 (50.7)	436 (48.2)	
Socio-economic status			
Low	415 (42.9)	342 (37.1)	<0.01
Middle	304 (31.4)	372 (40.4)	
High	249 (25.7)	207 (22.5)	
Children receiving assessment on request**	N=107	N=27	
Gender			
Boy	67 (62.6)	10 (40.0)	0.04
Girl	40 (37.4)	15 (60.0)	
Age (years)			
≤8	78 (72.9)	21 (77.8)	0.61
≥9	29 (27.1)	6 (22.2)	
Socio-economic status			
Low	68 (65.4)	17 (70.8)	0.61
Middle	22 (21.2)	2 (8.3)	
High	14 (13.5)	5 (20.8)	

*Missing data (triage approach: socio-economic status n=6; usual approach: age n=19, socio-economic status n=2).
**Missing data (triage approach: socio-economic status n=3; usual approach: gender n=2, socio-economic status n=3).

Referral to additional PCH assessments or to external services

The percentage of children referred from pre-assessment to a follow-up assessment in the first step of the triage approach was 45.6%.

We did not find any difference between the rates of referral for the total group of children referred to extra care (in other words, the children referred to additional PCH assessments and/or to external services) in the two approaches: 18.1% of the children in the triage group were referred to extra care after the follow-up assessments, and 19.2% of the children were referred from the usual approach (OR=0.9, 95%-C.I. (0.7-1.1)) (Figure 2, Table 2). A closer look at these rates indicates that there was a higher referral rate to additional PCH assessments (OR 1.3, 95%-C.I. 1.0-1.6) and a lower referral rate to external services in the triage approach than in the usual approach (OR0.4, 95%-C.I. 0.3-0.7).

Weight problems. The percentage of children referred to extra care was different in the group of children found to have a weight problem. In the triage group, 4.5% of the children were referred to extra care for a weight problem after 15.4% had been referred to a follow-up assessment by a PCH physician or nurse. In the usual group, 5.2% of the children were referred to extra care. The lower referral rate by triage PCH for a weight problem was particularly striking in the referrals to external services: 0.3% of the children, as opposed to 1.4% in the usual PCH group (OR=0.2, 95%-C.I. 0.1-0.7).

Psychosocial problems. We found no difference between the triage and usual groups in the percentage of children with psychosocial problems who were referred to extra care. However, we found a difference in the percentage of referrals to external services: 1.2% of the children in the triage group were referred to external services; the rate of referral was 2.5% in the usual group (OR=0.5, 95%-C.I. 0.2-1.0).

Visual problems. No differences were found between the referral rates to extra care in the triage and usual approaches for the health indicator 'visual disorder'.

Interaction effects were found for child age. In the age group of 5 to 6 years, no differences were found between the two approaches in the total referral rates for extra care (including additional PCH assessments and external services). When looking closer at the type of extra care to which children were referred, we found a higher referral rate to additional PCH assessments in the age group of 5 to 6 years when the triage approach was used (OR=1.9, 95%-C.I. 1.3-2.7).

In the age group of 10 to 11 years, a lower referral rate was found to extra care in the triage group (including additional PCH assessments and external services) than in the usual group (OR=0.6, 95%-C.I. 0.4-0.9). This effect was found for additional PCH assessments in particular (OR=0.5, 95%-C.I. 0.3-1.0).

In the age group of 10 to 11 years, a lower referral rate was found to extra care for weight problems (OR=0.6, 95%-C.I. 0.3-1.0) and for psychosocial problems (OR=0.5, 95%-C.I. 0.3-0.8) when the triage approach was used.When looking closer at the type of extra care, we found a higher referral rate to additional PCH assessments for psychosocial problems in the age group of 5 to 6 years when the triage approach was used (OR=2.2, 95%-C.I. 1.0-4.5).

Table 2. Association between referral to additional PCH assessment or to external services and the PCH approach (triage versus usual care)

	Triage approach N=974		Usual approach N=923			
	Referral after pre-assessment by PCH assistant	Referral after receiving a follow-up assessment from a PCH physician or nurse	Referral after assessment by PCH physician or nurse			
	n (%)	n (%)	n (%)	Odds ratio^	95% CI	p-value
All referrals						
Children referred to follow-up assessment	444 (45.6)	-	-	-	-	
Children referred to additional PCH assessment and/or external services	-	176 (18.1)~	177 (19.2)	0.9	0.7-1.1	0.42
additional PCH assessment	-	152 (15.6)	116 (12.6)	1.3	1.0-1.6	0.09
external services	-	35 (3.6)	73 (7.9)	0.4	0.3-0.7	<0.01
Indication for referral: weight problem						
Children referred to follow-up assessment	150 (15.4)	-	-	-	-	
Children referred to additional PCH assessment and/or external services	-	44 (4.5)	48 (5.2)	0.8	0.5-1.3	0.36
additional PCH assessment	-	43 (4.4)	38 (4.1)	1.0	0.7-1.6	0.89
external services	-	3 (0.3)	13 (1.4)	0.2	0.1-0.7	0.01
Indication for referral: visual disorder						
Children referred to follow-up assessment	47 (4.8)	-	-	-	-	
Children referred to additional	-	16 (1.6)	22 (2.4)	0.7	0.3-1.3	0.25

PCH assessment and/or external services						
additional PCH assessment	-	10 (1.0)	10 (1.1)	1.0	0.4-2.4	0.94
external services	-	8 (0.8)	14 (1.5)	0.5	0.2-1.3	0.15
Indication for referral: psychosocial problem						
Children referred to follow-up assessment	152 (15.6)	-	-	-	-	
Children referred to additional PCH assessment and/or external services	-	48 (4.9)	57 (6.2)	0.8	0.5-1.1	0.17
additional PCH assessment	-	38 (3.9)	36 (3.9)	0.9	0.6-1.5	0.82
external services	-	12 (1.2)	23 (2.5)	0.5	0.2-1.0	0.05

^Logistic regression analyses with referral by PCH as the outcome variable, the approach (triage follow-up assessment or usual assessment) as the independent variable, and socio-economic status as co-variate

~Some children were referred to both additional PCH assessment and external services.

PCH assessments on request

We found a higher rate of PCH assessments on request in the triage approach than in the usual approach ($p<0.01$) (Table 3). In particular, a higher rate was found to PCH assessments at the request of school professionals and of well-child care for the triage approach than in the usual approach . Furthermore, we found differences between the two approaches for the referral rates to additional PCH assessments pursuant to the PCH assessments on request. Half of the children seen on request were referred to additional PCH assessments and one out of five to external services in the triage approach. No children in the usual approach were referred to additional PCH assessments and two children (7.4%) were referred to external services.

Table 3. Association between PCH approach (triage versus usual care) and children receiving PCH assessments on request and referral of these children to additional PCH assessments or to external services

	Triage approach	Usual approach	p-value
	n (%)	n (%)	
	N=4050#	N=4611#	
Children receiving PCH assessment on request	107 (2.6)	27 (0.6)**	<0.01
	N=107	N=27	
Referring parties~			
School	18 (16.8)	0 (0.0) *	0.02
Parents	18 (16.8)	5 (18.5)	0.78
Well-child care	33 (30.8)	0 (0.0) **	0.01
Other	1 (0.9)	1 (3.7)	0.36

Unknown	37 (34.6)	21 (77.8) **	<0.01
Referral to additional PCH assessment and/or external services	62 (57.9)	2 (7.4) **	<0.01
additional PCH assessment	54 (50.5))	0 (0.0) **	<0.01
external services	23 (21.5)	2 (7.4)	0.09

#All children (4-12 years) at the schools included
^ Chi-square test / Fisher's exact test
~The five categories were tested separately. For example, the school as the referring party was tested relative to all categories as a reference to analyse differences between the triage and usual approaches.

DISCUSSION

The present study examined the impact of triage and task-shifting on care for children at risk identified by PCH or by external parties such as parents and schools. We compared the rates of referral to additional PCH assessments and external services after the identification of health concerns pursuant to routine assessments with either the triage approach or the usual approach. We did not find any differences between the total sum of referral rates to additional PCH assessments and external services in the two approaches. However, the referral rate to additional PCH assessments was higher in children aged 5 to 6 years and lower in children aged 10 to 11 years in the triage approach. The referral rates to external services were lower for both age groups when triage was used rather than the usual approach. The differences between the referral rates could be attributed to the different processes used to identify health problems in the two approaches. In the two-step triage approach, children requiring follow-up (in other words, children with suspected health problems) are assessed twice. After the pre-assessment by the PCH assistant, the PCH physician or nurse and the parents need to focus only on the suspected health problems. In this follow-up assessment, more time may be available to provide advice, recommendations and reassurance. This could possibly reduce the need for referral to external services. Because the routine assessments in the usual approach are intended to cover all the different screening items, little time is available for a further investigation of the problems identified. This could explain why the referral rate to external services is higher in the usual approach than in the triage approach. In particular, the lower referral rates in the triage approach to external services for weight problems and psychosocial problems as indicators of health problems could be explained by the positive fact that more time is available to investigate the problems during the follow-up assessment. Children with visual problems are usually referred directly to external

services in both approaches and this could explain the equal referral rates to external services for these problems. The lower referral rate to external services in the triage approach may also be explained by the fact that problems – minor psychosocial problems, for example – are resolved in the period between the pre-assessment and the follow-up assessment. On the other hand, parents may seek care in the period between the pre-assessment and the follow-up assessment and this may reduce the referral rates to external services in the triage approach.

In addition, the discipline conducting the assessment may also explain the differences found between the two approaches. The aim of task-shifting and pre-assessment by PCH assistants is to save time in order to allow for additional PCH assessments by physicians and nurses so that more attention can be paid to the care needs of children at risk. And indeed, we found a higher referral rate to additional PCH assessments for the age group of 5 to 6 years when the triage approach was used. However, in the age group of 10 to 11 years, we found a lower referral rate to additional PCH assessments in the triage approach. This could possibly be explained by the fact that all children aged 10 to 11 years are assessed by a nurse in the usual approach and children aged 5 to 6 years are assessed by a physician. When medical problems are suspected, nurses are required to refer the child for an additional PCH assessment by a physician. This leads to extra referrals to additional PCH assessments. However, in the triage approach, the PCH assistant preselects the children with suspected medical problems and refers them immediately for a follow-up assessment by a PCH physician. This is routine in the triage approach and does not qualify as an additional PCH assessment. Furthermore, it is also possible that there are more additional assessments with PCH nurses than with PCH physicians and that this leads to a higher referral rate to additional PCH assessments for the age group of 10 to 11 years in the usual approach.

A pilot study with the triage approach showed that referral rates to additional PCH assessments or to external services were lower than in the usual approach[19]. This has been confirmed in our study looking at referral to external services. Our results relating to referral rates to additional PCH assessments associated with the shifting of tasks from PCH physicians and nurses to PCH assistants for the age group of 10 to 11 years are in line with studies of task-shifting in primary care, which

found more additional assessments when nurses took over tasks from physicians, even though the number of referrals did not change[12,13].

We examined the results of the PCH assessments on request (made with the aim of devoting more attention to children at risk). Higher rates to PCH assessments on request were found in the triage approach but these findings must be treated with caution because of the low numbers involved. The referrals for these children came from school professionals in particular. It could be hypothesised that differences in PCH assessments on request between the triage and usual approach can be attributed to the fact that the triage approach results in a greater awareness among school professionals of the abilities of physicians and nurses to assess children on request. This explanation is in line with findings of our earlier study of school professionals, who responded that PCH services with the triage approach contribute more to support for children with specific needs than the usual approach[27]. Finally, the outcomes of the triage approach in PCH as measured in this study may have been affected by its relatively recent introduction by comparison with the usual approach. It can reasonably be expected that the triage approach will have a stronger impact on the number of PCH assessments on request when this approach has been in place for a longer period of time. It takes time to establish a relationship with parties such as school professionals.

Strengths and limitations of the study

The strengths of this study are that it is a "real-life" observational comparison that included four PCH regional services and random samples of schools stratified by socio-economic status and urbanity. We were able to use data from a homogeneous group of children with regard to gender and age range and controlled for differences in socio-economic status. The sample in the current study was selected from the general Dutch population from urban and rural areas, making generalisation of the findings to other PCH organisations possible. Although the power conditions to study the referral rates on request were not met in the analyses, the differences between the approaches were large enough to find significant associations. All four PCH services in this study used the same guidelines and registration procedures, reducing the possibility of identification and reporting bias. A limitation is that we were

not allowed to use and analyse the individual details of the children referred to additional PCH assessments or to external services given the absence of informed consent.

Implications for practice

Economic circumstances and changing health demands require the development of new ways of delivering care. More efficiency and flexibility in the delivery of the PCH programme are needed to address challenges such as reduced budgets, workforce shortages, the growing need for optimal use of expertise of professionals, and the wish to provide customised care. Other PCH services in the Netherlands have introduced more flexible PCH care delivery, with task-shifting[28]. The aim of the triage approach is to deliver more customised care in response to health issues that arise in the life cycle of children. It ensures a basic package of care for all children while preserving the strengths of the preventive health service: a low threshold and the wide reach necessary for the early identification of health problems. We found that physicians and nurses working with a triage approach delivered extra PCH care in terms of additional PCH assessments for the age group of 5 to 6 years and a higher rate to PCH assessments at the request of parents, school professionals or professionals in well-child care targeting children with specific needs. Our study provides further insight into the possibilities of a more flexible and demand-driven delivery of preventive health services for children.

Future research

Further research is needed to assess the satisfaction of the children, young people and their parents with a triage approach to routine PCH assessment and the resulting care. Research is also needed to determine the actual quality of detection and referrals using a triage approach. This would allow us to determine the accuracy of referral to extra care (in other words, to determine whether a referral is justified or not) and to enhance our understanding of the equity of care distribution to the children needing health care. Our study of the costs of the routine assessments in the two approaches showed that the triage approach resulted in a cost reduction of about one-third for the age group of 5 to 6 years and a minimal cost reduction for the age group of 10 to 11 years [29]. Further research is needed to

study the costs of onward referrals and subsequent assessments to determine whether the triage approach is actually cost-effective. Moreover, research is required to determine the impact of the triage approach on the long-term need for care.

Conclusions

The triage approach provides extra opportunities to deliver PCH assessments and PCH assessments on request for children at risk. The triage approach reduces the referral rate to external services. More research is needed into the outcomes of referral to extra care.

Funding statement

This study was financially supported by grants 156511002 and 156520007 from ZonMw-the Netherlands Organization for Health Research and Development. The funding source had no role in the study design, data collection, data interpretation, data analysis or writing of the report.

Ethical approval

The Medical Ethics Committee of Leiden University Medical Centre approved this study (reference P11.161/NV/nv).

Availability of data

Anonymised data can be provided by TNO to researchers on request.

List of abbreviations

BMI Body Mass Index

PCH Preventive Child Health care

Competing interests

The authors declare they have no competing interests.

Authors' contributions

JB had the original idea, contributed to the development of the triage protocols, acquisition and interpretation of data and drafting of this article.

MN contributed to the revision of the drafts and the intellectual content of this article.

SB contributed to the revision of the drafts and the intellectual content of this article.

MK contributed to data collection, and to the analysis and interpretation of the data. She was involved in revising the article.

MT contributed to the conception and design, analysis and interpretation of data. She was involved in revising the article.

PK contributed to the conception and design, analysis and interpretation of data and drafting of the article. He supervised the execution of the study.

Finally, all authors read and approved the final article.

Acknowledgements

We thank the personnel of the PCH services Municipal Health Service Noord- en Oost- Gelderland, Municipal Health Service Hollands Noorden, Municipal Health Service Drenthe and Municipal Health Service Gelderland-Midden for participating in this study and D. Heinen MSc for statistical advice.

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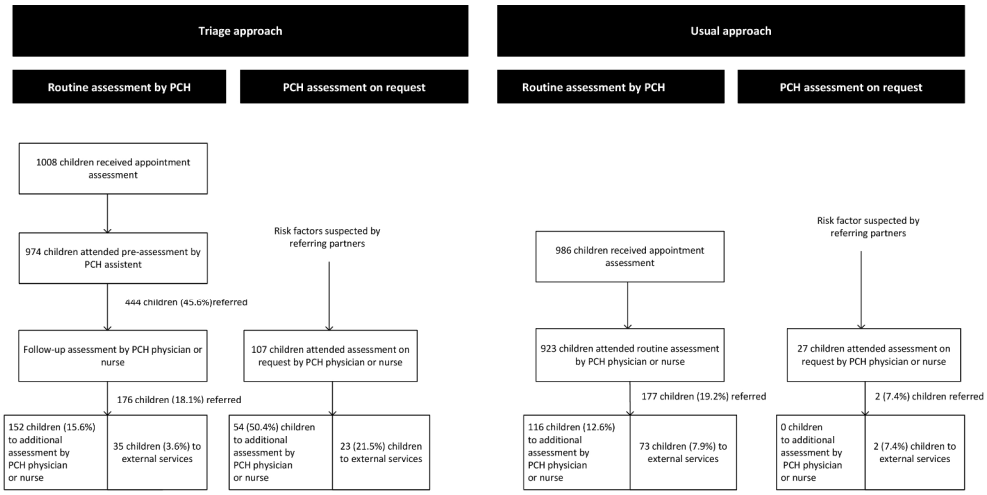
List of Figures

Routine assessment:	A health assessment routinely conducted by PCH services accessible for all Dutch children and provided unsolicited and free of charge, using a pre-defined schedule of invitations to the assessments from birth till the age of 18.
Usual approach of routine assessments:	The "traditional" way of routine assessments provided to all children by a PCH physician and PCH assistant, or by a PCH nurse who is sometimes supported by a PCH assistant.
Triage approach of routine assessments:	A two-step assessment approach of routine assessments, in which all children are preselected by a PCH assistant for a follow-up assessment. In case of suspected health problems the routine assessment also includes a follow-up assessment by a PCH physician or nurse.
Pre-assessment:	First step in the triage approach conducted by a PCH assistant accessible for all children to select children with suspected health problems.
Follow-up assessment:	Second-step in the triage approach by a PCH physician or nurse to children with suspected health problems who are referred after a pre-assessment by the PCH assistant.
Assessment on request:	Assessment at the request of parties such as parents or school professionals who suspect risk factors with regard to the health of the child. These assessments are conducted by a PCH physician or nurse and are not part of the routine assessment schedule. In both usual and triage approach, assessments on request are possible.
Additional PCH assessment:	An additional assessment of a child identified with health problems, conducted by a PCH physician or nurse, resulting from a routine assessment or an assessment on request.
External service:	A general practitioner, specialist or other care provider, to which children identified with health problems have been referred as a result of a routine assessment. additional PCH assessment, or assessment on request by PCH.
Extra care:	An additional PCH assessment or care by an external service directed to children identified with health problems.

***Figure 1**. Glossary of the stages of assessments and care provided by the usual and triage approaches of Preventive Child Health Care (PCH).*

169x162mm (300 x 300 DPI)



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STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1, 3
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	6, 7
Objectives	3	State specific objectives, including any prespecified hypotheses	7, 8
Methods			
Study design	4	Present key elements of study design early in the paper	8
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	8, 9
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	8
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	8
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	9, 10
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	10
Bias	9	Describe any efforts to address potential sources of bias	8, 11
Study size	10	Explain how the study size was arrived at	8
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	10, 11
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	11
		(*b*) Describe any methods used to examine subgroups and interactions	11
		(*c*) Explain how missing data were addressed	11~~n/a~~
		(*d*) If applicable, explain how loss to follow-up was addressed	n/a
		(*e*) Describe any sensitivity analyses	n/a
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8, 9
		(b) Give reasons for non-participation at each stage	n/a
		(c) Consider use of a flow diagram	9
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	12
		(b) Indicate number of participants with missing data for each variable of interest	12~~n/a~~
		(c) Summarise follow-up time (eg, average and total amount)	n/a
Outcome data	15*	Report numbers of outcome events or summary measures over time	12, 13, 14, 15
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	12, 13, 14, 15
		(*b*) Report category boundaries when continuous variables were categorized	12
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	13, 14
Discussion			
Key results	18	Summarise key results with reference to study objectives	16, 17
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	16, 17, 18
Generalisability	21	Discuss the generalisability (external validity) of the study results	18, 19
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	20

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

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Triage in Preventive Child Health Care: a Prospective Cohort Study of Care Use and Referral Rates for Children at Risk

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2017-016423.R2
Article Type:	Research
Date Submitted by the Author:	06-Sep-2017
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Primary Subject Heading:	Health services research
Secondary Subject Heading:	Public health
Keywords:	Triage, Task shifting, Health Service Supply and Distribution, PRIMARY CARE, Prevention, School Health Services

Triage in Preventive Child Health Care: a Prospective Cohort Study of Care Use and Referral Rates for Children at Risk

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Word count (manuscript): 5,021

ABSTRACT

Objectives

A novel triage approach to routine assessments was introduced to improve the efficiency of Preventive Child Health care (PCH): PCH assistants carried out pre-assessments of all children and sent the children with suspected health problems to follow-up assessments conducted by a physician or nurse. This two-step approach differed from the usual approach, in which physicians or nurses assessed all children. This study was aimed to examine the impact of triage and task-shifting on care for children at risk identified by PCH or parents and schools.

Design, participants

An observational prospective cohort design was used, with an analysis of the basic registration data from the preventive health assessments for 1897 children aged 5 to 6, and 10 to 11, years from a sample of 41 schools stratified by socio-economic status, region of PCH service and urbanisation.

Setting

A comparison was made between two PCH services in the Netherlands that used the triage approach and two PCH services that provided the usual approach.

Main outcome measures

The primary outcome measures were the referral rates to either additional PCH assessments or external services. The secondary outcome measures were the rates of PCH assessments requested by, for example, parents and schools.

Results

Overall, a higher referral rate to additional PCH assessments was found for the triage approach than for the usual approach (OR 1.3, 95%-C.I. 1.0-1.6), mainly in the age group of 5 to 6 years (OR 1.9, 95%-C.I. 1.3-2.7). We found a lower rate of referral to external services in the triage approach (OR 0.4, 95%-C.I. 0.3-0.7) and a higher referral rate to PCH assessments on request (OR=4.6, 95%-C.I. 3.0-7.0).

Conclusions

The triage approach provides extra opportunities to deliver PCH assessments and PCH assessments on request for children at risk. Further research is needed into the cost benefits of the triage approach.

Keywords

Triage. Task-shifting. Health service supply and distribution. Primary care. Prevention. School health services. Children. Screening.

ARTICLE SUMMARY

Strengths and limitations of this study

- The inclusion of four PCH services from urban and rural areas, improving the external validity of the study.
- The inclusion of a random sample of schools stratified by socio-economic status, region of PCH service and urbanisation.
- We selected groups of children that were homogeneous in terms of gender and age, and controlled in the analyses for differences in socio-economic status.
- We were not able to monitor the outcome of the referrals to additional PCH assessments or to external services because we were not allowed to analyse the individual details of the children in the absence of informed consent.

BACKGROUND

Changes in the prevalence of disorders such as mental health problems, the need to prevent violence, increases in lifestyle-related problems and apparent health inequities between subgroups of children all mean that improvements are needed in the system of community preventive services for children[1-6]. These preventive services face several challenges, such as accessibility to care, programme quality and the efficient use of professionals[7,8]. Changes and improvements to health care systems could be accomplished by introducing triage and the shifting of tasks between health care professionals. Task-shifting is defined as the delegation of existing tasks to current or new professionals who have less and/or more specific training[9]. Triage and task-shifting may result in the more optimal use of the skills and expertise of health care professionals, reduce workloads for physicians and nurses, and therefore improve the quality of care and result in greater patient satisfaction[9,10]. Research in primary care shows that shifting tasks from physicians to nurses dealing with chronic disorders results in more additional assessments by nurses after the initial visit of the patient and that the number of referrals to secondary care is similar for nurses and physicians. Nevertheless, this type of task-shifting has a clearly positive impact on patient satisfaction[11-14].

Preventive Child Health care (PCH) services in several countries provide vaccinations and routine assessments using a pre-defined age schedule (see Figure 1 for a glossary of terms used for PCH care). The aim is to monitor child growth and development and to prevent child health problems[8,15]. In the Dutch PCH programmes, all children receive 17 unsolicited routine assessments: 13 in the first 3 years of life (in well-child clinics) and 4 in the age group 4 to 18 years (in school health services).

Insert Figure 1 about here

The routine assessments consist of standardised screening procedures targeting several health-related topics. Specially trained community-based physicians, nurses and assistants ('PCH professionals') work separately from specialised clinical care-providers such as paediatricians or other clinical health professionals. In the usual approach in PCH, all children are initially assessed by a PCH physician or

nurse, who will sometimes receive support from PCH assistants who have been trained at the secondary vocational level that focuses specifically on medical issues The Dutch PCH services are free of charge and attendance rates can be more than 85%[16,17].When problems are identified, PCH physicians and nurses decide whether there is any need for advice, additional assessments by PCH, or referral to external services such as a general practitioner or a specialist. The referral to the services appropriate to the needs of the children is an essential component of the health screening programmes delivered by PCH[18].

The PCH programme needs to be more flexible and demand-driven than in the current pre-defined schedule, in which there are only four assessments during a school career, in order to respond to the changing care needs of the children. PCH assessments traditionally provide snapshots of the dynamic process of development and growth of children at isolated points in time, even though most children will have no problems at those times. PCH needs to improve its accessibility, be more available for children and parents throughout the school period, and offer care when it is needed.

To achieve a more flexible provision of care, a two-step triage approach was developed for children aged 4 to 18 years involving triage and the shifting of tasks from PCH physicians and nurses to PCH assistants[19]. In the triage approach, children are pre-assessed by a PCH assistant using a strict protocol which includes the completion of questionnaires by parents and teachers, and face-to-face screening (that covers areas such as growth, hearing and vision). Only children with suspected health concerns are selected by the PCH assistant for follow-up assessment by a PCH physician or nurse. The triage approach could reduce the involvement of physicians and nurses in routine assessments, and therefore release resources that can be used for PCH assessments for children at risk. When children are referred for follow-up assessment, the nature and complexity of the suspected health problems determines whether that assessment should be conducted by a physician or a nurse: physicians attend to medical and developmental disorders and nurses attend mostly to psychosocial problems and lifestyle issues. Pre-assessments at schools by PCH assistants are conducted in the absence of parents but with parental consent. Follow-up assessments by a physician or nurse take place in the presence of a parent in order to allow for interaction with the PCH professional about the potential health concerns

detected by the PCH assistant. In both the usual and the triage approaches, children in whom health concerns have been identified in the routine assessments may be referred to extra care, in other words additional PCH assessments or external services appropriate to the children's specific needs. In both approaches, children may be assessed at the request of, for example, parents or school professionals (we will refer to these assessments as 'PCH assessments on request'). PCH assessments on request are intended for children from age groups other than those pre-defined for the routine assessments in order to reach all children in need of care.A pilot study of the triage approach that compared appointment attendance and referral rates in the triage and the usual approach was conducted before the present study. We found that attendance levels were the same, and that the referral rate to additional PCH assessments or external services was lower, in the triage approach than in the usual approach[19]. Another study showed that routine assessments in a triage approach detect health concerns as effectively as the usual approach[20]. Our study of the costs of the routine assessments in the two approaches showed that the triage approach resulted in a cost reduction of about one-third for the age group of 5 to 6 years and a minimal cost reduction for the age group of 10 to 11 years[21]. The present study examined the impact of triage and task-shifting on care for children at risk who were identified by PCH or by external parties such as parents and schools. It addresses the following research questions:

- What are the rates of referral to additional PCH assessments and external services resulting from routine assessments in the triage approach as compared with the usual PCH approach?
- What are the rates of PCH assessments on request, including the referral rates resulting from these assessments, when a triage approach is used rather than the usual approach?

METHODS

An observational prospective cohort design was used to study the research questions.

Study sample

The study was conducted with routine and administrative data from four PCH services active in four separate regions in the Netherlands. Two services used the triage approach and two services the usual approach. Each PCH service covers a population of around 125,000 children from birth to the age of 18 years. A sample of primary schools stratified for socio-economic status (low, middle and high status), region of the PCH service, and urban or rural area was randomly selected from these four services. To obtain sufficient and equal numbers of children for both study groups (in other words, the triage and usual approach), 20 schools that used the triage approach were matched with 21 schools that used the usual approach. The socio-economic status of the schools was determined using national census statistics. Routine assessments were conducted by PCH services in Dutch primary schools for two age groups: 5 to 6 years, and 10 to 11 years. To study the referral rates to additional PCH assessments and external services, the study included all the children aged 5 to 6 and 10 to 11 years from the selected schools who were offered a routine assessment. A sample of 1008 children who received the triage approach was compared with a sample of 986 children who received the usual approach. In the usual approach, all children aged 5 to 6 years are assessed by a physician and children aged 10 to 11 years are assessed by a nurse. When medical problems are suspected, nurses must refer the child for an additional PCH assessment by a physician. In the triage approach, all children are pre-assessed by a PCH assistant and follow-up assessments are conducted by PCH physicians and nurses. In addition to routine PCH assessments, we also investigated PCH assessments on request. To study the referral rates to PCH assessments on request, we followed all children attending the schools selected for this study for a maximum of 12 months (the reference population). This resulted in a sample of 4050 children in the schools where the triage approach was used and 4611 children in the schools where the usual approach was adopted. Since there were no vital changes or interventions in health care, and all the data were fully anonymised and coded, and since the data did not include medical details that could be linked to individuals before inclusion in this study on a population level, no informed consent was needed.

Data collection

Study data were registered in digital PCH records during the study period. In addition, data were registered for the PCH assessments on request. The assessment procedures were described in uniform protocols for all PCH services covered by this study and the participating PCH professionals were informed about these protocols. For the sake of completeness, we compared a random sample from the analysis data file with the data in the PCH records. Children in the study sample who received triage pre-assessments or assessments as usual were included from January to April 2012. Data relating to children requiring triage follow-up assessment and PCH assessments on request were included and the children were followed until December 2012.

Procedures

When weight problems, visual disorders and/or psychosocial problems were identified by PCH physicians and nurses, the children were referred to additional PCH assessments or external services. We chose these three health indicators because the relevant procedures are established and known to be valid[17,22].

Children were referred for these indications after the follow-up assessment in the triage approach, and after the routine assessment in the usual approach. When school professionals or parents suspected the presence of risk factors in children, they were allowed to request an assessment by PCH for further identification. After problems were identified by a PCH physician or nurse, these children could also be referred for additional PCH assessments or to external services (Figure 2).

Insert Figure 2 about here

PCH professionals registered and coded socio-demographic variables in digital PCH records that included gender and age, weight, visual and psychosocial health status, and referrals to additional PCH assessments and to external services. The socio-economic status of the children was established using national census statistics and on the basis of postal codes for their home addresses using education, income and employment status of the local population[23].

Weight, visual and psychosocial health status were assessed and recorded in the digital PCH records as usual. Problems with weight (both overweight and underweight) were determined using the body mass index and assessment by the professional. The thresholds used by the international obesity task force were adopted as the BMI cut-off points for overweight and obesity[24]. Standard deviation (SD) scores for BMI were based on the Dutch general population[25]. Visual disorders, including amblyopia and impaired vision, were determined using a visual acuity test: the Snellen chart with SD scores based on the Dutch general population[22]. Psychosocial problems included child behaviour and emotional problems, social interaction problems and child abuse. The identification of these psychosocial problems was based on the assessment made by the PCH professional, and it also included the child's scores on the Strengths and Difficulties Questionnaire[26,27].

All referrals to additional PCH assessments or to external services were registered and coded by the PCH professionals.

Finally, records were kept of whether requests for PCH assessments were made by parents, school professionals or professionals in well-child care. The referrals to additional PCH assessments and to external services subsequent to these assessments were also registered.

Study outcomes

The primary outcomes of this study were the rates of referral to additional PCH assessment and to external services as a result of the routine assessments. The secondary outcomes were the rates of PCH assessments on request, and rates of referral to additional PCH assessment and to external services resulting from these assessments.

Statistical analyses

Our first step was to look at differences in background characteristics such as gender, age and socio-economic status between the two cohorts using chi-square tests. Secondly, we studied the rates of referral to follow-up assessments in the triage approach. We also made separate analyses of the referral rates to additional PCH assessment and external services, and the sum of referrals to additional

PCH assessments and to external services. We tested differences in rates of referral between the two approaches using three separate logistic regression analyses with the outcome variables 'referral to additional PCH assessment', 'referral to external services' and 'sum of referrals to additional PCH assessments and external services'. Adjusted Odd Ratios (OR) were calculated in all logistic regression analyses. We adjusted for socio-economic status. Missing data were excluded from the regression analyses. These analyses were repeated for the subgroups of children referred for weight problems, visual disorders and psychosocial problems.

Because routine PCH assessments were conducted in the age groups of 5 to 6 and 10 to 11 years, the interaction effects of child age and the type of approach (in other words, the triage and usual approaches) on the outcome measures were studied. When we found interaction effects associated with child age, the analyses were repeated separately for the age groups of 5 to 6 and 10 to 11 years.

Thirdly, we compared the rates of PCH assessments on request in the two approaches using Fisher's exact test. In these analyses, the total sample of children of the schools participating in this study was used as the reference population. We also assessed whether children were referred by different parties (school, parents, well-child care, other) in the two approaches. Furthermore, we assessed the differences between the two approaches in the rates of referral for the group of children who received a PCH assessment on request. Due to the small number of children referred to PCH assessment on request in the usual approach, it was not possible to adjust for background characteristics. We therefore used Chi-square and Fisher's exact tests (categories were tested separately). In these analyses, the sample of the group of children who received a PCH assessment on request was used as the reference population.

Effects were considered to be statistically significant when the p-value was ≤ 0.05 (2-sided). SPSS Statistics was used to analyse the data (SPSS 22.0 for Windows, SPSS Inc., Chicago, IL).

RESULTS

Study sample

To study the rates of referral to additional PCH assessments and external services, we compared a sample of 1008 children who were eligible for a pre-assessment in the triage approach with a sample of 986 children who were eligible for an assessment in the usual approach (Figure 2). To investigate the rates of PCH assessments on request a sample of 4050 children in the schools where the triage approach was used was compared with a sample of 4611 children in the schools where the usual approach was adopted.

We found no differences in the ages or genders of the children receiving routine assessments in the triage and usual approaches. However, the socio-economic status of the children did differ: the triage sample included more children with a lower socio-economic status (Table 1). No differences were found in the ages or socio-economic status of the group of children receiving PCH assessments on request. There was a gender difference in the group of children receiving assessments on request: more boys received an assessment on request in the triage approach than in the usual approach (Table 1).

Table 1. Characteristics of children assessed using the triage and usual approaches to PCH

Characteristics	Triage approach n (%)	Usual approach n (%)	p-value
Children receiving routine assessment*	N=974	N=923	
Gender			
Boy	485 (49.8)	455 (49.3)	0.83
Girl	489 (50.2)	468 (50.7)	
Age (years)			
≤8	480 (49.3)	468 (51.8)	0.28
≥9	494 (50.7)	436 (48.2)	
Socio-economic status			
Low	415 (42.9)	342 (37.1)	<0.01
Middle	304 (31.4)	372 (40.4)	
High	249 (25.7)	207 (22.5)	
Children receiving assessment on request**	N=107	N=27	
Gender			
Boy	67 (62.6)	10 (40.0)	0.04
Girl	40 (37.4)	15 (60.0)	
Age (years)			
≤8	78 (72.9)	21 (77.8)	0.61
≥9	29 (27.1)	6 (22.2)	
Socio-economic status			
Low	68 (65.4)	17 (70.8)	0.61
Middle	22 (21.2)	2 (8.3)	
High	14 (13.5)	5 (20.8)	

*Missing data (triage approach: socio-economic status n=6; usual approach: age n=19, socio-economic status n=2).

**Missing data (triage approach: socio-economic status n=3; usual approach: gender n=2, socio-economic status n=3).

Referral to additional PCH assessments or to external services

The percentage of children referred from pre-assessment to a follow-up assessment in the first step of the triage approach was 45.6% (444 of 974).

We did not find any difference between the rates of referral for the total group of children referred to extra care (in other words, the children referred to additional PCH assessments and/or to external services) in the two approaches: 176 of 974 children (18.1%) in the triage group were referred to extra care after the follow-up assessments, and 177 of 923 children (19.2%) were referred from the usual approach (OR=0.9, 95%-C.I. (0.7-1.1)) (Figure 2, Table 2). A closer look at these rates indicates that there was a higher referral rate to additional PCH assessments (OR 1.3, 95%-C.I. 1.0-1.6) and a lower referral rate to external services in the triage approach than in the usual approach (OR 0.4, 95%-C.I. 0.3-0.7).

Weight problems. The percentage of children referred to extra care was different in the group of children found to have a weight problem. In the triage group, 44 of 974 children (4.5%) were referred to extra care for a weight problem after 150 of 974 (15.4%) had been referred to a follow-up assessment by a PCH physician or nurse. In the usual group, 48 of 923 children (5.2%) were referred to extra care. The lower referral rate by triage PCH for a weight problem was particularly striking in the referrals to external services: 3 of 974 children (0.3%), as opposed to 13 of 923 (1.4%) in the usual PCH group (OR=0.2, 95%-C.I. 0.1-0.7).

Psychosocial problems. We found no difference between the triage and usual groups in the percentage of children with psychosocial problems who were referred to extra care. However, we found a difference in the percentage of referrals to external services: 1.2% of children (12 of 974) in the triage group were referred to external services; the rate of referral was 2.5% (23 of 923) in the usual group (OR=0.5, 95%-C.I. 0.2-1.0).

Visual problems. No differences were found between the referral rates to extra care in the triage and usual approaches for the health indicator 'visual disorder'.

Interaction effects were found for child age. In the age group of 5 to 6 years, no differences were found between the two approaches in the total referral rates for extra care (including additional PCH assessments and external services). When looking closer at the type of extra care to which children were referred, we found a higher referral rate to additional PCH assessments in the age group of 5 to 6 years when the triage approach was used (OR=1.9, 95%-C.I. 1.3-2.7).

In the age group of 10 to 11 years, a lower referral rate was found to extra care in the triage group (including additional PCH assessments and external services) than in the usual group (OR=0.6, 95%-C.I. 0.4-0.9). This effect was found for additional PCH assessments in particular (OR=0.5, 95%-C.I. 0.3-1.0).

In the age group of 10 to 11 years, a lower referral rate was found to extra care for weight problems (OR=0.6, 95%-C.I. 0.3-1.0) and for psychosocial problems (OR=0.5, 95%-C.I. 0.3-0.8) when the triage approach was used. When looking closer at the type of extra care, we found a higher referral rate to additional PCH assessments for psychosocial problems in the age group of 5 to 6 years when the triage approach was used (OR=2.2, 95%-C.I. 1.0-4.5).

Table 2. Association between referral to additional PCH assessment or to external services and the PCH approach (triage versus usual care)

	Triage approach N=974		**Usual approach N=923**			
	Referral after pre-assessment by PCH assistant	**Referral after receiving a follow-up assessment from a PCH physician or nurse**	**Referral after assessment by PCH physician or nurse**			
	n (%)	n (%)	n (%)	Odds ratio^	95% CI	p-value
	All referrals					
Children referred to follow-up assessment	444 (45.6)	-	-	-	-	
Children referred to additional PCH assessment and/or external services	-	176 (18.1)~	177 (19.2)	0.9	0.7-1.1	0.42
additional PCH assessment	-	152 (15.6)	116 (12.6)	1.3	1.0-1.6	0.09

external services	-	35 (3.6)	73 (7.9)	0.4	0.3-0.7	<0.01
Indication for referral: weight problem						
Children referred to follow-up assessment	150 (15.4)	-	-	-	-	
Children referred to additional PCH assessment and/or external services	-	44 (4.5)	48 (5.2)	0.8	0.5-1.3	0.36
additional PCH assessment	-	43 (4.4)	38 (4.1)	1.0	0.7-1.6	0.89
external services	-	3 (0.3)	13 (1.4)	0.2	0.1-0.7	0.01
Indication for referral: visual disorder						
Children referred to follow-up assessment	47 (4.8)	-	-	-	-	
Children referred to additional PCH assessment and/or external services	-	16 (1.6)	22 (2.4)	0.7	0.3-1.3	0.25
additional PCH assessment	-	10 (1.0)	10 (1.1)	1.0	0.4-2.4	0.94
external services	-	8 (0.8)	14 (1.5)	0.5	0.2-1.3	0.15
Indication for referral: psychosocial problem						
Children referred to follow-up assessment	152 (15.6)	-	-	-	-	
Children referred to additional PCH assessment and/or external services	-	48 (4.9)	57 (6.2)	0.8	0.5-1.1	0.17
additional PCH assessment	-	38 (3.9)	36 (3.9)	0.9	0.6-1.5	0.82
external services	-	12 (1.2)	23 (2.5)	0.5	0.2-1.0	0.05

^Logistic regression analyses with referral by PCH as the outcome variable, the approach (triage follow-up assessment or usual assessment) as the independent variable, and socio-economic status as co-variate

~Some children were referred to both additional PCH assessment and external services.

PCH assessments on request

We found a higher rate of PCH assessments on request in the triage approach than in the usual approach ($p<0.01$) (Table 3). In particular, a higher rate was found for PCH assessments at the request of school professionals and of well-child care for the triage approach than in the usual approach. Furthermore, we found differences between the two approaches for the referral rates to additional PCH assessments pursuant to the PCH assessments on request. Half of the children seen on request were referred to additional PCH assessments and one out of five to external services in the triage approach. No children in the usual approach were referred to additional PCH assessments and 2 of 27 children (7.4%) were referred to external services.

Table 3. Association between PCH approach (triage versus usual care) and children receiving PCH assessments on request and referral of these children to additional PCH assessments or to external services

	Triage approach	Usual approach	p-value
	n (%)	n (%)	
	N=4050#	N=4611#	
Children receiving PCH assessment on request	107 (2.6)	27 (0.6)**	<0.01
	N=107	N=27	
Referring parties~			
School	18 (16.8)	0 (0.0) *	0.02
Parents	18 (16.8)	5 (18.5)	0.78
Well-child care	33 (30.8)	0 (0.0) **	0.01
Other	1 (0.9)	1 (3.7)	0.36
Unknown	37 (34.6)	21 (77.8) **	<0.01
Referral to additional PCH assessment and/or external services	62 (57.9)	2 (7.4) **	<0.01
additional PCH assessment	54 (50.5))	0 (0.0) **	<0.01
external services	23 (21.5)	2 (7.4)	0.09

#All children (4-12 years) at the schools included
^ Chi-square test / Fisher's exact test
~The five categories were tested separately. For example, the school as the referring party was tested relative to all categories as a reference to analyse differences between the triage and usual approaches.

DISCUSSION

The present study examined the impact of triage and task-shifting on care for children at risk identified by PCH or by external parties such as parents and schools. We compared the rates of referral to additional PCH assessments and external services after the identification of health concerns pursuant to routine assessments with either the triage approach or the usual approach. We did not find any differences between the total sum of referral rates to additional PCH assessments and external services in the two approaches. However, the referral rate to additional PCH assessments was higher in children aged 5 to 6 years and lower in children aged 10 to 11 years in the triage approach. Overall, the referral rates to external services resulting from the routine assessments were lower when triage was used rather than the usual approach. The differences between the referral rates could be attributed to the different processes used to identify health problems in the two approaches. In the two-step triage approach, children requiring follow-up (in other words, children with suspected health problems) are assessed twice. After the pre-assessment by the PCH assistant, the PCH physician or nurse and the parents need to focus only on the suspected health problems. In this follow-up assessment, more time may be available to provide advice, recommendations and reassurance. This could possibly reduce the need for referral to external services. Because the routine assessments in the usual approach are

intended to cover all the different screening items, little time is available for a further investigation of the problems identified. This could explain why the referral rate to external services is higher in the usual approach than in the triage approach. In particular, the lower referral rates in the triage approach to external services for weight problems and psychosocial problems as indicators of health problems could be explained by the positive fact that more time is available to investigate the problems during the follow-up assessment. Children with visual problems are usually referred directly to external services in both approaches and this could explain the equal referral rates to external services for these problems. The lower referral rate to external services in the triage approach may also be explained by the fact that problems – minor psychosocial problems, for example – are resolved in the period between the pre-assessment and the follow-up assessment. On the other hand, parents may seek care in the period between the pre-assessment and the follow-up assessment and this may reduce the referral rates to external services in the triage approach.

In addition, the discipline conducting the assessment may also explain the differences found between the two approaches. The aim of task-shifting and pre-assessment by PCH assistants is to save time in order to allow for additional PCH assessments by physicians and nurses so that more attention can be paid to the care needs of children at risk. And indeed, we found a higher referral rate to additional PCH assessments for the age group of 5 to 6 years when the triage approach was used. However, in the age group of 10 to 11 years, we found a lower referral rate to additional PCH assessments in the triage approach. This could possibly be explained by the fact that all children aged 10 to 11 years are assessed by a nurse in the usual approach and children aged 5 to 6 years are assessed by a physician. When medical problems are suspected, nurses must refer the child for an additional PCH assessment by a physician. This leads to extra referrals to additional PCH assessments. However, in the triage approach, the PCH assistant preselects the children with suspected medical problems and refers them immediately for a follow-up assessment by a PCH physician. This is routine in the triage approach and does not qualify as an additional PCH assessment. Furthermore, it is also possible that there are more additional assessments with PCH nurses than with PCH physicians and that this leads to a higher referral rate to additional PCH assessments for the age group of 10 to 11 years in the usual approach.

A pilot study with the triage approach showed that referral rates to additional PCH assessments or to external services were lower than in the usual approach[19]. This has been confirmed in our study looking at referral to external services. Our results relating to referral rates to additional PCH assessments associated with the shifting of tasks from PCH physicians and nurses to PCH assistants for the age group of 10 to 11 years are in line with studies of task-shifting in primary care, which found more additional assessments when nurses took over tasks from physicians, even though the number of referrals did not change[12,13].

We examined the results of the PCH assessments on request The triage approach was developed to reduce the cost of routine assessments and release resources to conduct PCH assessments on request for children with specific health-care needs. Higher rates were found for PCH assessments on request in the triage approach . The referrals for these children came from school professionals in particular. Differences in PCH assessments on request between the triage and usual approach may be attributed to the fact that the triage approach results in a greater awareness among school professionals of the abilities of physicians and nurses to assess children on request. This explanation is in line with the findings of our earlier study of school professionals, who responded that PCH services with the triage approach contribute more to support for children with specific needs than the usual approach[28]. However, we did not study the reasons for referral to PCH assessments on request. A possible reason for the introduction of the triage approach could be to improve the cost-benefit ratio for PCH. An earlier study of the costs of the routine assessments showed that the triage approach resulted in a cost reduction. However, we did not study the costs of onward referrals and of the PCH assessments on request.

Finally, the outcomes of the triage approach in PCH as measured in this study may have been affected by its relatively recent introduction by comparison with the usual approach. It can reasonably be expected that the triage approach will have a stronger impact on the number of PCH assessments on request when this approach has been in place for a longer period of time. It takes time to establish a relationship with parties such as school professionals.

Strengths and limitations of the study

The strengths of this study are that it is a 'real-life' observational comparison that included four PCH regional services and random samples of schools stratified by socio-economic status and urbanity. We were able to use data from a homogeneous group of children with regard to gender and age range, and we controlled for differences in socio-economic status. The sample in the current study was selected from the general Dutch population from urban and rural areas, making generalisation of the findings to other PCH organisations possible. Although the power conditions to study the referral rates on request were not met in the analyses, the differences between the approaches were large enough to find significant associations. All four PCH services in this study used the same guidelines and registration procedures, reducing the possibility of identification and reporting bias. A limitation is that we were not allowed to use and analyse the individual details of the children referred to additional PCH assessments or to external services given the absence of informed consent.

Implications for practice

Economic circumstances and changing health demands require the development of new ways of delivering care. More efficiency and flexibility in the delivery of the PCH programme are needed to address challenges such as reduced budgets, workforce shortages, the growing need for optimal use of expertise of professionals, and the wish to provide customised care. Other PCH services in the Netherlands have introduced more flexible PCH care delivery, with task-shifting[29]. The aim of the triage approach is to deliver more customised care in response to health issues that arise in the life cycle of children. The triage approach has the potential to deliver a basic package of care for all children while preserving the strengths of the preventive health service: a low threshold and the wide reach necessary for the early identification of health problems. In earlier studies we found that access to PCH and the detection of health problems were comparable with the usual approach. In this study we found that physicians and nurses working with a triage approach delivered extra PCH care in terms of additional PCH assessments for the age group of 5 to 6 years and a higher rate of PCH assessments at the request of parents, school professionals or professionals in well-child care targeting children

with specific needs. Our study provides further insight into the possibilities of a more flexible and demand-driven delivery of preventive health services for children.

Future research

Further research is needed to assess the satisfaction of the children, young people and their parents with a triage approach to routine PCH assessment and the resulting care. Research is also needed to determine the actual quality of detection and referrals using a triage approach. This would allow us to determine the accuracy of referral to extra care (in other words, to determine whether a referral is justified or not) and to enhance our understanding of the equity of care distribution to the children needing health care. Further research is needed into the outcomes of referral to extra care. Moreover, we studied only the costs of the routine assessments, but research will also be needed into the costs of onward referrals to extra care and the costs of PCH assessments on request.. So further research is needed to determine whether the triage approach is actually cost-effective. Moreover, research is required to determine the impact of the triage approach on the long-term need for care.

Conclusions

The triage approach provides extra opportunities to deliver PCH assessments and PCH assessments on request for children at risk. In the triage approach, fewer children are referred to external services than in the usual approach in the case of the routine assessments. More research is needed into the outcomes of referral to extra care and into the cost benefits of the triage approach.

Funding statement

This study was financially supported by grants 156511002 and 156520007 from ZonMw-the Netherlands Organization for Health Research and Development. The funding source had no role in the study design, data collection, data interpretation, data analysis or writing of the report.

Ethical approval

The Medical Ethics Committee of Leiden University Medical Centre approved this study (reference P11.161/NV/nv).

Data Sharing Statement

Anonymised data can be provided by TNO to researchers on request.

List of abbreviations

BMI Body Mass Index

PCH Preventive Child Health care

Competing interests

The authors declare they have no competing interests.

Authors' contributions

JB had the original idea, contributed to the development of the triage protocols, acquisition and interpretation of data and drafting of this article.

MN contributed to the revision of the drafts and the intellectual content of this article.

SB contributed to the revision of the drafts and the intellectual content of this article.

MK contributed to data collection, and to the analysis and interpretation of the data. She was involved in revising the article.

MT contributed to the conception and design, analysis and interpretation of data. She was involved in revising the article.

PK contributed to the conception and design, analysis and interpretation of data and drafting of the article. He supervised the execution of the study.

Finally, all authors read and approved the final article.

Acknowledgements

We thank the personnel of the PCH services Municipal Health Service Noord- en Oost- Gelderland, Municipal Health Service Hollands Noorden, Municipal Health Service Drenthe and Municipal Health Service Gelderland-Midden for participating in this study and D. Heinen MSc for statistical advice.

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List of Figures

Routine assessment:	A health assessment routinely conducted by PCH services accessible for all Dutch children and provided unsolicited and free of charge, using a pre-defined schedule of invitations to the assessments from birth till the age of 18.
Usual approach of routine assessments:	The "traditional" way of routine assessments provided to all children by a PCH physician and PCH assistant, or by a PCH nurse who is sometimes supported by a PCH assistant.
Triage approach of routine assessments:	A two-step assessment approach of routine assessments, in which all children are preselected by a PCH assistant for a follow-up assessment. In case of suspected health problems the routine assessment also includes a follow-up assessment by a PCH physician or nurse.
Pre-assessment:	First step in the triage approach conducted by a PCH assistant accessible for all children to select children with suspected health problems.
Follow-up assessment:	Second-step in the triage approach by a PCH physician or nurse to children with suspected health problems who are referred after a pre-assessment by the PCH assistant.
Assessment on request:	Assessment at the request of parties such as parents or school professionals who suspect risk factors with regard to the health of the child. These assessments are conducted by a PCH physician or nurse and are not part of the routine assessment schedule. In both usual and triage approach, assessments on request are possible.
Additional PCH assessment:	An additional assessment of a child identified with health problems, conducted by a PCH physician or nurse, resulting from a routine assessment or an assessment on request.
External service:	A general practitioner, specialist or other care provider, to which children identified with health problems have been referred as a result of a routine assessment. additional PCH assessment, or assessment on request by PCH.
Extra care:	An additional PCH assessment or care by an external service directed to children identified with health problems.

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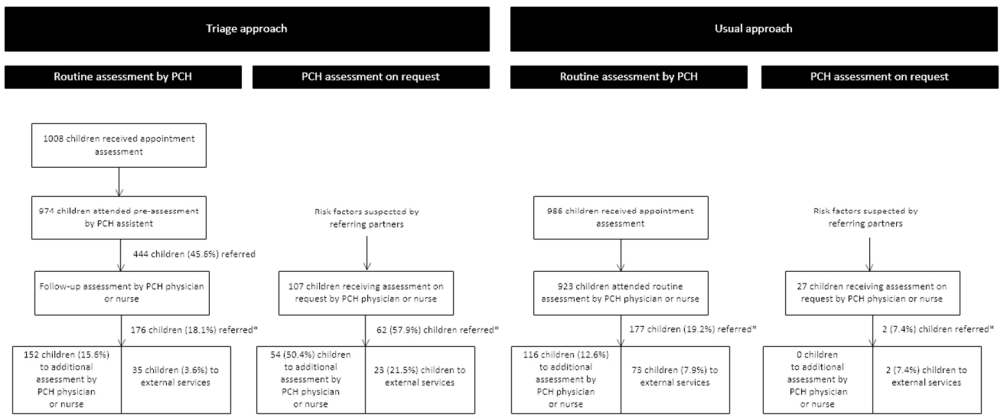

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STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1, 3
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	6, 7
Objectives	3	State specific objectives, including any prespecified hypotheses	7, 8
Methods			
Study design	4	Present key elements of study design early in the paper	8
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	8, 9
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	8
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	8
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	9, 10
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	10
Bias	9	Describe any efforts to address potential sources of bias	8, 11
Study size	10	Explain how the study size was arrived at	8
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	10, 11
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	11
		(*b*) Describe any methods used to examine subgroups and interactions	11
		(*c*) Explain how missing data were addressed	11~~n/a~~
		(*d*) If applicable, explain how loss to follow-up was addressed	n/a
		(*e*) Describe any sensitivity analyses	n/a
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8, 9
		(b) Give reasons for non-participation at each stage	n/a
		(c) Consider use of a flow diagram	9
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	12
		(b) Indicate number of participants with missing data for each variable of interest	12~~n/a~~
		(c) Summarise follow-up time (eg, average and total amount)	n/a
Outcome data	15*	Report numbers of outcome events or summary measures over time	12, 13, 14, 15
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	12, 13, 14, 15
		(*b*) Report category boundaries when continuous variables were categorized	12
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	13, 14
Discussion			
Key results	18	Summarise key results with reference to study objectives	16, 17
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	16, 17, 18
Generalisability	21	Discuss the generalisability (external validity) of the study results	18, 19
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	20

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.