



Kind & Gezin

# ALGO® HEARING SCREENING

REPORT FOR 1999

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ANNUAL RESULTS FROM FLANDERS

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# CONTENTS

## FOREWORD

## INTRODUCTION: Organisation of universal early hearing screening in Flanders

### PART 1 ACTIVITIES AND DEVELOPMENTS IN 1999

1. The present situation in neonatal hearing screening in Flanders
2. Logistical follow-up and support
  - 2.1. Purchase of Algo appliances
  - 2.2. The follow-up of technical problems
  - 2.3. Maintenance and product development
  - 2.4. Consumption of disposable items
3. Training and support
4. The referral centres
5. Meetings and publications
6. The Scientific Advisory Body for the Support of Hearing Screening
7. New projects

### PART 2 TEST RESULTS FOR FLEMISH REGION 1999

1. Recording of Algo data
2. Test results 1999
  - 2.1 Overview of all districts
  - 2.2 Target group cover
  - 2.3 Refusal of the Algo test
  - 2.4 Valid neonatal hearing tests carried out externally
  - 2.5 Babies not approached by Kind & Gezin (no screening offered)
  - 2.6 Screening, deprivation and ethnicity
3. Referral results for the Flemish Region 1999
  - 3.1 Introduction
  - 3.2 Choice of referral
  - 3.3 Referral results by incidence and degree of hearing impairment
  - 3.4 Incidence determination
  - 3.5 The rehabilitation and support phase

## SUMMARY AND CONCLUSIONS

## REFERENCES

# FOREWORD

In 1998 Kind & Gezin [Child & Family] implemented Universal Early Hearing Screening in the Flemish Region and the Brussels Capital Region. The goal of this universal introduction of automated brainstem audiometry, as a screening instrument was to identify all congenital hearing impairments before the third month of life. This would be of optimal benefit for the development opportunities of babies with hearing impairment, which had been detected early.

After thorough preparations and a particularly successful test project in four districts, in 1998 the Algo screening was progressively implemented in all 60 districts of the Flemish Region and the Brussels Capital Region as well as in the area of the Belgian Armed Forces in Germany. On 15 October 1998, universal introduction was completed. As a result Flanders was the first geographical region where early hearing screening was systematically offered to all babies. Flanders was thus the first to follow the recommendations of the Joint Committee on Infant Hearing 1994 Position Statement (American Academy of Pediatrics, 1994) and the European Consensus Statement on Neonatal Hearing Screening (Milan, 1998).

Since 1999 no further distraction tests (Ewing – at nine months) have been carried out by Kind & Gezin. If there is doubt or unease on the part of parents or infant welfare baby clinics after the Algo test age (up to 5 or 6 months), the baby in question is referred to a referral centre or “Centre of Excellence”.

This report contains the results from the first full year of universal early hearing screening in Flanders. It is both a management report and a research report.

The first part describes some organisational aspects, which were taken on board last year. Items specifically related to the local situation are not included in the English version.

The second part contains the figures from the screening and referral details relating to babies born in 1999.

For the sake of clarity for readers who are less familiar with the programme, by way of an introduction an extract from a recently published article (Tijdschrift Jeugdgezondheidszorg [Youth healthcare journal] October 2000) has been included.

Both the in-house databank management software IKAROS and Kind & Gezin’s own ICT department played an essential role in the collection and processing of the mass of data. The databank data were regularly tested for accuracy. Those carrying out the tests were made responsible for inputting the correct data and were able, among other things, to amend or correct the data they had keyed in.

A special word of thanks is due to the Datawarehouse co-ordinator for IKAROS, Mrs Ingrid Testelmans, and the ICT team, who made a substantial contribution to the realisation of this report.

We should also like to thank the members of the Scientific Advisory Body for Hearing Screening and the experts who contributed to this report, in particular Prof. Dr Paul Van de Heyning, Prof. Dr Christian Desloovere and Prof. Dr Patrick Onghena.

# INTRODUCTION

## ***Organisation of universal early hearing screening in Flanders using automated brainstem audiometry***

### **Early hearing screening**

Permanent Childhood Hearing Impairment (PCHI) occurs in 1-1.4 per thousand newborns. The number of births in the Flemish Region was 63,042 in 1998 and 61,906 in 1999, which implicates that every year approximately 65 babies with permanent childhood hearing impairment can be expected in this area.

In the group of neonatal intensive care babies the risk is even as high as 1 to 5%.

Children with an auditory disability are deprived of the sensory input, which is essential for the development of speech. Furthermore, the disability has a pernicious effect on the total development of the social, emotional, comprehension and motor aspects of the personality and on the process of education and parent/child interaction.

Research has shown that early intensive rehabilitation with auditive stimulation of the cerebral cortex before the age of six months leads to a significantly higher level of receptive and expressive language abilities compared with children who do not receive a hearing aid until the age of 7 to 18 months.

Until 1997, systematic testing for hearing problems in the Flemish Region was carried out using the Ewing test at 9 months. It was not generally possible to begin rehabilitation until after the age of two years, which is far too late. Since 1997 hearing defects have been detected by brainstem audiometry at the age of four weeks.

The Joint Committee on Infant Hearing and the American Academy of Pediatrics have as their aim the universal screening for hearing impairment in babies. This recommendation has been confirmed by European authorities.

Flanders, including the Brussels Capital Region, was the first region in the world to introduce a universal hearing screening programme for the whole population. Between March 1997 and March 2000, more than 110,000 healthy babies were screened for hearing defects by the district nurses from Kind & Gezin (K&G) using automated auditory brainstem response tests.

In this introduction we describe the organisation of the screening programme in Flanders. There will also be a report on the Algo test project carried out in 1997, and on the results in the year in which the screening programme was implemented (1998).

### **The apparatus used**

The Algo test is an objective hearing test directly derived from the traditional Auditory Brainstem Response test (ABR – also known as the BERA test). The ABR test is generally regarded as the “gold standard”, the reference test for evaluation of the hearing system. It is an application of the technique of electro-encephalography. When a tone is applied to the ear, the brain (brainstem) responds to this with electrical responses, which are measurable via electrodes on the skull. The signal obtained is compared with a reference signal (template) from children with normal hearing. The detection algorithm employs binomial sampling: the statistical programme calculates the likelihood ratio (LR), the probability ratio, which states how much a response plus background noise differs from a pure noise or no –response condition. After 500 and not more than 15,000 clicks the apparatus shows a ‘pass’ result if there is 99.98% certainty of good hearing and a ‘refer’ if that certainty is not achieved.

The test is carried out by one person who does not require audiological training. The apparatus is portable, works on batteries and does not require a special test environment. Both ears are automatically tested one after the other (or separately if desired). The apparatus corrects for ambient noise and for myogenic interference.

## **The organisation Kind & Gezin**

Kind & Gezin (Child & Family) is a Flemish public agency whose purpose is to promote welfare and health of all children up to the age of three years with special interests in their immediate living conditions. To this end all mothers who have just given birth are visited in the maternity ward and also receive three house calls from a nurse. K&G organise preventive consultations for babies, in which the children are examined, advice is given and vaccinations are carried out.

Further tasks are prenatal and perinatal preventive care, child-minding and out-of-school care initiatives, child abuse and neglect, children's rights, adoption and the care of children in particular living situations.

The screening of babies for hearing defects is one of K & G's tasks as laid down in a decree (Decree of the Flemish Community 29 May 1984).

For the implementation of preventive care, K&G has around 600 district nurses working in 330 welfare baby clinics spread over 62 districts, each with a district centre. They function as self-regulating teams in co-operation with the welfare baby clinic medical officers, which means that each district evaluates the cover of its target group and among other things also determines autonomously which is for them the location of choice for hearing screening (e.g. at the district centre, during house calls, in Kind & Gezin's welfare baby clinic premises, in the preventive care centre – a more extended welfare baby clinic) in order to maximise target group cover.

The district nurses have contact with virtually all newborn babies via the bedside visit at the maternity ward, house calls or consultations in the welfare baby clinic. The K&G IKAROS databank covers all newborn babies in Flanders.

## **The organisation of hearing screening in Flanders**

During the visit to the maternity ward every new mother is made aware of hearing screening. She is given extensive information and a folder about the Algo test, which explains how to ensure optimal test conditions (e.g. no oil bath just before the test). During the first home visit or preventive consultation, an appointment is made for the test.

At about the age of four weeks the district nurse carries out the hearing screening. This is fully integrated into the normal programme of basic preventive care, so that no additional time or additional staff need be provided for carrying out the hearing screening, and the target group can easily be approached.

Babies who achieve a normal test result in the first or second test are further monitored in the welfare baby clinic as regards their speech and language development, in order to detect secondary hearing impairment, "late onset" hearing impairment or progressive hearing disturbances in good time. For this, use is made of a method, which systematically evaluates the development of the neuromotor system and communication and of active observation by the parents. Any suspicion or doubt on the part of the parents or team members, and any new risk involving possible hearing impairment (brain injury, meningitis, etc.) lead to a new hearing evaluation.

If a possible hearing impairment is detected at the first AABR screening ('refer' result), a second screening is carried out within 48 hours in the presence of the welfare baby clinic medical officer. The latter examines the ears with an otoscope and draws up a specific case history based on the risk list of the Joint Committee on Infant Hearing Screening.

If the second test is again positive, contact is immediately made with the family doctor or paediatrician and in mutual consultation the baby is immediately referred to a specialised referral centre or university service.

This swift referral procedure, which is subject to a strict collaboration protocol, guarantees optimal follow-up without 'losing' referred children. Thus considerable time and money are also saved for the parents in question and for the community.

The 23 university Ear Nose and Throat (ENT) departments and specialised referral centres for early monitoring, diagnosis and integral rehabilitation in Flanders are tasked with carrying out a hearing evaluation within two weeks in order to ascertain or rule out a hearing defect (case history, ENT examination giving special consideration to known stigmata, informal and semi-objective audiometry, tympanometry, oto-acoustic emissions, threshold determination using ABR.).

Upon confirmation of a hearing defect, in a second phase additional specialised tests are carried out with a

view to a comprehensive diagnosis (radiology, CT scan, (neuro)paediatric consultation with attention to the heart, central nervous system, kidneys, thyroid, with specific technical tests depending on any abnormalities found, ophthalmologic consultation, determination of the karyotype, genetic counselling). The multidisciplinary approach also begins immediately, with integral rehabilitation and home support (audiology, speech therapy, physiotherapy, teaching and psychological support and contact groups). The Algo programme manager is kept informed at every stage.

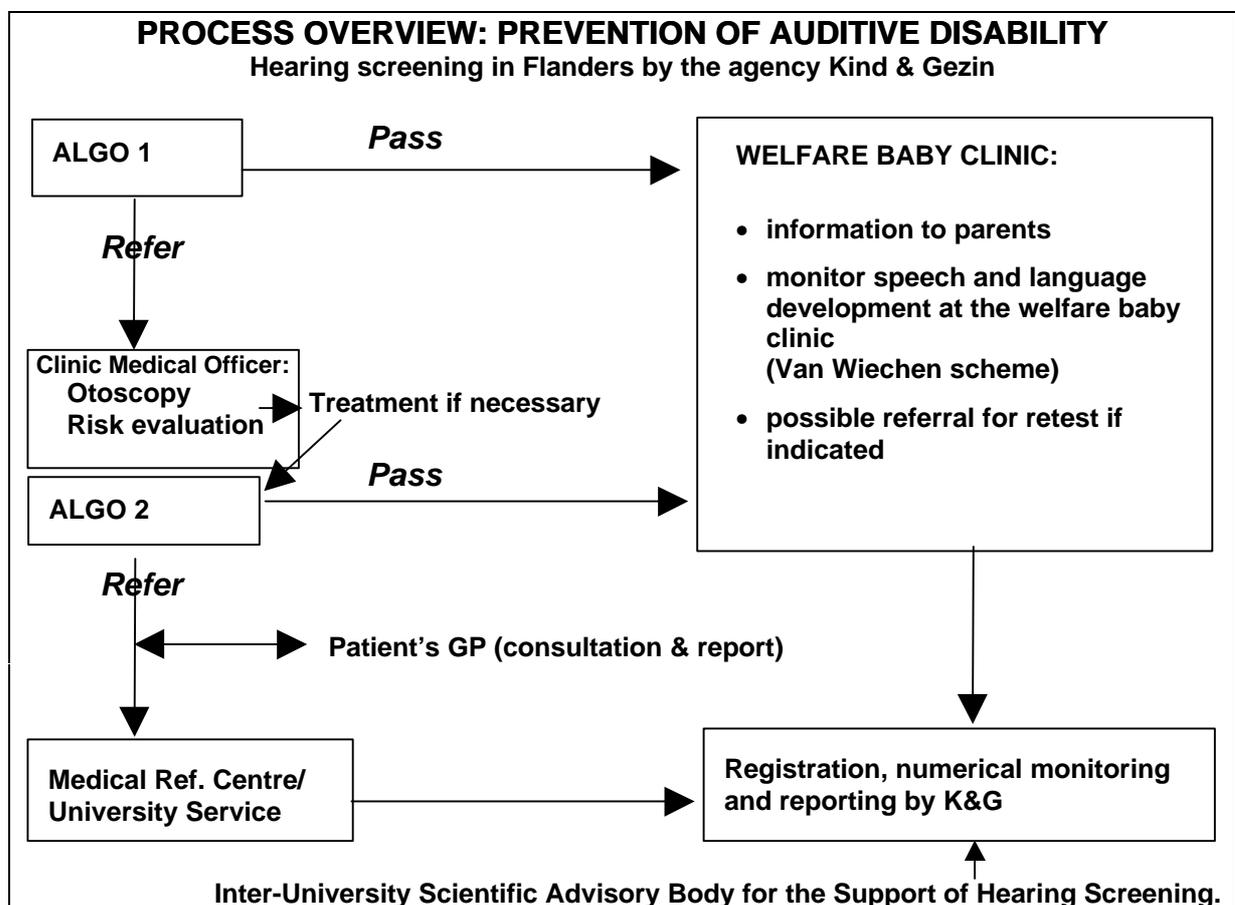
All of this is carried out in accordance with a strict protocol, which has been drawn up together with the university centres and has been endorsed by the referral centres and also by the Flemish Minister of Public Health. Only those centres that endorse this protocol are certified as referral centres.

Any baby with a hearing defect should be detected before the age of three months and must be referred. In this way medical diagnostic and audiological tests can be completed before the age of four to six months in order to make optimum use of the therapeutic options.

The protocol guarantees for each child a minimum of medical and diagnostic tests and swift intervention. It is also partly due to this that to date no single child has been lost from the diagnostic and therapeutic circuit, or from rehabilitation.

The referral centres also undertake to keep both Kind & Gezin and the GP informed of the test and rehabilitation data via a standardised report. In this way a clear overview of congenital hearing impairments in Flanders is at the disposal of Kind & Gezin. The processing and interpretation of these data permits accurate evaluation of the programme and supportive control of the protocol. An inter-university Scientific Advisory Body supervises the AABR programme and makes proposals for changes. The Flemish Ministry of Public Health and the Medical Board of Physicians approved this protocol and this preferential collaboration.

The referral centres, confronted with a very young population, also faced a new challenge: in a short time they had to develop expertise for which there was virtually no precedent. By means of mutual consultation they have streamlined the process of medical and audiological diagnostics, early home intervention and rehabilitation. Naturally, early screening is only of any use if the steps that follow also succeed.



## **The Algo test project in 1997**

Based on a study of the literature, contacts with numerous centres of expertise in the field of screening in Europe and the USA, and practical tests, the automated Auditory Brainstem Response test (AABR) was chosen for the Flemish programme, to be carried out with the Algo 1E hearing screener from Natus Med. Inc.

In the period from 15 March to 17 June 1997 a test project was set up in four Flemish districts, two in a rural area and two in a more urban area. Various scenarios were subjected to critical evaluation: whether to carry out the hearing screening during the home visit, in the district centre or in one of the Kind & Gezin welfare baby clinics or preventive care centres.

Aspects considered were feasibility and whether the new system could be integrated into the basic care programme, also client and team satisfaction, the effect on the normal basic care programme, target group cover, the test duration, the failure rate, the effectiveness of the referral protocol, the total costs and the number of appliances required for maximum target group cover, inter alia.

The effect of notification prior to the test, test preparation time, follow-up and referral protocol, training of the district nurses and possible use of skin preparation techniques also needed to be evaluated.

As part of this test project, 896 Algo tests were carried out in a two-phase screening. Thirty-two district nurses worked on the pilot project, following 3 hours of theoretical training and an additional 2 hours of field training. Each district had two screening appliances available. The tests and also the registrations had to be carried out within the operational care services. All data were inputted into the information system at Kind & Gezin (IKAROS).

Seven initial tests or 0.82% were positive ('refer') and thus had to be repeated. Six babies had a negative second test result (false positive after first test). The "refer rate" after the first test was thus considerably lower than the 3 to 4% reported in the literature.

One baby had a repeat positive result and upon further investigation was shown to have pronounced bilateral perceptive hearing impairment.

The average test age was 30.3 days. After six weeks of the test project the median test duration was 6 minutes and the preparation took 4 minutes. The test duration was significantly longer if babies were screened before the age of 3 weeks or after the age of 5 weeks. Other research has also shown that the results after 4 weeks are better than immediately after birth. Transient conductive hearing impairment or neurological maturation processes are believed to be the reason for this. The older babies become, the more physically active and visually adjusted they become, resulting in longer test duration.

It was possible to keep down the costs of the programme in various ways, so that the average all-in cost for an Algo screening was only BEF 364 or approx. 9 EURO.

After the test project everyone was convinced of the quality of the test. The test was considered by parents to be very positive and relevant. What is more, carrying out the test proved simple, it was quickly over for a resting or sleeping child and made no specific demands on the test subject or the environment. Without a doubt, this was also due to the expertise of the district nurses in dealing with the babies, and the standardised method of working. This new test increased the district nurses' sense of self-worth. They also experienced more appreciation from clients.

The conclusion was that the Algo test is one, which contains all the properties of a good screening instrument. The validity and reproducibility are high, the test is quick, non-invasive, child-friendly and easy to use, qualities necessary for maximum target group cover.

More than ever it became obvious that a successful and universal screening programme needs a clear concept and a good organisational structure. Based on this vision, realistic instructions and implementation protocols were developed, as were efficient referral and follow-up procedures, and clear arrangements were made with external partners.

Based on the test programme and consultation with the university ENT departments and some renowned rehabilitation centres, the integrated prevention programme for hearing screening was drawn up and fine-tuned.

Proposals were submitted to the manufacturer Natus Medical Inc. for improvement of the appliance, in particular as regards compactness, user-friendliness and mobility. This led to the Algo 1F version (Flanders), now called the Algo Portable.

## **The Algo test results for 1998**

Implementation of the Algo test in Flanders began in February 1998 and was completed 8 months later, on 15 October.

Since the implementation was progressive not all babies born in 1998 could be screened. District nurses succeeded in testing 38,048 babies with Algo screening.

2.73% of parents refused the test, 3.48% had already undergone a neonatal hearing test before discharge from the maternity ward.

Both the refusals and the external screenings reduced as implementation progressed. The data from all the tests offered were keyed into the databank. Of the overall target group, 93.87% of the 43,406 newborn babies in the start-up districts were covered.

142 babies failed the first test, which brought the 'refer' rate after one test to 0.37%. There were 64 babies with a double 'refer' result who were referred for further diagnosis and possible integral rehabilitation and support. For 818 babies (2.1%) the test had to be repeated because they were restless.

Hearing impairment was confirmed in 55 referred babies (32 unilateral, 23 bilateral), while 8 babies proved to have normal hearing after all. This group was given further preventive follow-up at the welfare baby clinic.

As a result of the hearing screening, hearing-impaired children could be fitted with a hearing aid at the age of 3-5 months and intensive integral support, early home intervention and multidisciplinary rehabilitation could be initiated.

During the implementation year the consensus grew among the referral centres that the diagnostic procedures where unilateral hearing impairment was confirmed should be limited, but that careful follow-up should be ensured.

# PART 1

## ACTIVITIES AND DEVELOPMENTS IN 1999

### ***1. The present situation in neonatal hearing screening in Flanders***

Almost every woman receives a visit from a district nurse between giving birth and discharge from the maternity ward. Every maternity ward receives one or more visits a week from a district nurse from Kind & Gezin. The co-operation of the hospitals with Kind & Gezin is based on the quality decree for health care institutions (networking and continuity of care).

In 1999 three maternity wards in Flanders were offering valid hearing screening to their newborn babies. From a scientific point of view only the following screening methods can be regarded as valid for young babies: Auditory Brainstem Response (ABR), Automated Auditory Brainstem Response (AABR, brand names include Algo) and Oto-acoustic Emission tests (OAE). Newborn babies, who had undergone another, non-valid hearing test were therefore traced in order to offer them the Algo test.

In 1999 a similar neonatal hearing test was offered at the Sint Augustinus Hospital in Wilrijk (in co-operation with K&G, see below), the Municipal Hospital in Aalst and the Imelda Hospital in Bonheiden. In general it can be said that parents complained that in these cases the maternity wards gave them insufficient information, or no information at all, about the nature of the test carried out on their baby, and that they were not informed of whether or not they had to pay for this. In addition the test was not carried out systematically and there was no central registration and follow-up or quality control.

For a programme of universal early hearing screening the maximum target group should always be aimed at. If K&G was informed of a unilateral positive test result in the maternity hospital using a valid neonatal hearing test the parents, in consultation with the maternity ward concerned, were encouraged to have a re-test carried out. If necessary Kind & Gezin itself carried out the re-test and then reported the result to the maternity ward.

It is very difficult to cover the maximum target group within a hospital ward, as is also shown by examples from other countries. The decreasing hospitalisation period after giving birth, the pressure of staff changes, a complex follow-up, also an increasing number of home births, make universal hearing screening very difficult to achieve prior to discharge. In addition, the test after birth leads to a large number of 'refer' results, which have to be re-tested. From a psychological point of view there are also good reasons for postponing the test for a while. The first weeks of life are after all crucial to the process of parental bonding ("attachment") with the new child. Concerns about possible disabilities after a first 'refer' test, or final confirmation after referral, may seriously disrupt this process. Since in any case intervention cannot begin until a few months later, it is better to postpone this test.

For this reason Kind & Gezin do not offer a free Algo screening test until the second month of life (between 4 and 6 weeks).

In order to be successful, a programme to prevent auditive disability has to be organised on a large scale. The standardised screening is after all only part of the programme, the first stage. Universal registration, fast re-tests of the initial 'refer' results and referral only to a competent and experienced referral centre for adequate diagnosis, rehabilitation and early home intervention are also essential elements. Kind & Gezin brought this model into being in conjunction with the university departments and the referral centres, with an integrated, co-ordinated approach.

In the interests of maximum cover, a special effort must be made to approach families seeking asylum in Flanders, or families here illegally. Their babies younger than four months are automatically offered an Algo test.

At the moment most high-risk premature babies still miss the systematic hearing screening. As discussed later under 'New projects', in the near future a network is to be set up for general hearing screening together with intensive care wards for neonates (the NICU departments).

In the course of 1999 some centres developed closer co-operation, ranging from permanent telephone links, systematic referrals to government-recognised services for early home intervention, consultation and the exchange of experiences concerning rehabilitation methods, to general project-based support for a day nursery for hearing-impaired children.

## **2. Logistical follow-up and support**

### **2.1. Purchase of Algo appliances**

Each district initially had 3 appliances available for carrying out the Algo tests (for 1000 births/year). It was then calculated that approximately 85% of newborns would be tested within the project. In the first year the final figure was 87.66% and in 1999 it was as high as 90.04%. Naturally this has implications for the level of use of the appliances. Increasing pressure on the number of appliances available was also caused by shifts in the test scenario in order to maximise the service offered, by the increasing number of part-time employees and by the division of districts.

In early January 1999, Cordial Medical Europe BV supplied a further 10 Algo Portable appliances.

### **2.2. The follow-up of technical problems**

A good 95% of all calls to the Algo help-line due to technical problems immediately obtain adequate help or advice. Less than 5% concern device failures necessitating intervention, or for which a part needs to be replaced. In 1999 Kind & Gezin's technical department launched an electronic follow-up system for defects and repairs of Algo appliances.

In 1999 there were 90 defects involving a need for a part to be replaced.

The five most common defects, starting with the commonest, are:

- 1) the print unit fails due to a connection fault or jamming
- 2) the plastic clip which protects the battery does not close/no longer closes the battery compartment
- 3) one or more of the electrode connection leads no longer conduct electricity
- 4) the carrying bag shows signs of premature wear and tear
- 5) the battery exhibits a storage error or no longer has its maximum charging capacity.

### **2.3. Maintenance and product development**

The Algo Portable appliance is not only very child-friendly in use, it is also easy to maintain. The monthly maintenance of the 190 operational appliances consists of completely discharging the NiMH battery, carrying out some automatic tests and checking the connections. The district nurses do this.

The Acoustic Transducer Assembly or the loudspeaker/microphone module should be calibrated annually in order to ensure the standard output level during tests.

## **2.4. Consumption of disposable items**

While carrying out Algo screening some disposable items are consumed.

Ear couplers isolate baby's ear from ambient interference and in healthy babies the district nurses use these more than once. From the orders placed every three months by the districts, it appears that an ear coupler can on average be used three to four times. This is of course important in helping to keep costs down.

## **3. Training and support**

All newly appointed district nurses receive the brief Algo training.

In order to offer support with problematic tests a checklist/step-by-step plan has been developed and provided to the districts.

The Algo programme manager provided direct assistance with carrying out 27 Algo tests. Often these were tests which had earlier repeatedly failed, or where due to special circumstances (such as a medical abnormality) extra help and support were desired.

The Algo experts from the various provinces took part in a half-day of provincial Algo consultation.

## **4. The referral centres**

The recommendation on whether or not to accept an application from a potential referral centre or to remove a centre from the list is within the remit of the inter-university [Scientific Advisory Body for the Support of Hearing Screening.

## **5. Meetings and publications**

During 1999 K&G participated in 15 meetings about hearing screening at home and abroad.

An English-language publication on the Algo project in Flanders has been prepared and is available at the Web-site of Kind & Gezin (:[www.kindengezin.be](http://www.kindengezin.be))

## **6. The Scientific Advisory Body for Hearing Screening**

On 29 November the inter-university Scientific Advisory Body for Hearing Screening" 'wetenschappelijke adviesraad ondersteuning gehoorscreening' (WAOG) was set up. It comprises academics from the various Flemish universities, and its aim is to monitor and advise on the Flemish programme for hearing screening.

Prof. Dr Louw Feenstra (Catholic University of Leuven) was elected as the first chairman.

## **7. *New projects***

In January 1999 a one-year collaboration project was begun with the university ENT department of the St. Augustinus Hospital in Wilrijk, in which full-term babies were given a neonatal Oto-acoustic Emission test by one of the hospital audiologists. The object of this project was to increase the in-house screening service of this ENT department, in combination with the follow-up programme by Kind & Gezin. If the parents refused to have an OAE re-test carried out in the hospital, Kind & Gezin endeavoured to carry out an Algo test.

As part of this project 1846 full-term newborn babies were screened with OAE, that is 62.15% of all valid neonatal hearing tests carried out externally.

From this project we can establish that the final cover in the districts concerned is not increased by testing in the hospital, despite the extra efforts of all those concerned (motivating, recording, tracing, re-testing, etc.). On the other hand the administrative burden and the costs are considerably higher than when implemented as part of the Flemish preventive umbrella service.

Due to the high prevalence of hearing impairment in babies who have spent time in a neonatal intensive care unit (NICU) (3-7%), it is extremely important that this risk group should undergo hearing screening. The use of ototoxic medication in life-threatening situations carries an additional risk.

On 1 April 1999 the first consultation meeting took place with the 8 Flemish Neonatal Intensive Care Units with a view to implementing hearing screening for all high-risk premature babies.

# PART 2

## TEST RESULTS FOR FLEMISH REGION 1999

### 1. *Recording of Algo data*

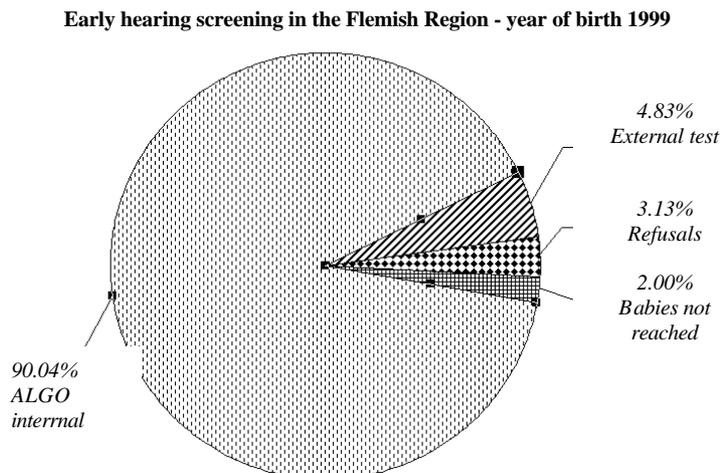
All the numerical data were recorded via Kind & Gezin's IKAROS databank.

The data from the databank were collected on the basis of the locality, in which the baby concerned lived, and were related to the data from the databank of the National Institute for Statistics.

Neither the tests carried out externally (outside the collaborative project) nor the tests on high-risk babies who were long-term patients in the neonatal intensive care units have been processed in this report.

After every positive test the district nurses make contact via the Algo help-line. The district team thus receives extra support for every 'refer' test and for every referral, while the referral databank remains very accurate.

In 1999, 55,388 babies were screened in the Flemish Region using the Algo test.



**Figure 1: Proportion of families approached for an Algo test**

## 2. Test results in the Flemish Region 1999

Only the babies that we tested ourselves have been included in this report, not N.I.C.U. graduates and not those tests carried out in a maternity hospital (except for the collaborative project).

### 2.1. Overview of all districts (except Brussels districts I & II)

#### TARGET GROUP COVER

Number of births:	61,913	
Number of perinatal deaths:	401	
Number of babies to be examined	61,512	
<b>Babies tested by K&amp;G:</b>	<b>55,388</b>	<b>90.04%</b>
Refusals for test	1,924	3.13%
Already tested on maternity ward	2,970	4.83%
- as project financed by K&G	1,846	3.00%
- others	1,124	1.83%
<b>Number of approached babies</b> (= Test offered)	<b>60,282</b>	<b>98.00%</b>

#### TEST OUTCOMES

• Number of first tests	<b>55,388</b>	
Pass with the first test	54,969	
Refer with the first test	419	= <b>0.76%</b> (refer ratio after first test)
<hr/>		
• Number of babies re-tested (after 'refer' at test 1):	<b>419</b>	
Pass with the second test	294	70.17% of test 2
Referred babies after test 2	125	29.83% of test 2
<hr/>		
• Total number of babies referred	<b>125</b>	= 2.26 per 1000 / first tests
<hr/>		
• Total number of babies to be re-tested:		
'Refers' with the first test	419	0.76%
Incomplete tests	2,119	3.82%
Babies to be re-tested	<u>2,538</u>	<u>4.58%</u>
<hr/>		
• Total tests carried out (times)	59,907 (test 1 + 'refers' first test + incomplete 1 or more times)	

<b>TARGET GROUP COVER</b> (significance)	<b>1998</b> (in operational districts)	<b>1999</b> (in all Flemish districts)
Number of babies tested by K&G	38,048	55,388
% of population tested by K&G (S)	87.66%	90.04%
Refusals for the test (S)	2.73%	3.13%
Total number of babies approached (S)	93.87%	98.00%
<b>TEST OUTCOMES</b> (significance)	<b>1998</b>	<b>1999</b>
Refer rate after first test (% of 1 <sup>st</sup> test)	0.37%	0.76%
Refer rate after second test (% of 2 <sup>nd</sup> test)	44.29%	29.83%
Total babies referred in ‰ of the population	1.7‰ (n=64)	2.3‰ (n=125)
Incomplete tests	2.1%	3.8%
Ascertained hearing impairment on referral (NS)	87.9%	85.6%
Classification (NS)	52.9% unilateral 47.1% bilateral	48.6% unilateral 51.4% bilateral
N per 1000 bilateral > 40dB	(0.6‰)	0.8‰

**Table 1: Comparison of target group cover and test outcomes in 1998 and 1999 with Algo screening**

In 1999 the 'refer' rate after the first test was 0.76%. A study has shown that in other screening programmes 3% (Gabbard, Northern and Yoshinaga-Itano, 1999) or more (Mason, 1993) of the first tests showed a 'refer' result.

Due to the ability to repeat within the normal working arrangements, tests that lasted longer than 20 minutes were broken off and a new appointment was made. The number of incomplete tests increased by 1.72% in comparison with 1998, to 3.82%. Accurate checking of the input data and stricter application of the time limit of 20 minutes for each Algo test were the reasons for this increase. The amount of 'refer' results and the amount of children to be re-tested according to the same 20-minute norm totalled 4.58% of the children who have to be re-tested after the first Algo test. This is at the level of the 4% quality standard set by the Joint Committee on Infant Hearing (J.C.I.H., 2000) in the Year 2000 Position Statement.

The referral rate after the second test was considerably lower in 1999 than in 1998: about one third of the babies who had a 'refer' result in the first test also had a second 'refer' result.

## **2.2. Target group cover**

In 1999, 61,913 births were recorded in the Flemish Region (data from April 2000). The number of newborns who died prior to early hearing screening was 401, so 61,512 babies were eligible for screening. The districts made maximisation of target group cover their primary objective for 1999.

A total of 98.00% of newborns available for screening was offered a test, an increase of 4.13%.

This difference is statistically significant [ $\chi^2$  (1, N=104918)=148.9,  $p < .00001$ ]. This can be explained by general acceptance of the test, optimum “tracing and chasing” of non-screened babies by the districts, successful integration of Algo screening into the tasks of the districts, and a high level of staff motivation. District nurses who made an Algo test proposal usually received consent from the parents to carry out the test. Only rarely were they confronted by a refusal or told that a valid hearing screening test had already been carried out at the hospital.

In 1999 Kind & Gezin itself screened 55,388 babies or 90.04% of the target group. In 1998 Kind & Gezin’s district nurses had screened 87.66% of the target group, which represents an increase of 2.38% in comparison with 1998. The increase in the number of babies tested by ourselves in 1999 in comparison with 1998 is also statistically significant [ $\chi^2$  (1, N=104918)=1214,  $p < .00001$ ]. In the two Brussels districts 1,075 children were screened.

In total 59,907 Algo tests were undertaken by Kind & Gezin or its partners in the Flemish Region.

## **2.3. Refusal of the Algo test**

In 1999 also, some parents refused to have an Algo test carried out. The main reasons given were: “not interested”, “a simple reflex test was carried out during the stay in the maternity ward”, “my own GP will probably do that” and “circumstances” such as holiday, moving away, etc.

1,924 refusals of Algo screening were recorded or 3.13%. Although this number is small, there appears to be a statistically significant difference between the percentage of refusals in 1998 (2.73%) and the percentage in 1999 [ $\chi^2$  (1, N=104918)=13.67,  $p = .0002$ ]. There is no obvious explanation for this. Possibly there are more refusals in the group approached only after greater efforts are made. There is also a statistically significant increase in refusals in the population with non-Belgian nationality (not the Moroccans or Turks). Six of the 8 districts with the most refusals are situated on the outskirts of the Brussels Region.

## **2.4. Valid neonatal hearing tests carried out externally**

Click-evoked oto-acoustic emissions (C.E.O.A.E.), distortion-product-evoked oto-acoustic emissions (D.P.O.A.E.) and standard or automated brainstem audiometry (A.B.R. or A.A.B.R.) are among the valid hearing tests which may or may not occasionally be carried out on newborns in maternity wards.

In 1999 a total of 2,970 valid hearing tests for neonates were recorded as carried out externally. Of these 1,846 were part of a collaboration project with a hospital. (See ‘New projects’.)

This represents an increase of 1.35% over 1998.

## 2.5. Babies not approached by Kind & Gezin (no screening offered)

Kind & Gezin approached not all newborns. For 1,230 babies or 2.00% of the target group, it did not prove possible for the districts to offer a hearing test. One important element of this is the N.I.C.U. babies who are long-term patients in neonatal intensive care. Other reasons for inability to offer screening were emigration, no information or wrong information on the home address, lack of a fixed abode or repeated non-response to invitations and telephone calls.

In 1998 Kind & Gezin was unable to approach 2,659 babies for hearing screening, or 6.13% of the target group in the districts then implemented.

By carrying out systematic databank checks on unscreened children and monthly reports on the missed babies to all districts, it was possible to reduce the number of not approached babies in 1999 by 4.13%.

## 2.6. Screening, deprivation and ethnicity

In 1999, in the Flemish Region 3,072 babies were born into underprivileged families (these are families with young children which are monitored by Kind & Gezin and which, according to standardised and scientifically based criteria, are in a multi-aspect poverty situation - source: Kansarmoedeatlas 1999, Kind & Gezin). Kind & Gezin screened 2,617 of these babies, or 85.19%, with the Algo test.

<b>UNDERPRIVILEGED FAMILIES</b> (significance)	<b>Numbers</b>	<b>% Underpriv.</b>	<b>for comparison % of total population</b>
<b>Babies born in 1999 into underprivileged families</b>	3,072	100%	100%
<b>Algo screening carried out by K&amp;G</b>	<b>2,617</b>	<b>85.18%</b>	<b>90.04%</b>
<b>Refusals for Algo test</b> (NS)	<b>107</b>	<b>3.48%</b>	<b>3.13%</b>
<b>Hearing screening performed prior to discharge from maternity ward</b>	<b>88</b>	<b>2.86%</b>	<b>4.83%</b>
<b>Algo test offered by K&amp;G</b> (S)	<b>2,812</b>	<b>91.54%</b>	<b>98.00</b>
<b>Babies not approached</b>	<b>260</b>	<b>8.46%</b>	<b>2.00</b>

**Table 2: Target group cover for hearing screening in babies born in 1999 into underprivileged families**

In this target group 107 refusals for the Algo test were recorded (3.48%). The difference from the number of refusals in the non-underprivileged population is not statistically significant.

The total target group approached in the underprivileged group is 91.54%, and 260 babies could not be approached. This is statistically significantly worse than the percentage in the non-underprivileged population group.

[ $\chi^2$  (1, N=61512)=689.4,  $p < .00001$ ] Only 62 children can be expected to be missed in the general Flemish population (2% van 3,072).

There are also noticeable differences according to ethnicity, as regards refusal of Algo hearing screening. The nationality of the mother at birth was taken as the criterion.

	<b>Births</b>	<b>% refusing Algo</b>	<b>Comparison with Belgian ethnicity</b>
<b>Moroccan ethnicity</b>	1,730	2.89%	NS
<b>Turkish ethnicity</b>	1,626	0.43%	S
<b>Other non-Belgian ethnicity*</b>	4,239	4.22%	S
<b>Belgian ethnicity</b>	50,571	2.28%	

**Table 3: Number of refusals of Algo screening by ethnicity in 1999 (without the category ‘unknown ethnicity’, such as people without papers)**

\* Both European and non-European nationalities.

There is no statistically significant difference between the percentage of refusals in families of Moroccan and Belgian origin.

The number of refusals by mothers of Turkish origin is statistically significantly lower than in the case of those of Belgian origin.

Mothers of non-Belgian nationality other than those of Moroccan or Turkish nationality refused an Algo test statistically significantly more often than mothers of Belgian origin. This heterogeneous group includes Southern and Eastern European nationalities in particular. It thus appears that Kind & Gezin will have to make additional efforts to optimise the target group cover for these babies.

### **3. Referral results for the Flemish Region 1999**

#### **3.1. Introduction**

The number of babies born in 1999 who were referred after a repeated positive Algo result was 125. A welfare baby clinic medical officer referred each of these babies to one of the 23 Flemish referral centres for Kind & Gezin in consultation with the GP, for diagnostic tests and/or integral support and rehabilitation.

The appointment at the referral centre was in all cases made by the Kind & Gezin welfare baby clinic medical officer, giving the parents the date, time and the name of the person whom the parents would meet. If parents did not come to the first or a subsequent appointment, the district nurse contacted the parents and arranged a new appointment. If further follow-up was broken off, a suitable solution was sought in consultation with external services and the Algo Programme Manager.

Families with a baby with an early diagnosis of hearing impairment received special attention and support from Kind & Gezin. Over and above the basic care services these families were eligible for specific care services consisting of extra home calls and consultations, in which the welfare baby clinic team tailored the services to the individual needs.

The referral centres undertook to report the results of diagnoses, support and integral rehabilitation to the attending physician and to Kind & Gezin. The processed results were submitted to the Scientific Advisory Body for Hearing Screening, and following approval were made available to the referral centres.

#### **3.2. Choice of referral**

The choice of referral centre was largely determined by the preference of the parents and the attending physician.

Some centres are more specialised, or exclusively specialised, as diagnostic centres and therefore receive many primary referrals. Centres whose competence is more in the field of rehabilitation or support receive more secondary referrals.

#### **3.3. Referral results by incidence and degree of hearing impairment**

As already mentioned above, in 1999, 125 babies were referred to a referral centre following a repeat positive Algo test. All the babies referred were monitored by Kind & Gezin to ensure appropriate follow-up and reporting, and so that no results were lost.

Hearing impairment was confirmed in 107 or 85.60% of the 125 babies referred. In 18 babies or 14.40%, normal hearing was reported after referral.

Diagnosis reported after referral	Number	%
Hearing impairment ascertained	<b>107</b>	85.60%
Normal hearing	18	14.40%
Total	<b>125</b>	100%

**Table 4: Overview of actual positive and false positive screening results according to reports of the referral results in 1999**

The percentage of babies with ascertained hearing impairment in 1999 (85.6%) is not statistically significantly lower than in 1998 (87.9%). Normal hearing has been established for only 18 babies following two stages AABR-screening, representing approximately 3 in 10,000 of the babies examined.

The group of 107 babies with ascertained hearing impairment was divided according to the incidence of unilateral and bilateral hearing impairment. This difference is important for the referral centres as regards deciding whether or not to apply further diagnostic means, and whether or not to commence integral support/rehabilitation.

<b>Cases of diagnosis of hearing impairment</b>	<b>Unilateral hearing impairment</b>	<b>Bilateral hearing impairment</b>	<b>Total</b>	<b>%</b>
Hearing impairment classified audiometrically	31	53	<b>84</b>	78.5%
Hearing impairment (as yet) not classified audiometrically	21	2	23	21.5%
<b>Overall total</b>	<b>52</b>	<b>55</b>	<b>107</b>	<b>100%</b>

**Table 5: Overview of the 107 cases of hearing impairment diagnosed in 1999 by whether or not classified**

In the Flemish Region in 1999, for 78.5% of the 84 diagnosed cases of hearing impairment the degree of impairment was classified. It is not always possible to classify the degree of hearing impairment at a very young age.

One baby with repeated unilateral Algo 'refer' result proved after referral for the OAE test not to have abnormal results, while in threshold determination with ABR, only peak one could be visualised. This proved to be a central neuropathy.

For the two babies with confirmed bilateral hearing impairment for which no audiometrical classification was achieved, the diagnosis was also of central neuropathy.

Screening the cohort by using an OAE test should not have revealed these babies with central neuropathy.

In 55 of the 107 babies' diagnosed or 51.40%, a bilateral hearing impairment was identified. One baby with diagnosed bilateral hearing impairment >120 dB has since died of carnitine-acetylcarnitine-translocase deficiency.

The ratio of unilateral/bilateral in 1999 (48.6%/51.4%) does not differ significantly from the ratio ascertained in 1998 (52.9%/47.1%).

In other screening projects also, a ratio of around 50/50 was found for unilateral/bilateral diagnosed hearing impairment (Yoshinaga-Itano C., Colorado project 1998, Neumann K., Hessen project 1998).

<b>Classified cases of hearing impairment based on BERA threshold</b>	<b>Unilateral hearing impairment</b>	<b>%</b>	<b>Bilateral hearing impairment</b>	<b>%</b>	<b>Total</b>
21-40 dB	13	41.94	7	13.21	20
41-70 dB	5	16.13	18	33.96	23
71-90 dB	2	6.45	9	16.98	11
>91 dB	11	35.48	19	35.85	30
<b>Total</b>	<b>31</b>	<b>100</b>	<b>53</b>	<b>100</b>	<b>84</b>

**Table 6: Overview of the 84 cases of classified hearing impairment according to the BERA threshold in 1999**

### **3.4. Incidence determination**

In 1999 congenital bilateral hearing impairment of at least 40 dB F.I. for the best ear was demonstrated with certainty in 46 babies. In 2 babies with bilateral hearing impairment the degree could not be classified. This brings the incidence of perceptive hearing impairment to 0.83 per thousand. The data from 1998 showed an incidence of 0.5 per thousand.

The number to be expected in a total population is 1 in 1000, which for the population tested by K&G amounts to 55.

A risk population, however, shows a prevalence of 1 to 3 in 100. The risk population consists in particular of premature babies in one of the 8 Neonatal Intensive Care Units (NICU's). In the Flemish Region, the number of NICU babies averages 2500/year, some of them requiring long-term hospital care. Among these then, a further 20 or so cases of hearing impairment may be expected. As yet this group has received only limited hearing impairment testing and almost never from K&G. They are therefore excluded from this report. In future, arrangements will be made with all NICU departments in Flanders for hearing screening of this population and recording thereof.

In 1999 a single false negative test result was discovered. Since the baby in question had already undergone a hearing test in intensive care, the defect was ascertained in good time for possible rehabilitation.

The differential diagnosis between congenital, progressive or late onset hearing impairment could not be established.

One baby in whom severe hearing impairment was ascertained at birth using threshold determination with Auditory Brainstem Response later passed the Algo screening. After repeated tests with OAE and ABR it was concluded with some reservations that the baby concerned showed bilateral hearing impairment of 50 dB for the high frequencies. In view of the slight reactions with the OAE test it was assumed that a brainstem defect was the cause of these contradictory test results.

### **3.5. The rehabilitation and support phase**

The referral centres made 14 rehabilitation reports concerning babies born in 1999 with diagnosed hearing impairment after an Algo referral. According to the present protocol, an initial rehabilitation report is not expected until 6 months after confirmation of the diagnosis and onward referral.

The parents of two babies with diagnosed hearing impairment withdrew from the referral centre's support plan. In both cases Kind & Gezin organised a round table discussion with all those involved at which action plans were drawn up in order to regain the parents' co-operation. Ethical questions were also not avoided here.

After 1999 we are gradually entering the phase in which children who were diagnosed with the Kind & Gezin screening programme are making progress in developing speech due to rehabilitation and medical intervention. This is the ultimate aim of this programme.

The results known so far are encouraging, but it is still too early to include them in this report. In the next report on the year 2000, extensive attention will be devoted to them.

# SUMMARY AND CONCLUSIONS

The data show that the Flemish hearing screening programme is efficient and has achieved virtually maximum target group cover in the non-high-risk population. Kind & Gezin approaches almost all young families on the basis of its government assignment. By using the birth data from the National Institute for Statistics, and the screening data from the Kind & Gezin IKAROS databank, it was possible to obtain very accurate data. The logistical aspects of the Algo programme are conclusive and are controlled via a databank.

The target group cover of 85% proposed in 1997 was easily exceeded in the start-up year. Target group cover rose again in 1999 by 4.13% to 98% of all babies born in the Flemish region. This increase is statistically significant.

In the interests of maximum cover, particular attention must be devoted to the underprivileged population, in which cover is currently lower than for the average population. There are also more refusals from parents of non-Belgian ethnicity other than Moroccans and Turks.

The Algo programme manager is essential to realisation of and high cover for this screening project. The monthly lists of babies who have not yet been screened are also an important instrument for increasing the level of cover.

125 babies were referred to one of the 23 referral centres in Flanders after two positive Algo tests. In 107 babies, or 85.6%, hearing impairment was confirmed. In 55 this impairment was bilateral, in 51 unilateral. The number of babies ascertained with bilateral hearing impairment of at least 40 dB F.I. for the best ear was 46, which represents an incidence of 0.83 ‰ of the population tested. The majority of high-risk premature babies did not have their hearing tested, and are therefore not included in this report. The incidence of congenital hearing impairment in this target group is at least 1%. Collaboration with the Neonatal Intensive Care Units will therefore be extended in the near future in order to monitor this high-risk group closely.

The number of 'refer' results after a first Algo test was very low in the Flemish programme (0.76%), considerably lower than the 2 to 3% found in the scientific literature on this subject. The strict standardisation, the implementation by district nurses, and the observance of strict protocols are undoubtedly some of the reasons for this. This keeps down the cost price of the test and contributes to good acceptance of the test procedure by parents and the medical profession. Nor do the referral centres suffer any extra burden.

Despite the very high sensitivity of the AABR hearing screening test (we must also take account of the existence of a (slight) risk of false negative test results, leading to (too) late identification of the disability. Progressive hearing impairment and late onset hearing impairment also cannot be detected by early hearing screening.

In 1999 a single false negative test result was discovered. Since the baby concerned had already undergone a hearing test in intensive care, the defect was ascertained in time for possible rehabilitation. The differential diagnosis of a congenital, progressive or late onset defect could not be made.

The specificity of the Algo test is also very high but cannot prevent babies being referred wrongly after a false positive test. In 1999 only 18 babies referred after a second test proved to have normal hearing. For a population of 55,388 tested babies this means that only approximately 3 in 10,000 of the babies examined were referred needlessly.

Kind & Gezin also has a tradition of collaboration and consultation with universities and organisations. The early notification and involvement of all university ENT departments and the most important rehabilitation centres and the joint drafting of the protocols have had a positive influence on acceptance by GP's and specialists. This collaboration has now been made permanent in the inter-university Scientific Advisory Body for Hearing Screening. The involvement of the attending physician in every referral not only guarantees the follow-up of the child and the family, but also supports the programme. Owing to the obligation to report on the part of the referral centres and the permanent records, there is feedback to the field of action and the attending physicians. In this way it was possible to provide optimal care services for the 125 babies who were referred after a repeat positive Algo test, and particular attention was devoted to ensuring that nobody slipped through the net.

In 1998 Prof. Dr Fernando Grandori, Chairman of the biennial "International Conference for Newborn Hearing Screening" in Milan, called the Flemish Programme "the ideal model for Universal Early Hearing Screening".

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