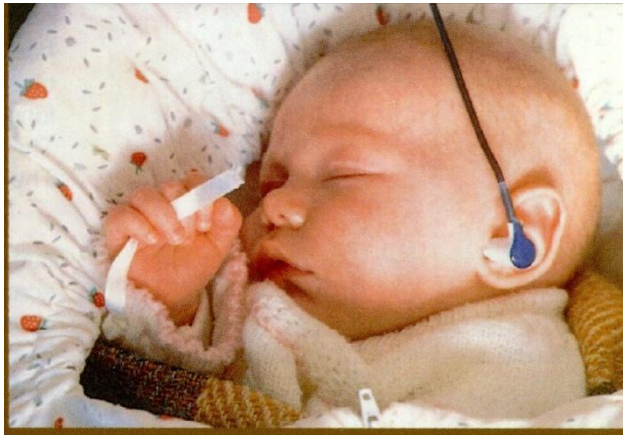


# Newborn Hearing Screening - How to get it implemented?

*Katrin Neumann*



Dept. of Phoniatics and Pediatric Audiology, University of Frankfurt/M  
Germany

## Prevalence of Permanent Hearing Loss in Neonates which needs treatment

Region-dependent:

1.8/1000 (Australia; bilateral), ~1/1000 (Brazil; bilateral; Sweden), 1-3/1000 (China; bilateral) and ~5/1000 (unilateral), 2.3 /1000 Germany (1.6/1000 bilateral, 0.7/1000 unilateral); 1.61/1000 of at-risk infants (India; bilateral); 1/1000 (Serbia; bilateral) and 0.3/1000 (unilateral), 1.05/1000 (Colorado; bilateral) and 0.45/1000 (unilateral), 1.83/1000 (Washington D.C.), **3/1000 (Philippines)**

**Range: 1/1000 – 6/1000**

# Which Consequences Does an Infant Hearing Loss Have?

- Disturbed development of hearing, speech and language, learning, reading and spelling
- Emotional and cognitive disturbances
- Consequences for the families
- education and
- professional performance

**Mean loss of income for life of persons with congenital hearing disorders:**

**300.000 – 500.000 \$**

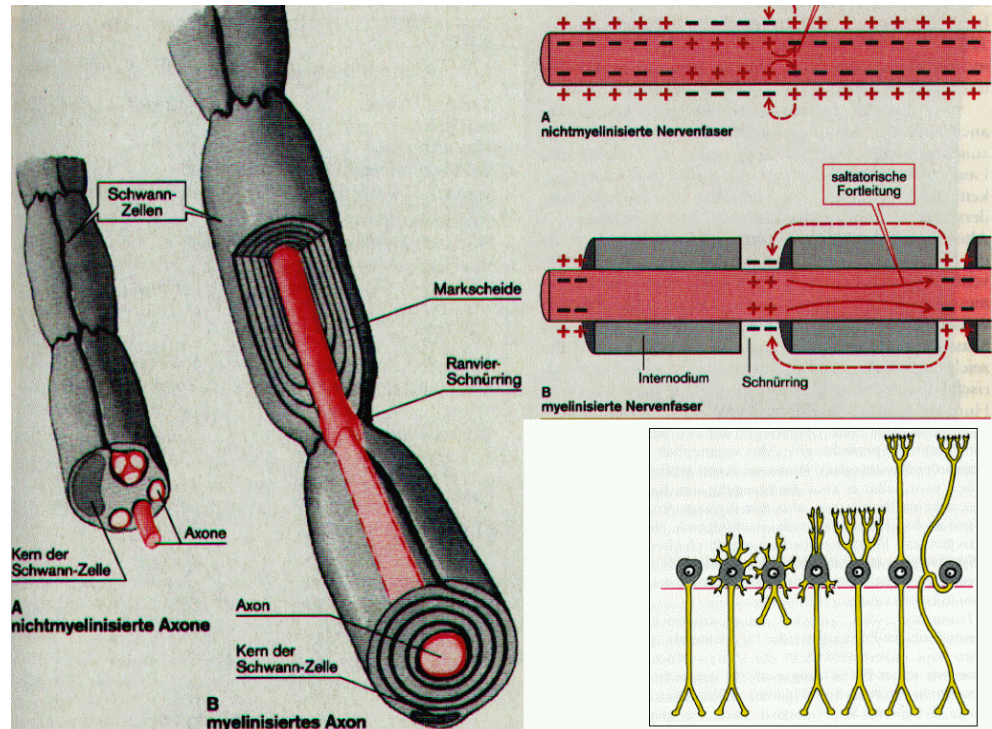
(Northern and Downs, 1991, USA)

# Development of the Auditory System

Basic processes mainly during the last prenatal weeks and first postnatal months

## Sensitive time windows for maturation of the Auditory Pathway

- dendritogenesis completed after 40 weeks (Lenarz, 1997)
- myelination of the axons of the auditory nerve up to the inferior colliculus completed up to the end of the first year (Moore, 1995)



# No Earlier Diagnosis and Treatment in Regions with Sporadic Newborn Hearing Screening!

German Central Register of Infant Hearing Disorders (Gross, 2001):

→ A sporadic or regional screening is not enough.

**Screening program was required**, which includes from the first beginning certain quality criteria

Screening results have to be judged by answering the question:  
Do children with neonatal hearing disorders indeed receive an earlier therapy as so far?

# Newborn Hearing Screening in Germany mandated since Jan. 1, 2009

**Every newborn has the right** to receive a NHS.

**Written information for parents, disagreement** needs to be signed by a parent

detection of a bilateral permanent childhood hearing loss (PCHL) from **35 dBHL** on

to be **diagnosed** up to the end of the **3rd month** of life

**Therapy start** up to the end of the **6th month** of life

**Financing:** Health insurances

## Methods:

**TEOAE and in case of failing AABR** (two-stage) or **AABR alone**

failing the primary screening (TEOAE or AABR) → control-AABR (same day recommended, but up to 10th day of life latest)

failing control-AABR → pediatric-audiological diagnostics

**at-risk babies: obligatory AABR**

**binaurally**

**Time frame of the screening: up to the 3rd day of life recommended**, latest until 10th day of life

in-patient screening: before delivery

**preterm newborns:** latest up to the calculated birth date

**severely ill babies:** NHS considering additional diseases, but up to the end of the 3rd month of life latest

## **Responsibility: must be clearly defined**

in-patient screening: physician who is responsible for the maternity ward

out-patient birth: midwife or the physician who guided birth responsible for the initiation of the screening

out-patient screening: by ENT, pediatrician, or phoniatrician/pediatric audiologist

pediatric-audiological diagnostics: phoniatriicians/pediatric audiologists or pediatric-audiologically qualified ENTs



## Quality Assurance

Coverage rate of the NHS in the hospital 95%

At least 95% of the babies who failed the primary screening should get a control-AABR

(a) before delivery from the maternity ward (in-patient screening)

(b) in the same practise where the screening has been performed (out-patient screening)

Proportion of children who need a pediatric-audiological confirmation diagnostics should not be higher than 4% (also for practises)

Defined follow-up diagnostics after a failed primary and control screening

Two steps:

**Step1: Repeated and extended screening**

**→ 90% pass**

**Step 2: Full pediatric-audiological diagnostics**

Every child undergoes regular pediatric examinations during the first 6 yrs. of life, documented in a booklet  
 → ensures minimal tracking

## Früherkennungsuntersuchung von Hörstörungen bei Neugeborenen (Neugeborenen-Hörscreening)

Sign of  
 Pediatrician

Disagreement of parents /sign

Primary screening (TEOAE / AABR passed or failed?

Control-AABR passed or failed?

Pediatric audiological diagnostics initiated? When?

Results of a Pediatric audiological diagnostics? Hearing loss? Ear?

Talk with the parents about the results of the examinations?

Durchführung der Untersuchung nach Aufklärung von den Eltern oder Erziehungsberechtigten abgelehnt am:		Unterschrift des Erziehungsberechtigten	Stempel/Unterschrift des Kindes
Erstuntersuchung mittels TEOAE oder AABR, in der Regel in den ersten 3 Lebenstagen			
durchgeführt am:	beidseits unauffällig <input type="checkbox"/>	auffällig rechts <input type="checkbox"/> links <input type="checkbox"/>	Stempel/Unterschrift
TEOAE oder AABR	<input type="checkbox"/>	rechts <input type="checkbox"/> links <input type="checkbox"/>	
Kontroll-AABR bei auffälliger Erstuntersuchung, in der Regel bis U2			
durchgeführt am:	beidseits unauffällig <input type="checkbox"/>	auffällig rechts <input type="checkbox"/> links <input type="checkbox"/>	Stempel/Unterschrift
AABR	<input type="checkbox"/>	rechts <input type="checkbox"/> links <input type="checkbox"/>	
Pädaudiologische Diagnostik bei auffälliger Kontroll-AABR			
veranlasst am:			Stempel/Unterschrift
Ergebnisse der pädaudiologischen Diagnostik, in der Regel bis zur 12. Lebenswoche			
durchgeführt am:	unauffällig <input type="checkbox"/>	auffällig <input type="checkbox"/>	Stempel/Unterschrift
Ergebnis: rechts Ergebnis: links	<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/>	
Untersuchungsergebnisse und ggfs. erforderliche Therapie mit den Eltern oder Erziehungsberechtigten besprochen am:			Stempel/Unterschrift

+ annual statistics of the birth clinics

## Data from Germany from 2005, 2006, and 2010 (German Registry of Childhood Hearing Loss, DHZ)

- 11 of 16 German federal states send regular reports to the DHZ.
- **74%** of the 245 children born in year **2005** who were identified with a permanent hearing loss and were reported to the DZH were diagnosed by a NHS, in **2006** this percentage increased to **85%**.
- mean age at diagnosis of the **screened** children: **4.7 mos. in 2005**  
**4.2 mos. in 2006**  
of the **not screened** children: **16.5 mos. in 2005**  
**12.5 mos. in 2006**
- **42%** of the children received **intervention before 6 mos. of age** in 2005 and **61% in 2006**
- **After implementation of a nation-wide NHS:** mean age at diagnosis of a permanent infant hearing loss (**screened and not screened children**) decreased to **12 mos. In 2010**

**Problem:** Financing of regional screening centers and tracking

## Hessen, Germany

- 51,000 deliveries per year
- 83 birth clinics: NHS in all clinics
- 74 clinics: electronic data transfer to a screening center → tracking
- 9 clinics: no central data collection → no tracking
- 1650 trained examiners with certificate (2008)



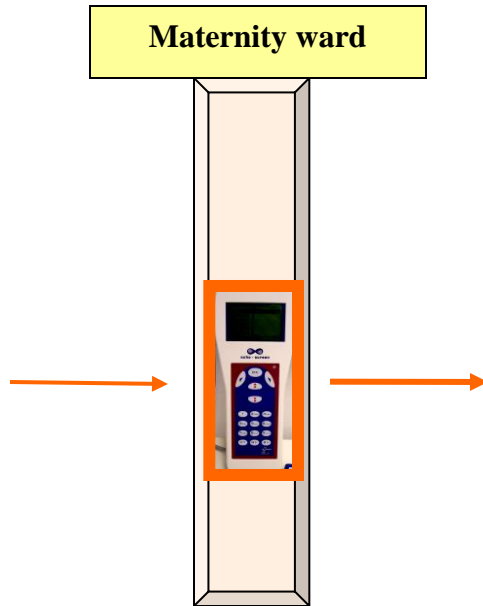
## Hessian NHS program: meets international quality criteria:

1. coverage rate 95 % → in-patient screening ✓
2. < 4 % babies fail the primary screening → two-stage screening protocol; TEOAE-AABR ✓
3. follow-up rate  $\geq 95$  % → after a failed primary screening babies directly referred to pediatric-audiological institutions (✓)
4. clear organization of follow-up → parents provided with addresses of pediatric audiological follow-up institutions ✓
5. diagnostics finished within 3 mos., therapy starts within 6 mos. → first pediatric-audiological consultation within 2 weeks, tracking with reminder letters and telephone calls in two-week intervals ✓
6. further quality standards: central data processing, tracking, certified training and supervision of the screening staff ✓





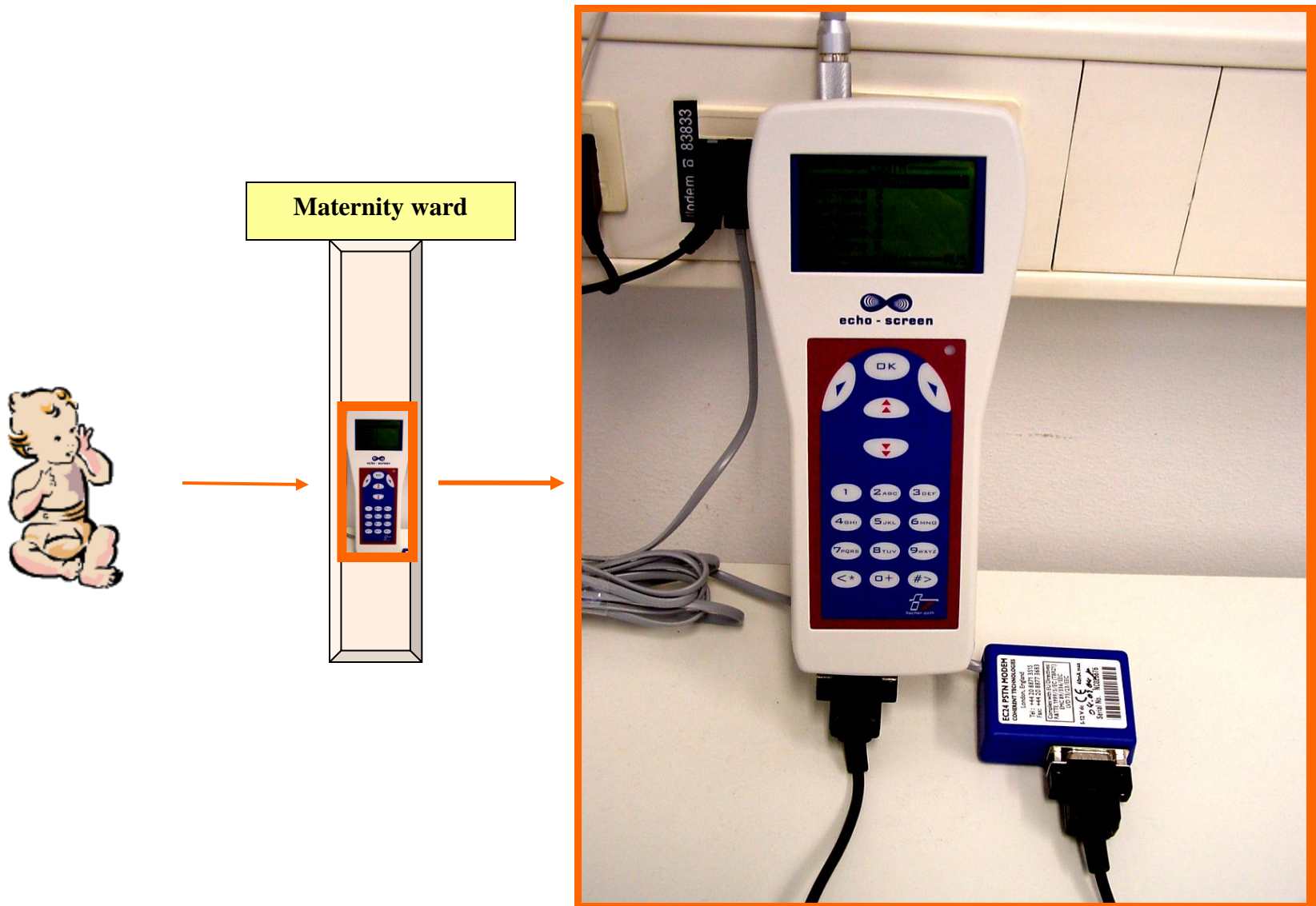
# Electronic data collection, database, tracking



first German NHS-Programm  
with automated data transfer and  
quality assurance  
(Neumann et al., 2006)

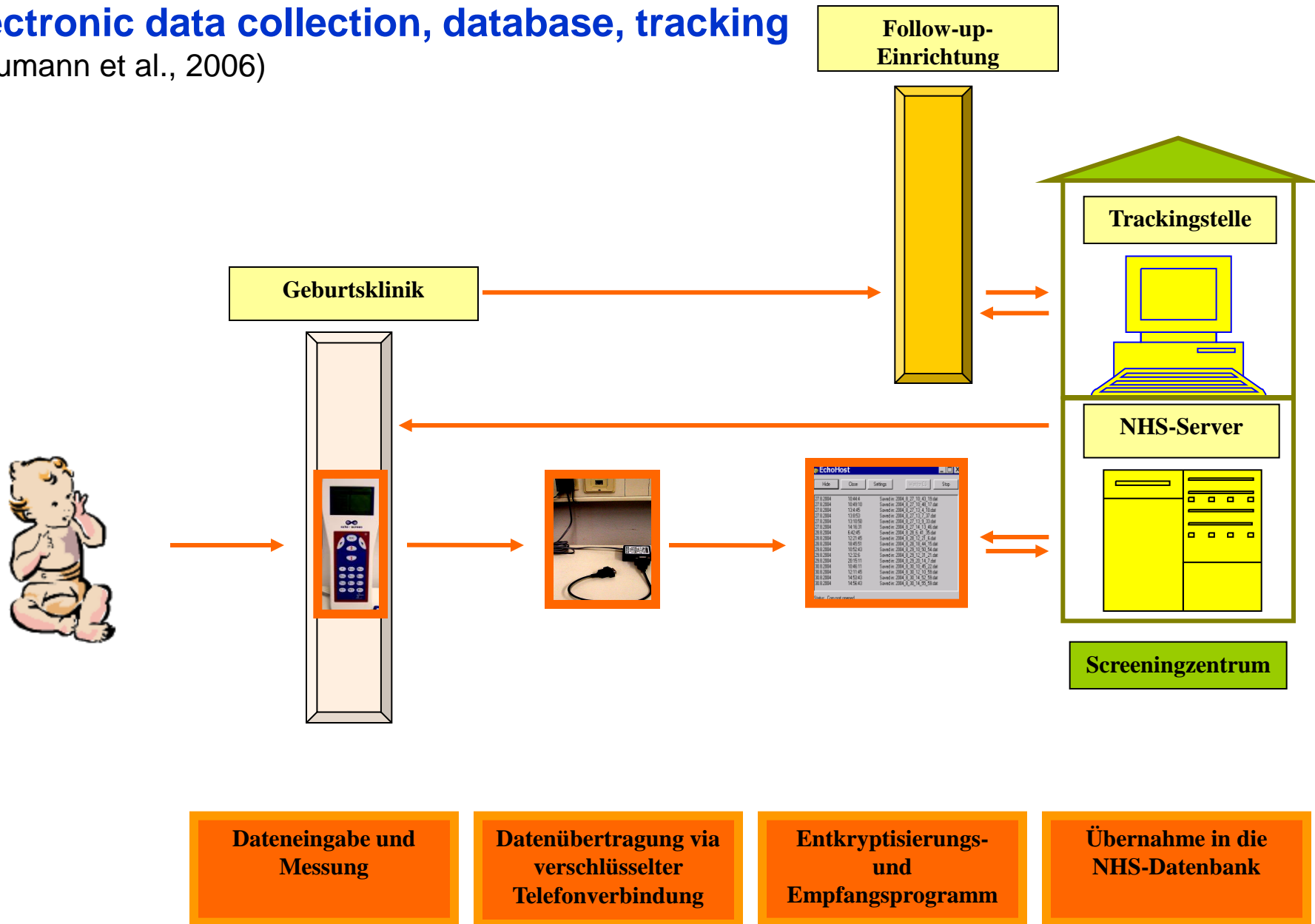
# Electronic data collection, database, tracking

(Neumann et al., 2006)



# Electronic data collection, database, tracking

(Neumann et al., 2006)

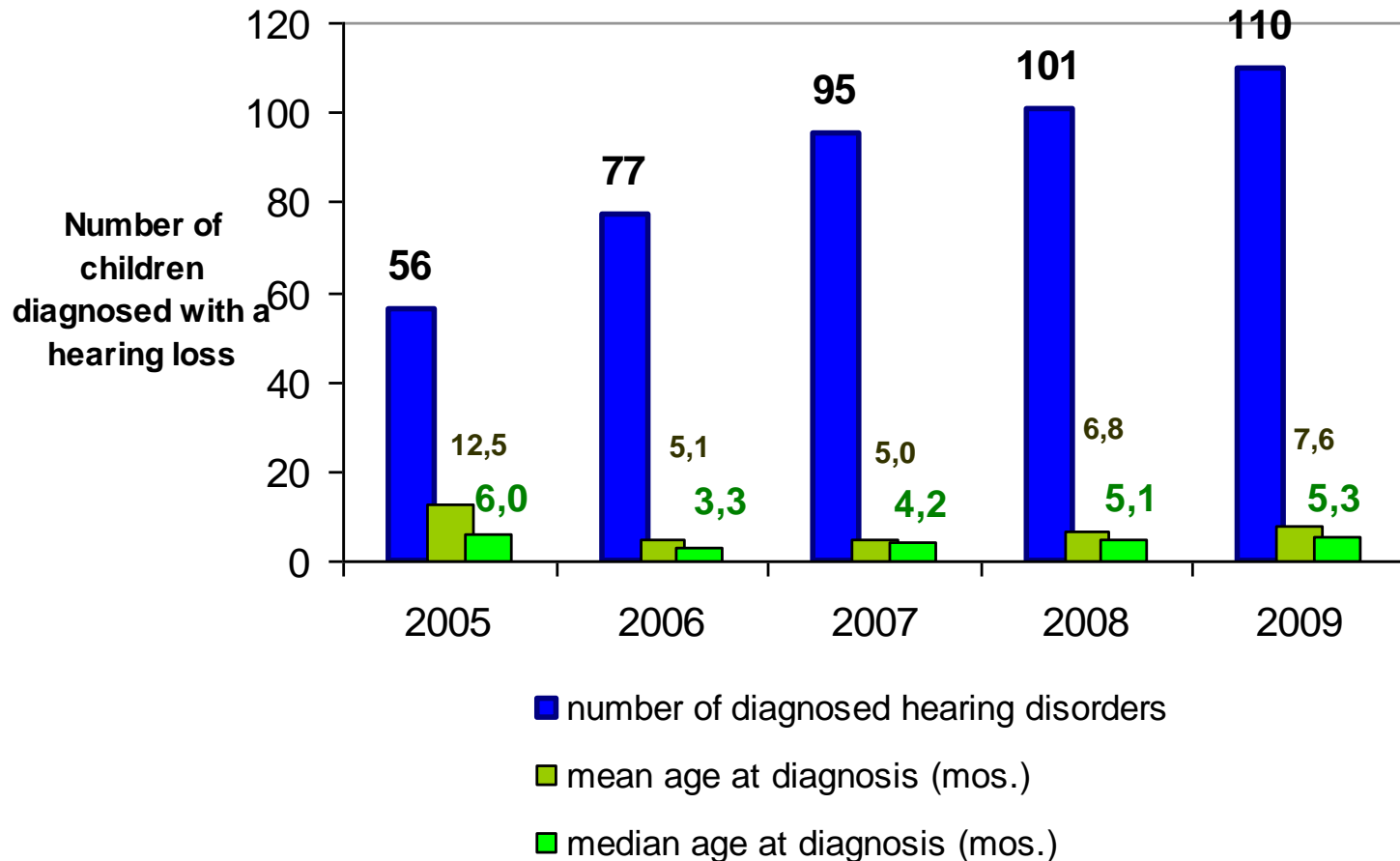




# State of Hesse: Age at Diagnosis in the Hessian NHS program

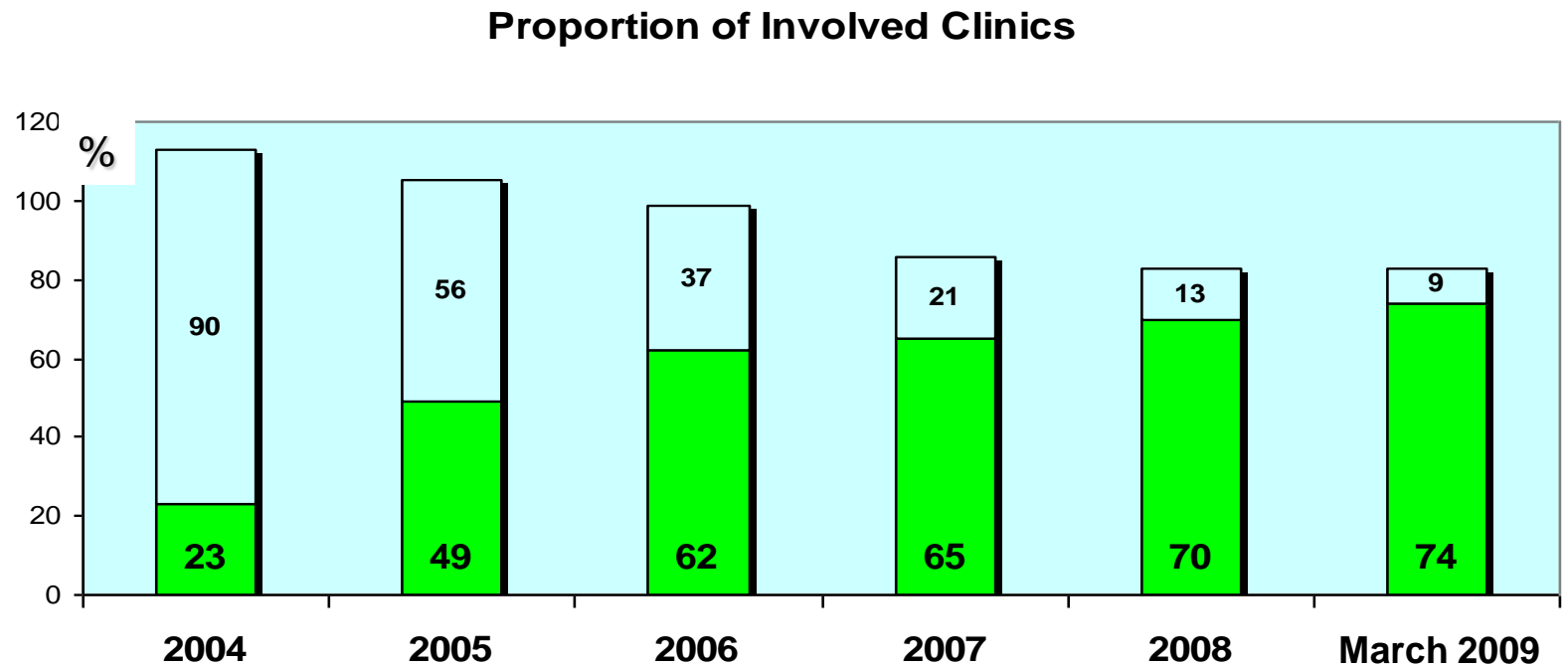
Database comprises datasets of 210.870 children at current

## Age at Diagnosis of a Connatal Infant Hearing Loss

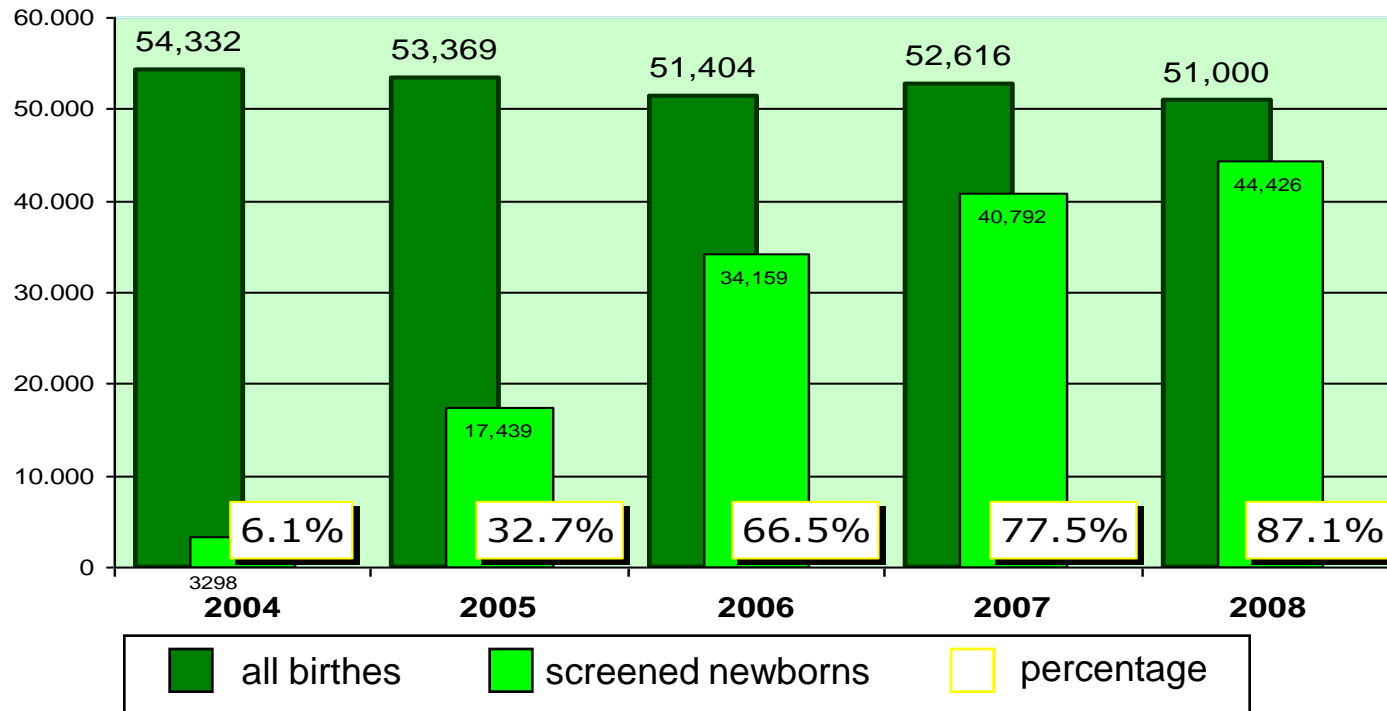


Increase of age at diagnosis by lacking follow-up capacity?

# Implementation of a UNHS in the Hessian Birth Clinics



# Development of Coverage Rates in the Hessian NHS Program



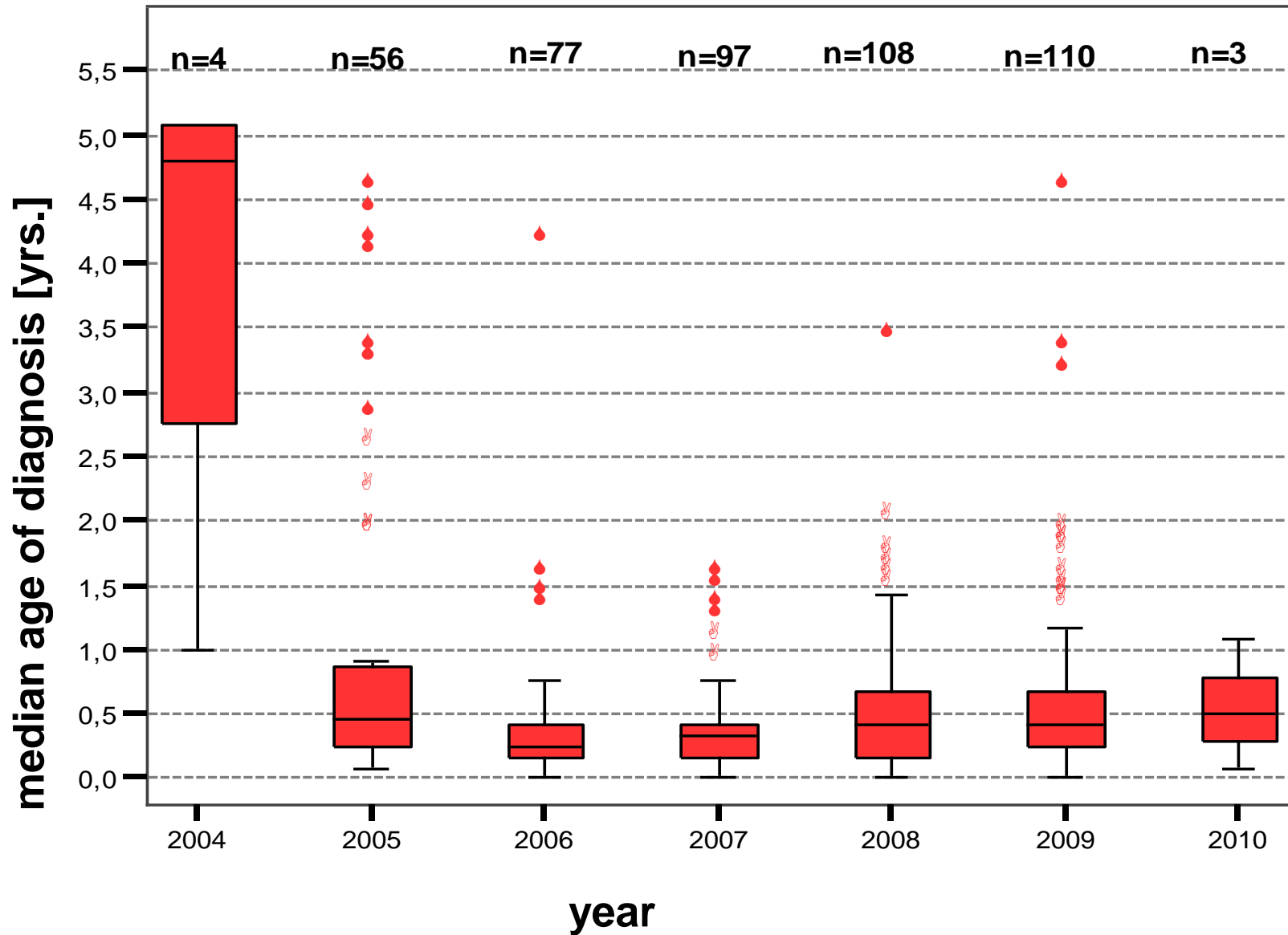
Coverage rates in clinics involved in the Hessian NHS program in 2008: 97.2%

# Outcome Hessen: NHS Database 2005 and 2006

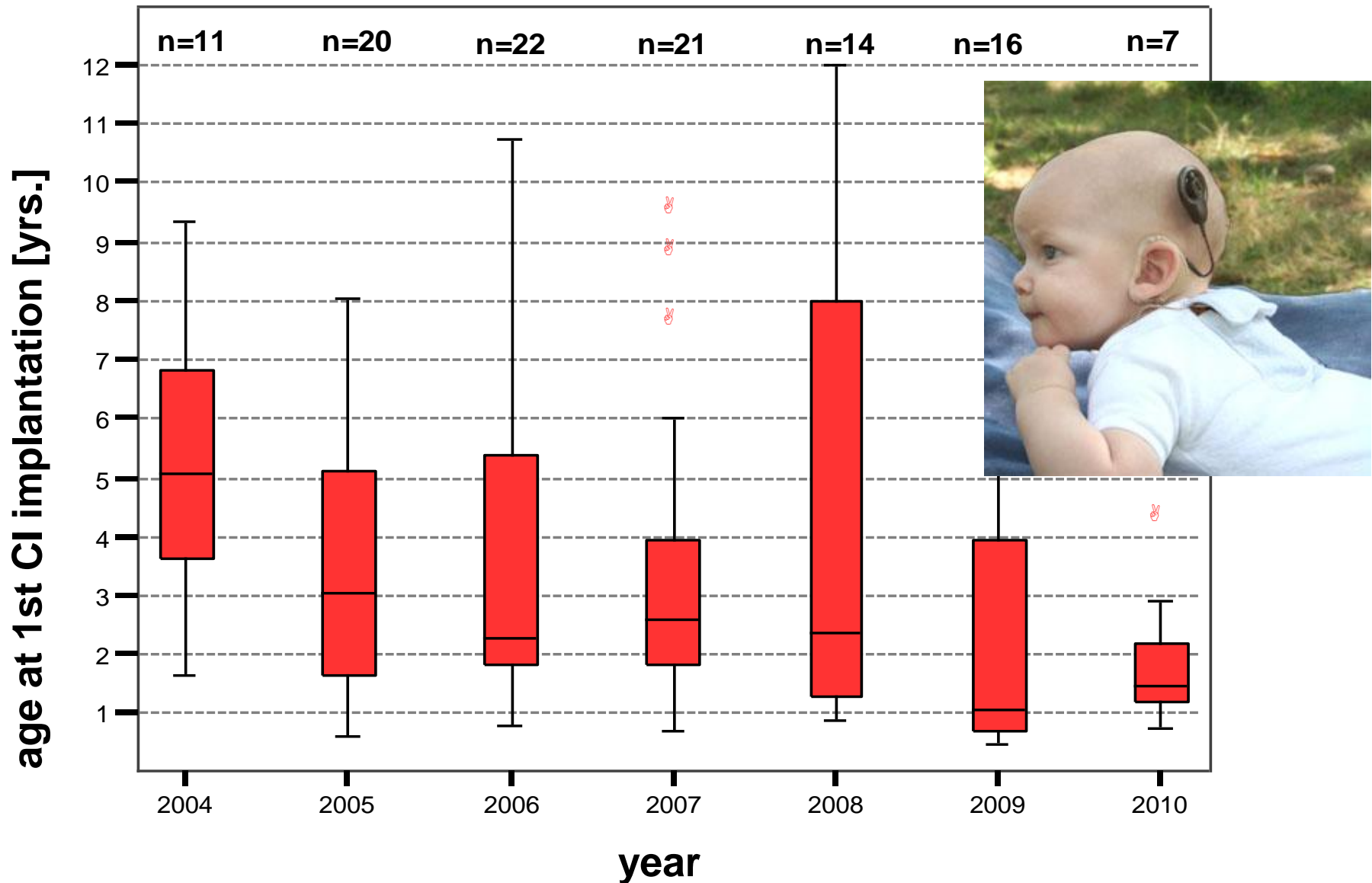
data of 34,129 babies

Prevalence (incl. monaural hearing impairments)		2.1-2.8 / 1000
Median age at diagnosis (detected by screening)	2005	3.1 mos.
	2006	3.2 mos.
(not detected by screening)	2006	16.7 mos.
Median age at therapy start (detected by screening)	2005	3.5 mos.
(not detected by screening)	2005	49.5 mos.
Program specificity	2005	97.2 %
	2006	96.5 %
Hessen 2005: Median age at diagnosis of all hearing impaired children		6.3 mos.
	2006	3.9 mos.
Germany: Median age at diagnosis	2005	39 mos.
<b>→In 2005 64% of all children with hearing loss in Hessen detected by a NHS, in 2006 already 93%!</b>		
Less than one month delay between detection and therapy start		

# Development of age medians of diagnosing an permanent infant hearing loss in the state of Hesse, Germany



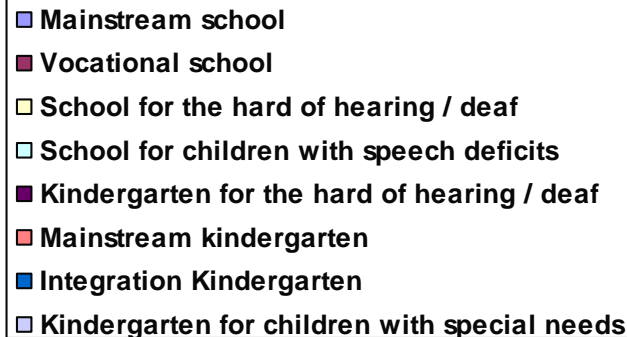
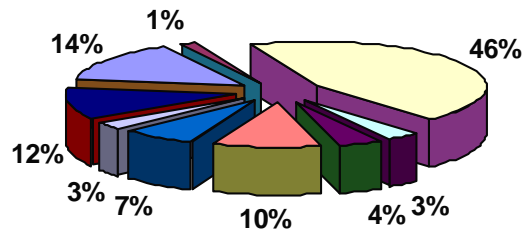
# Development of age medians of 1st CI implantation (University of Frankfurt)



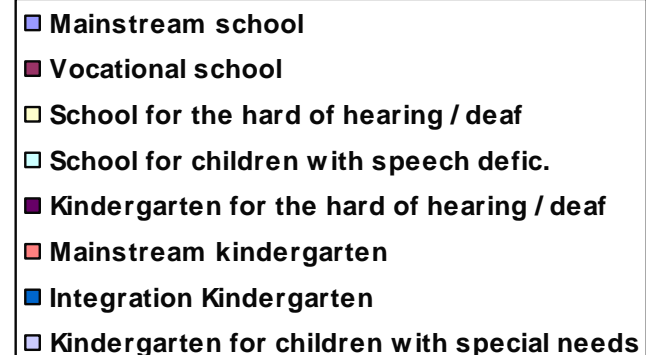
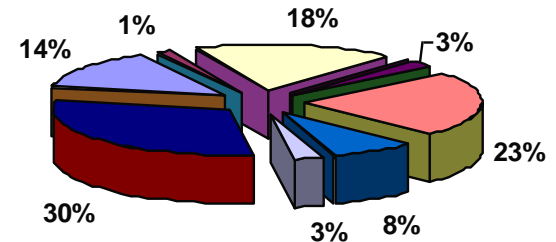
## Education of children implanted with CI (Diller, 2006)

- 56 % of the Hessian children, who received a CI between 3 and 6 yrs. Of age were educated in 2006 in schools of the deaf or special schools
- only 24 % of the children who got a CI before their 3<sup>rd</sup> birthday were educated in schools of the deaf or special schools

### Late implanted



### Early implanted



## Tracking

Quality assurance and evaluation of the EHDI (Neumann et al., 2009)

### Regional Screening center

1 per federal state

Tracking of babies who failed the screening or had incomplete measurements (follow-up tracking)

Tracking of babies who missed the screening (completeness tracking, related to a birth cohort, region, or institution)

Screening center stores the regional data

Transfers data to nation-wide institution of UNHS quality assurance

Informs maternity wards quarterly about the screening results

Responsible for training and retraining of the screening staff

Assures continuity of the screening



# Central data processing and analysis

## Domains

1. transmission of screening data from the birth clinic to a screening center
2. transmission of follow-up data from the follow-up institution to a screening center
3. data analysis and tracking (follow-up and completeness) by the screening center
4. feedback information from the screening center to the maternity wards (important for keeping motivation) and follow-up institutions
5. provision of statistics/epidemiology

## Software

developed by the Clinic of Phoniatics and Pediatric Audiology of the University of Frankfurt together with Labodat, Dresden

experience of internationally approved NHS software is integrated

working also in China

# View of Child

LD\_NHS Mutter / Kind

Meier, Max 022-200

Name

Meier

Vorname

geb. am

...

Straße

Postleitzahl

Ort

Telefon

Diagnose

Befunde

Verfahren	Datum
TOAE	16.01.2004
TOAE	16.01.2004
ABR	20.01.2004
ABR	20.01.2004
ABR	25.01.2004
ABR	25.01.2004

LD\_NHS Kind-Ansicht

Meier, Max 022-200 ( ) geb.: . .

akt.Status:

R

L

Verfahren	Bdat	Zeit	Ohr	Result_bt
TOAE	16.01.2004	00:00:00	L	Fail
TOAE	16.01.2004	00:00:00	R	Abort
ABR	20.01.2004	01:00:00	L	Pass
ABR	20.01.2004	01:00:00	R	Pass
ABR	25.01.2004	10:00:0	L	Pass
ABR	25.01.2004	10:00:0	R	Pass

Diagnose

Suchen

Neuer Patient

Patient Löschen

Befund ändern

Kind-Ansicht

Schließen

Status Setzen

s_bt	Eins.-Nr.
llig	10
ermin verein	0
ffällig	20

# TRACKING OF FAILS

## done by the screening center

EarScreen  
Bearbeiten

Kontrolle REFER nach Erstscreening  
Eingänge vom 01.05.2004 bis 07.09.2004

☐ ohne Brief ☐ mit Brief ☒ Alle

Brief auswählen

unauffällig

Datum	Eins.Nr	Einsender	Name	Vorname	geb.am	letzte Aktion	Maßnahme	Fu_Anmeldung
25.07.2004	7803	BAD HOMBURG	EMER	SGL/MBL	25.07.2004	03.09.2004	Brief: Arztbrief	
26.07.2004	2950	RUSSELH	S...	Najaab	22.07.2004	03.09.2004	Brief: Arztbrief	
27.07.2004	2950	RUSSELH	EMELY	EMELY	25.07.2004	03.09.2004	Brief: Arztbrief	
27.07.2004	2660	HEPPENH	ADOLPH	SERDAL	22.07.2004	03.09.2004	Brief: Arztbrief	
28.07.2004	2950	RUSSELH						
29.07.2004	2950	RUSSELH	M...	M	26.07.2004	03.09.2004	Brief: Arztbrief	
30.07.2004	2701	HOMBERG	SINAN	SINAN	29.07.2004	03.09.2004	Brief: Arztbrief	
30.07.2004	2660	HEPPENH	PAULA	PAULA	29.07.2004	03.09.2004	Brief: Arztbrief	
01.08.2004	7806	BAD SODEN / TAUNUS	Felix	Felix	25.07.2004	03.09.2004	Brief: Arztbrief	
02.08.2004	2701	HOMBERG	SCHNEIDER	MAREN	24.07.2004	03.09.2004	Brief: Arztbrief	
03.08.2004	7806	BAD SODEN / TAUNUS	Leopold	Leopold	01.08.2004	03.09.2004	Brief: Arztbrief	30.08.2004 Fu Anmld.FF
04.08.2004	7804	BENSHEIM "HEILIG-GEIST"	JAN SOEREN	JAN SOEREN	01.08.2004	03.09.2004	Brief: Arztbrief	
04.08.2004	7808	FRANKFURT MAIN -HÖCHST	Suleyman, Adem	Suleyman, Adem	27.05.2004	03.09.2004	Brief: Arztbrief	
05.08.2004	2570	GELNHAUSEN	JANA	JANA	03.08.2004	03.09.2004	Brief: Arztbrief	
05.08.2004	7806	BAD SODEN / TAUNUS	Oliver	Oliver	04.08.2004	03.09.2004	Brief: Arztbrief	
06.08.2004	7803	BAD HOMBURG	ELISAVET	ELISAVET	27.07.2004	03.09.2004	Brief: Arztbrief	
06.08.2004	7811	FRANKFURT-HÖCHST	Lisa-Marie	Lisa-Marie	25.07.2004	03.09.2004	Brief: Arztbrief	
09.08.2004	2701	HOMBERG	CALVIN PASCAL	CALVIN PASCAL	07.08.2004	03.09.2004	Brief: Arztbrief	
09.08.2004	2570	GELNHAUSEN	DAN ELIAS	DAN ELIAS	08.08.2004	03.09.2004	Brief: Arztbrief	
09.08.2004	2950	RUSSELH	ALINA	ALINA	03.08.2004	03.09.2004	Brief: Arztbrief	
09.08.2004	7805	OFFENBACH - KLINIKUM	Paula, Marie	Paula, Marie	06.08.2004	03.09.2004	Brief: Arztbrief	
10.08.2004	2950	RUSSELH	PHILIPP	PHILIPP	08.07.2004	03.09.2004	Brief: Arztbrief	
10.08.2004			Leon	Leon		03.09.2004	Brief: Arztbrief	
12.08.2004	7803	BAD HOMBURG	YANIC	YANIC	09.08.2004	03.09.2004	Brief: Arztbrief	
15.08.2004	7804	BENSHEIM "HEILIG-GEIST"	NATASCHA	NATASCHA	12.08.2004	03.09.2004	Brief: Arztbrief	
16.08.2004	7804	BENSHEIM "HEILIG-GEIST"	FINN	FINN	13.08.2004	03.09.2004	Brief: Arztbrief	
16.08.2004	2950	RUSSELH	MICHELLE	MICHELLE	12.08.2004	03.09.2004	Brief: Arztbrief	

- list of children who failed the primary screening
- last action of the screening center (letter, telephone call)
- appointment for follow-up
- detailed data per child can be shown and selected for the follow-up institution

# Standard letters

LD\_Hör-Screening

Bearbeiten

LD\_NHS Briefe

Schon geschriebene Briefe

Löschen

Einsender-Anschrift

Brief auswählen ...

Standard-Briefe verwalten

Schließen

Patnotiz

Meier, Max 022-200 geb. ...

Notiz

Datum	Zeit	Bezeichnung	Nutzer

Telefon-Protokoll

Standard-Briefe

Bild zuordnen

Zeile löschen

Zeile anzeigen

Schließen

Diagnose

Befunde

Verfahren	Datum	Zeit	Ohr	Mess	Zustand						
TOAE	16.01.2004	00:00:00	L	2	r						
TOAE	16.01.2004	00:00:00	R	2	r						
ABR	20.01.2004	01:00:00	L	2	r	Pass	0	20		0	
ABR	20.01.2004	01:00:00	R		u	Pass	0	20		0	
ABR	25.01.2004	10:00:0	L		r	Pass	0	20		0	
ABR	25.01.2004	10:00:0	R		r	Pass	0	20		0	

Suchen

Neuer Patient

Patient Löschen

Befund ändern

Kind-Ansicht

Schließen

Status Setzen

bt	Eins.-Nr.
g	10
min verein	0
25.01.2004 unauffällig	20

Start

Befund ändern...

nhs auf "screeni...

Programmanc...

LD\_Hör-Screening

DE 11:17

# Telephone protocol

LD\_NHS Mutter / Kind

Meier, Max 022-200 () geb.: . .

Mutter

Name

Meier

Vorname

geb. am

. .

Straße

Postleitzahl

Ort

Telefon

Kind

Name

Meier

Vorname

Max 022-200

Geschlecht

geb. am

. .

Zeit (hh:mm)

:

Heft-Nr

0

Sprache

Suchen

Neuer Patient

Patient Löschen

Befund ändern

Kind-Ansicht

Schließen

Diagnose

Befunde

Verfahren	Datum	Zeit	Ohr	Mess	Zustand	Ergebnis	Untersucher	Eins-Nr	Einsender	Geräte_Id
TOAE	16.01.2004	00:00:00	L	2	r	Fail	0	10		0
TOAE	16.01.2004	00:00:00	R	2		Abort	0	10		0
ABR	20.01.2004	01:00:00	L	2	r	Pass	0	20		0
ABR	20.01.2004	01:00:00	R		u	Pass	0	20		0
ABR	25.01.2004	10:00:0	L		r	Pass	0	20		0
ABR	25.01.2004	10:00:0	R		r	Pass	0	20		0

Status

Status Setzen

Datum	Status_bt	Eins.-Nr.
16.01.2004	auffällig	10
20.01.2004	FU Termin verein	0
25.01.2004	unauffällig	20

LD\_NHS

?

Telefon-Protokoll anlegen?

OK

Abbrechen

Start

Patientennotitz ...

nhs auf "screeni...

Programmansic...

LD\_Hör-Screening

DE 11:19

## Remarks on a child

**Patnotiz** ✕

**tertius, tertius geb.03.03.1930**

**Notiz**

Interne  
Anmerkungen zum Patienten

Datum	Zeit	Bezeichnung	Nutzer
10.03.2004	10:49	Nachfolgeuntersuchung, Brief Für Die Eltern	weiwo

Telefon-Protokoll    Standard-Briefe    Bild zuordnen

Zeile löschen    Zeile anzeigen    Schließen

# Screeners

Coded with a number,  
Re-training required?

EarScreen

Bearbeiten

EarScreen Untersucher

20 Messungen davon 25.00 % Refer

Verfahren	Datum	Zeit	Ohr	Ergebn	Kommentar	Kind	Untersucher	Eins.-Nr.	Geräte-ID
TEOAE	31.07.2004	15:40:48	L	Pass		BAYERN	Mo St	7805	15000
TEOAE	31.07.2004	15:42:03	R	Pass		BAYERN	Mo St	7805	15000
TEOAE	01.08.2004	16:57:23	L	Pass		MA	Mo St	7805	15000
TEOAE	01.08.2004	16:59:58	R	Pass		MA	Mo St	7805	15000
TEOAE	01.08.2004	17:19:46	L	Pass		W	Mo St	7805	15000
TEOAE	01.08.2004	17:22:50	R	Pass		W	Mo St	7805	15000
TEOAE	01.08.2004	17:31:10	L	Pass		K	Mo St	7805	15000
TEOAE	01.08.2004	17:32:28	R	Pass		K	Mo St	7805	15000
TEOAE	02.08.2004	18:52:20	L	Pass		UL	Mo St	7805	15000
TEOAE	02.08.2004	18:53:10	R	Pass		UL	Mo St	7805	15000
TEOAE	02.08.2004	19:03:20	L	Pass		M	Mo St	7805	15000
TEOAE	02.08.2004	19:06:30	R	Pass		M	Mo St	7805	15000
TEOAE	03.08.2004	17:18:13	L	Pass		AS	Mo St	7805	15000
TEOAE	03.08.2004	17:18:59	R	Pass		AS	Mo St	7805	15000
TEOAE	09.08.2004	00:00:00	L	Refer		S	Mo St	7805	15000
TEOAE	09.08.2004	00:00:00	R	Refer		S	Mo St	7805	15000
AABR	09.08.2004	11:11:11	L	Refer		S	Mo St	7805	15000
AABR	09.08.2004	11:11:11	R	Refer		S	Mo St	7805	15000
TEOAE	23.08.2004	00:00:00	L	Refer		F	Mo St	7805	15000
TEOAE	23.08.2004	00:00:00	R	Pass		F	Mo St	7805	15000

2327

Suchen

Doppelte Namen

Neuer Patient

Patient Löschen

Befund ändern

Kind-Ansicht

Schließen

Status

Status Setzen

Datum	Status_bt	Eins.-Nr.
09.08.2004	auffällig	7805

# Follow-up data

Follow UP Daten

Kindname, Kindvorname (m)
geb.: 14.08.2004

akt.Status: auffällig

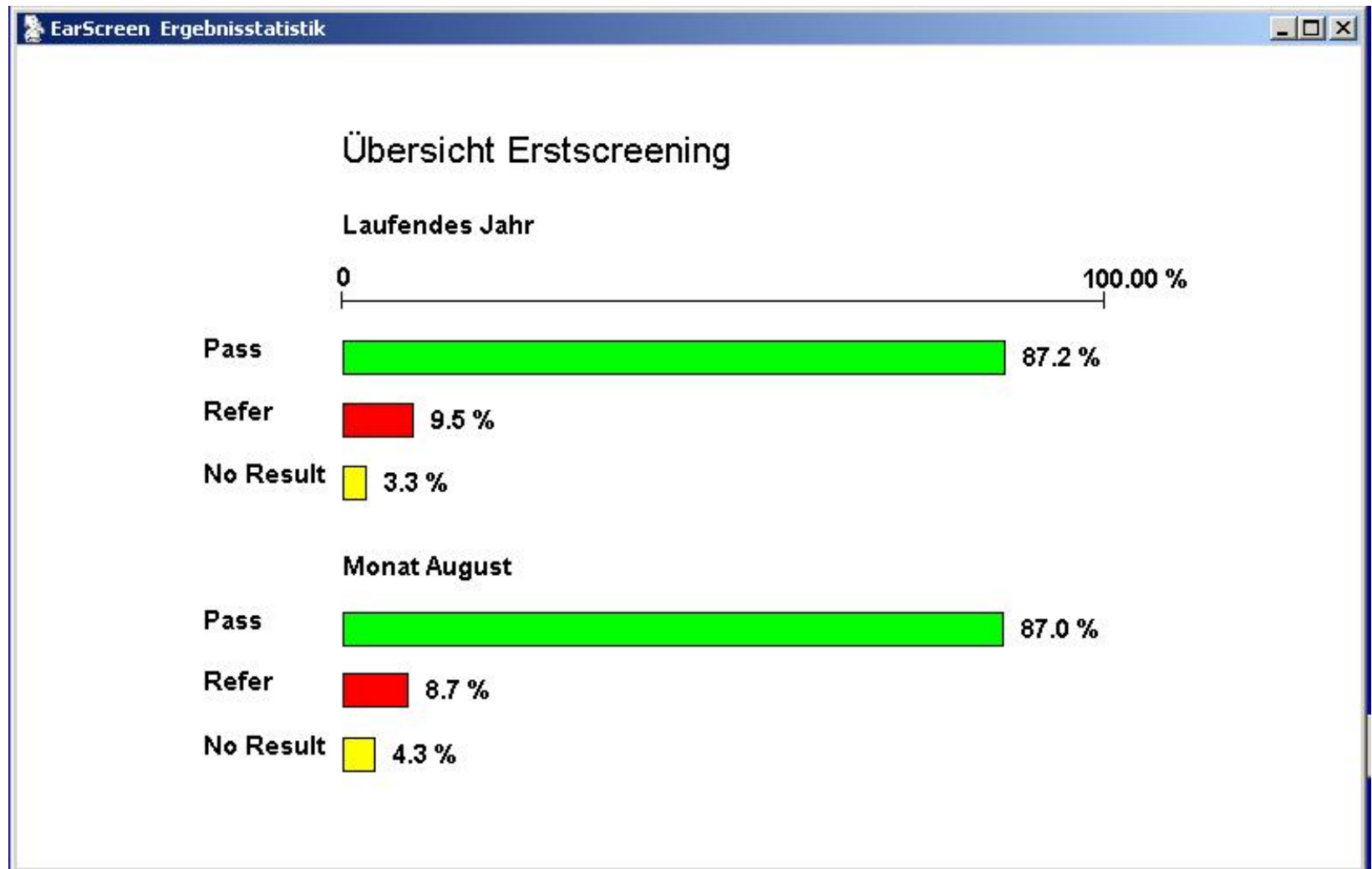
Ergebnis

Therapie

	Einrichtungen	linkes Ohr		rechtes Ohr	
		Verfahren	Ergebnis	Verfahren	Ergebnis
Primärscreening					
Follow UP					
		Ergebnis	Notched Nois - ABR	Notched Nois - ABR	
		Status Hörstörung	Hörstörung	Hörstörung	
		Art der Hörstörung	sensorineurale Hörstörung	sensorineurale Hörstörung	
Stärke des Hörverlustes ermittelt mit Notched Noise - ABR					
<div> <div>0,5 kHz</div> <div>1 kHz</div> <div>2 kHz</div> <div>4 kHz</div> <div>Click</div> </div> <div> <div>Rechts [dB]</div> <div></div> <div></div> <div></div> <div></div> <div></div> </div> <div> <div>Links [dB]</div> <div></div> <div></div> <div></div> <div></div> <div></div> </div>					



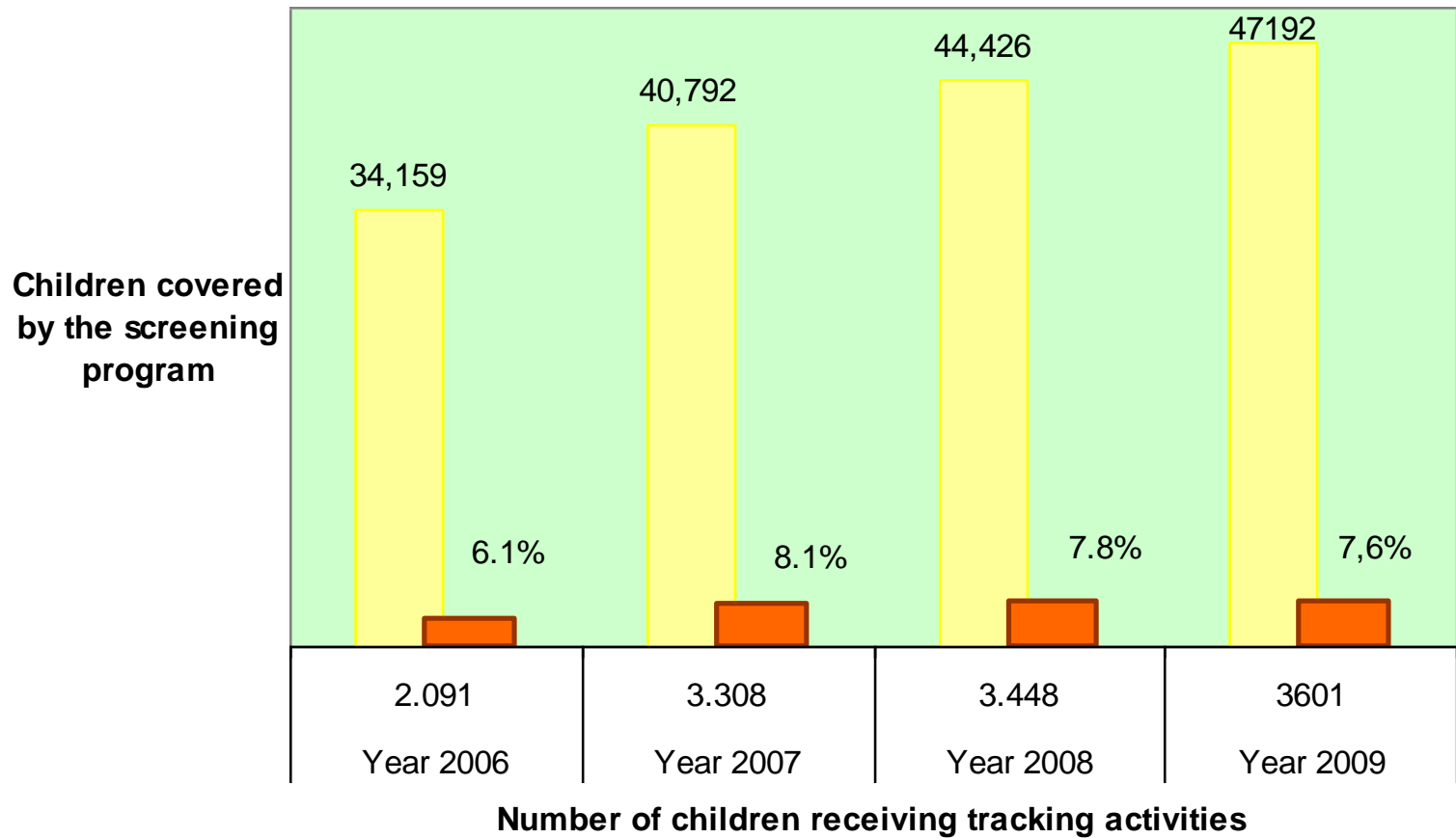
# Statistics, Epidemiology



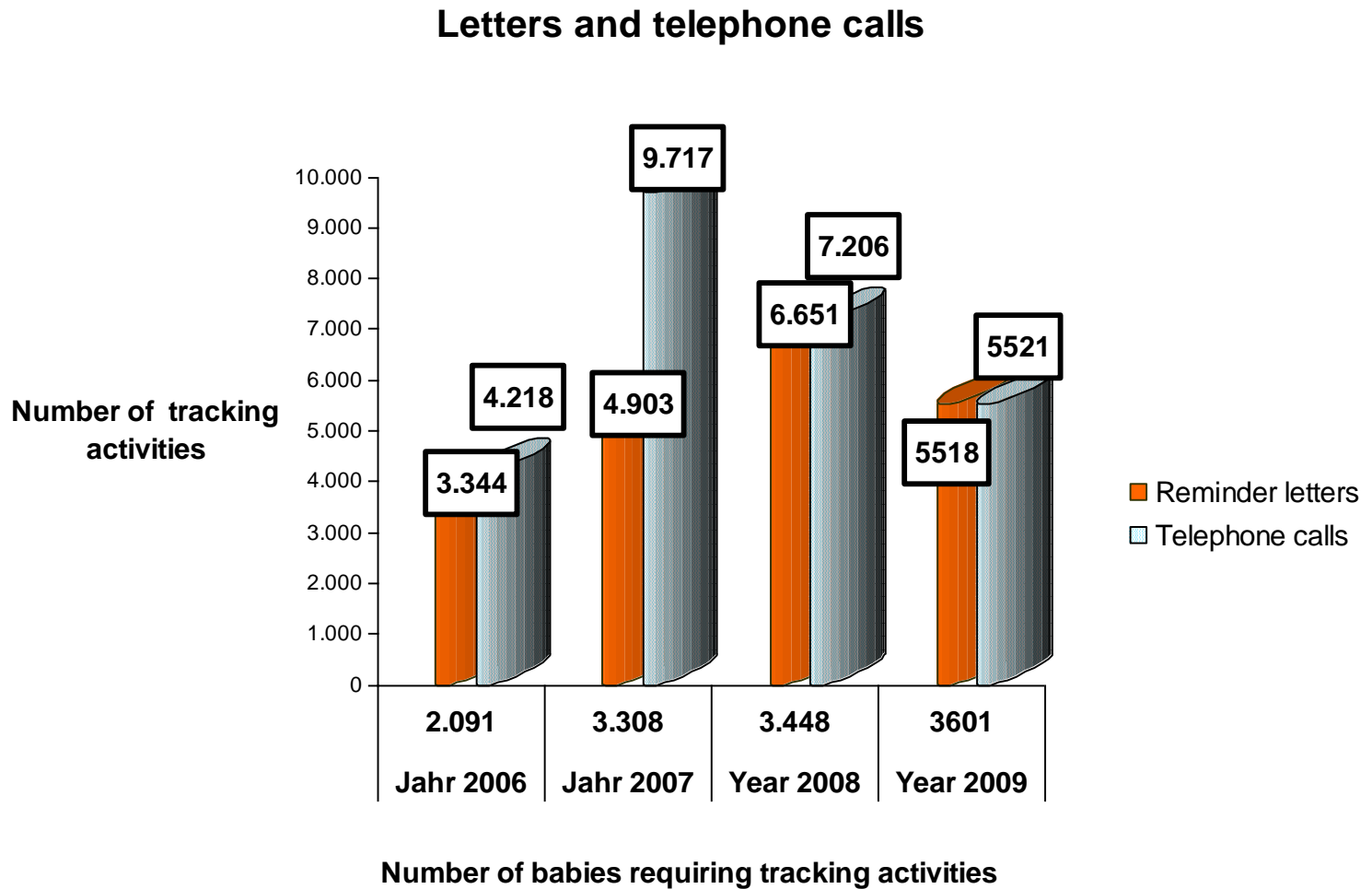
Annual Statistics

# State of Hesse: Tracking Effort

## Children receiving at least one tracking activity



# Tracking Effort for a Follow-up Tracking + a Completeness Tracking (Neumann et al., 2009)



The effort of a tracking largely exceeds that one of a tracking which searches only for babies who have failed the screening.

# Tracking Effort

<b>Babies who needed at least one tracking action in 2008 had 6 days after birth...</b>	Frequency	Percentage
...been screened without result (e.g. screening abort )	108	3.1
...been transferred to another ward	64	1.9
...failed the screening	1367	<b>39.6</b>
not yet been enrolled or only information received (e.g. long-term NICU)	833	24.2
...passed the screening (e.g.incomplete information)	806	23.4
...completed follow-up elsewhere	1	<0.1
...not received a screening (e.g. out-patient birth)	253	7.3
...screening declined	12	0.3
...been lost to follow-up	1	<0.1
...become a finished case (e.g. baby died)	3	0.1
<b>Total</b>	<b>3448</b>	<b>100</b>



## Quality Influencing Factors: Example „Qualification of Examiner“

Examiner	Number of trials	Number REFERS	REFERS %	Screening abortions	% abortions	Calibration errors	% calibration errors	% useless trials
An Qu	151	10	6,6	87	57,6	3	2,0	66,2
Ko Ap	60	18	30,0	14	23,3	0	0,0	53,3
St Bu	53	14	26,4	9	17,0	4	7,6	50,9
Bä Mi	47	2	4,3	12	25,5	8	17,0	46,8
Ch Se	43	3	7,0	22	51,2	0	0,0	58,1
Be Ko	34	11	32,4	1	2,9	0	0,0	35,2
He Bu	31	1	3,2	12	38,7	2	6,5	48,3
Sa Sc	29	11	37,9	3	10,3	3	10,3	58,6
Gu Sc	28	13	46,4	6	21,4	4	14,3	82,1
Ut Ge	26	2	7,7	10	38,5	1	3,9	50,0
El Bu	16	0	0,0	4	25,0	0	0,0	25,0
Pe Sc	14	8	57,1	0	0,0	1	7,1	64,2

## Conclusion

A UNHS protocol which is implemented should consider from the first beginning on the requirements of evidence-based medicine and quality assurance.

A completeness tracking and a tracking of the children who have not passed the screening is necessary and must be organized and financed by the overhead structures.

An ongoing education of the screening staff must be guaranteed. Pedaudiological services which deal adequately with treatment and reghabilitation of very young children must be established.

## Devices

### **...must be affordable**

Senti (Path medical): ~1200 € preschool/school screening (adaptive pure tone audiometry, OAE, AABR; from age 4 on)

### **for Newborn Hearing Screening: affordable TEOAE device (~1000 €) planned, given that enough devices are sold**

developer: GNOtometrics+Path medical+University of Frankfurt, Germany

### **...must face battery/power supply problems**

→solar charger

### **...must face humidity problems**

**...must be accessible?** OAE via mobile phones (mostly distributed technical device in the world)?

**...local evidence required that the equipment is functioning correctly**

# Thank you for your attention!



WHO informal consultation on neonatal and infant hearing screening.  
WHO Headquarters, Geneva, Switzerland, 09-10 November, 2009