

Use of the paediatric bronchoscope, flexible and rigid, in 51 European centres

A. Barbato*, M. Magarotto*, M. Crivellaro*, A. Novello Jr*, A. Cracco*,
J. de Blic**, P. Scheinmann**, J.O. Warner+, M. Zach#

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ABSTRACT: We have undertaken a survey to establish current practices and differences in the use of bronchoscopes in children in European centres.

A questionnaire was sent to all 220 members of the Paediatric Assembly of the European Respiratory Society (ERS). The questions concerned the following points: indications for bronchoscopy; site of bronchoscopy; type of sedation; any oxygen supplementation during the procedure; number of procedures performed in the previous 12 months; number of procedures performed in the neonatal intensive care unit; number of bronchoalveolar lavages (BALs); side-effects during and after the procedures; and diagnostic yield.

Fifty one European centres (40.8% of the European centres contacted) took part in the study. A total of 7,446 bronchoscopies had been performed in the last 12 months: 4,587 using the flexible bronchoscope and 2,859 using the rigid bronchoscope. At centres using only the fiberoptic bronchoscope, the most frequent indication was "recurrent/persistent pneumonia" (17%); at centres using only the rigid bronchoscope, it was "foreign body inhalation" (36.7%); at centres using both methods, the most frequent indication was "other indications" (23.9%).

In 12 months, 2,231 BALs were performed: 1,419 in immunocompetent children and 812 in immunocompromised patients. In centres using only the fiberoptic bronchoscope, the highest yield was for "stridor" (81%); in centres using only the rigid bronchoscope, the highest yield was for "persistent atelectasis" (68%); and in centres using both instruments, it was for "foreign body inhalation" (93%).

The results of the study suggest that bronchoscopy in children is now a well-established procedure at several European centres, while others are just beginning to use this technique.

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In the past, bronchial endoscopy called for the use of the rigid bronchoscope and was consequently used very infrequently in children [1]. The advent of thin and ultra-thin fiberoptic bronchoscopes has considerably extended the use of this procedure [2], even in the neonatal field [3].

Since there is no European survey of the highly specialized paediatric pneumology centres where rigid and flexible bronchoscopes are routinely used in children, the Paediatric Bronchology Group of the European Respiratory Society (ERS) prepared a questionnaire and sent it to all member paediatricians with a view to gaining a picture of the situation in Europe and obtaining information on the most common indications for paediatric bronchoscopy, the number of procedures performed each year, where such procedures are carried out, what type of sedation is used and what results are obtained.

Materials and methods

The questionnaire was sent in March 1995 to all 220 members of the Paediatric Assembly listed on the ERS Roster of July 1993, using the Scientific Group Code 07.01, .02, .03, .04, .05, .06 and .07. There were 172

*Dept of Pediatrics, University of Padova, Italy. **Service d'Allergologie et Pneumologie Infantiles-Hôpital Necker-Enfants Malades, Paris, France. +Dept of Child Health, Southampton General Hospital, Southampton, UK. #Klinische Abteilung für Pulmonologie/Allergologie, University Kinderklinik, Graz, Austria.

Correspondence: A. Barbato
Via Giustiniani 3
35128 Padova
Italy

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paediatricians from 125 European centres, and 48 from 43 centres outside Europe. The questions concerned the following points: the most common indications for bronchoscopies performed in the previous 12 months; the site where the rigid or flexible bronchoscopy was performed (specially-equipped room, operating theatre, intensive care unit); the type of sedation used with the rigid or flexible bronchoscope; any oxygen supplementation during the procedure; the number of procedures performed in the previous 12 months; the number of procedures performed at the neonatal intensive care unit (NICU) in the previous 12 months; the number of bronchoalveolar lavage (BAL) procedures performed in the previous 12 months, both in immunocompetent and immunodepressed children; side-effects during and after the procedure using the rigid and flexible bronchoscope; and diagnostic yield.

Statistical analysis

The data are presented in numerical form and where a reply in the form of a percentage was expected, the results are presented as median and mean percentage values and SD or range.

Results

Of the 168 centres contacted, 67 answered and returned the questionnaires (*i.e.* 39.8% of all the centres contacted); nine of these were left out of the statistical analysis because they came from centres outside Europe and another seven because they replied that they did not have the necessary facilities for performing endoscopy. The 51 European centres that were included in the study (40.8% of the 125 European centres contacted) are listed in the appendix.

When the answers from a given centre were incomplete, the centre was contacted again by fax or telephone and asked to provide the missing information. This was the case in 10% of centres.

From the analysis of the 51 European centres, it was found that 7,446 bronchoscopies were performed on children in Europe during the 12 months prior to filling in the questionnaire; 4,587 of these were performed using a flexible bronchoscope and 2,859 using a rigid instrument. Five centres used only the rigid bronchoscope, while 17 centres used only the flexible instrument, and 29 centres used both types of instrument.

Table 1 lists the median and mean percentage values and range of the most frequent indications for bronchoscopy in children. The most frequent indications varied from one centre to another, according to whether they used the flexible or rigid bronchoscope, or both. For the centres using only the flexible instrument, the most frequent indications were "recurrent/persistent pneumonia" (17%), "wheezing that does not respond to appropriate therapy" (15.5%), and "persistent atelectasis" (14.3%). At the centres using only the rigid bronchoscope, the most common indications were "foreign body inhalation" (36.7%) and "stridor" (21.6%). The most frequent indications at the centres using both instruments were "other indications" (23.9%) and "foreign body inhalation" (17.9%).

The least frequently mentioned indications were "haemoptysis" at the centres using flexible bronchoscopy (2.6%) or both methods (2.7%), and "pulmonary tuberculosis" at the centres using only the rigid bronchoscope (6.0%). Some details are missing in the area of the table concerning centres using the rigid bronchoscope alone, because either only one or no centres answered, making it impossible to analyse the percentages concerned.

Table 1. – Indications for bronchoscopy in centres using fibreoptic bronchoscope (FB), rigid bronchoscope (RB), or both (FB + RB)

Indications	FB			RB			FB + RB		
	Median	Mean	Range	Median	Mean	Range	Median	Mean	Range
Recurrent/persistent pneumonia	16	17.0	3–45	15	17.5	10–30	15	15.7	1–50
Persistent atelectasis	14	14.3	3–30	10	12.2	4–25	14	11.9	2–25
Wheezing that does not respond	11	15.5	5–46	5	6.3	4–10	6	9.1	2–20
Stridor	10	13.3	1–35	25	21.6	10–30	10	14.0	3–40
Other indications	9	13.7	2–52	nc	nc	nc	13	23.9	2–90
Chronic cough	7	7.9	2–26	nc	nc	nc	10	10.2	2–23
Interstitial pneumonia	5	6.4	2–17	nc	nc	nc	5	6.5	1–20
Pulmonary tuberculosis	5	6.2	1–13	6	6.0	2–10	5	4.5	1–10
Suspected lung malformation	5	8.1	2–20	10	10.6	2–20	5	8.6	1–40
Foreign body inhalation	4	4.9	1–10	25	36.7	17–80	10	17.9	2–70
Haemoptysis	2	2.6	1–5	nc	nc	nc	2	2.6	1–10

All values are expressed as the percentage of centres performing each procedure in response to a given indication. nc: impossible to calculate the median and mean percentage.

Site of bronchoscopy

The rigid bronchoscopy took place in the operating room in 23 centres, in the intensive care unit (ICU) in seven centres and in an equipped room in 15 centres. Fibreoptic bronchoscopy was performed in the operating room at 19 centres, in the ICU at 22 centres, and in equipped rooms at 30 centres. In some cases, the site varied according to the circumstances.

Sedation

Rigid bronchoscopy was performed under general anaesthesia in 31 centres, and under local anaesthesia and sedation with midazolam *i.v.* in two centres; one centre used local anaesthesia and propofol *i.v.* The questionnaire did not establish what type of drug was used to induce general anaesthesia. Sedation was provided for fibreoptic bronchoscopy, using the anaesthetics indicated in table 2. Local anaesthesia was provided by lidocaine 2% in the upper airways and 0.5% in the lower airways, and atropine 0.01 mg·kg⁻¹ body weight *i.v.* or *s.c.*

Oxygen consumption

Oxygen was routinely used during rigid bronchoscopy at 27 centres, and prescribed as needed in seven centres. During fibreoptic bronchoscopy, the use of oxygen was routine in 18 centres and as needed in 28 centres.

Table 2. – Sedation during fibreoptic bronchoscopy

	Centres	n
Midazolam <i>i.v.</i>	23	
Meperidine <i>i.v.</i>	7	
Diazepam <i>i.v.</i>	3	
Droperidol <i>per os</i>	3	
Propofol <i>i.v.</i>	3	
Fentanyl <i>i.v.</i>	2	
Ketamine <i>i.v.</i>	2	
Diazepam <i>per os</i>	1	
Diazepam rectal	1	
Diazepam <i>i.v.</i> rectal	1	
Thiopentone <i>i.v.</i>	1	
Propofol + Fentanyl <i>i.v.</i>	1	
Midazolam rectal	1	
Others	1	

Number of procedures

The number of procedures performed at the various centres, using the rigid or flexible bronchoscopes, is given in table 3. There were two centres where more than 500 bronchoscopies were performed in a year, seven centres performed 200–500 bronchoscopies in a year, 15 performed 100–200, 14 performed 50–100 and 13 performed 8–50. Of the 7,446 bronchoscopies performed at the centres taking part in the study, 631 were performed in the NICU.

Table 3. – Bronchoscopic procedures performed at 51 centres

Centre No.*	Type of broncho.	Procedures performed n				Total
		NICU	Children	RB	FB	
1	RB + FB	67	1363	1144	286	1430
2	FB	60	652	0	712	712
3	RB + FB	20	412	302	130	432
4	RB + FB	20	360	19	361	380
5	RB + FB	80	240	16	304	320
6	RB + FB	10	300	279	31	310
7	RB + FB	22	241	5	258	263
8	FB	4	253	0	257	257
9	RB + FB	0	246	22	224	246
10	RB + FB	10	170	54	126	180
11	FB	0	170	0	170	170
12	RB + FB	10	139	7	142	149
13	FB	10	130	0	140	140
14	FB	10	130	0	140	140
15	RB + FB	25	100	112	13	125
16	RB + FB	0	120	24	96	120
17	RB + FB	45	72	94	23	117
18	FB	5	111	0	116	116
19	RB + FB	2	110	101	11	112
20	RB + FB	6	101	48	59	107
21	FB	0	106	0	106	106
22	RB	20	80	100	0	100
23	RB + FB	10	90	70	30	100
24	FB	10	90	0	100	100
25	RB + FB	12	73	2	83	85
26	RB + FB	10	65	67	8	75
27	FB	0	74	0	74	74
28	FB	65	6	0	71	71
29	RB + FB	6	65	21	50	71
30	FB	2	67	0	69	69
31	RB + FB	15	50	59	6	65
32	RB + FB	0	60	3	57	60
33	RB + FB	10	50	54	6	60
34	RB + FB	0	60	6	54	60
35	FB	5	50	0	55	55
36	RB	0	53	53	0	53
37	RB + FB	6	45	5	46	51
38	RB + FB	25	25	45	5	50
39	FB	0	43	0	43	43
40	RB + FB	10	30	20	20	40
41	RB + FB	0	37	37	0	37
42	RB	4	30	34	0	34
43	RB + FB	0	32	3	29	32
44	FB	2	28	0	30	30
45	FB	0	24	0	24	24
46	RB	0	20	20	0	20
47	RB + FB	3	10	12	1	13
48	RB	0	12	12	0	12
49	FB	0	12	0	12	12
50	RB + FB	10	0	9	1	10
51	FB	0	8	0	8	8
Total		631	6815	2859	4587	7446

*: The numbers correspond to the centres listed in the appendix. RB: rigid bronchoscope; FB: fiberoptic bronchoscope; NICU: neonatal intensive care unit; broncho.: bronchoscope.

BAL

In 12 months, a total of 2,231 BAL procedures were performed, 1,419 in immunocompetent children and 812 in immunodepressed children. Only three centres were found to have performed more than 100 BAL procedures in immunocompetent children, and two had performed more than 100 in immunodepressed children (fig. 1).

Side-effects

Table 4 indicates the side-effects reported during and after the use of the rigid bronchoscope and the fiberoptic bronchoscope. Only one centre reported bleeding in more than 10% of cases during rigid bronchoscopy. After the procedure, on the other hand, seven centres reported cough and one centre mentioned fever developing in more than 10% of cases.

As for the flexible instrument, two centres reported bronchospasm during the procedure in over 10% of cases, one of these centres also reported reactions to drugs and the other also reported laryngospasm in over 10% of cases. The number of fiberoptic bronchoscopies performed at these centres was less than 100 per year.

On the other hand, over 50% of centres reported occasional side-effects (in fewer than 5% of cases) after fiberoptic bronchoscopy (bleeding, bronchospasm, laryngospasm, reactions to medication). Only three centres reported fever in more than 10% of children after fiberoptic bronchoscopy, and another two described cough in over 10% of cases. The incidence of occasional side-effects after fiberoptic bronchoscopy was evenly distributed between centres performing more or fewer than 100 fiberoptic bronchoscopies per year.

Diagnostic yield

The diagnostic yield for bronchoscopy is given in percentage form in table 5. A distinction was made between the yields according to whether the centres used the flexible or the rigid instrument, or both. This question was answered by 25 centres, accounting for a total of 1,900 flexible bronchoscopies (at 12 centres), 380 rigid bronchoscopies (at three centres) and 1,117 bronchoscopies, either flexible or rigid, at the 10 centres using both methods.

The percentages were not calculated if only one centre provided an answer.

In the centres using only fiberoptic bronchoscopy, the highest yield was for "stridor" (81%) and "pulmonary tuberculosis" (68%). At the centres using only rigid bronchoscopy, the highest yield was for "persistent atelectasis" (68%) and in equal measure (67%) for "stridor" and "foreign body inhalation". In the centres using both instruments, the highest yield was for "foreign body inhalation" (93%) and "stridor" (91%). The lowest yield was for "foreign body inhalation" and for "other indications" (45%) at the centres using flexible bronchoscopy, for "wheezing that does not respond to appropriate therapy" (27%) at the centres using the rigid bronchoscope, and for "chronic cough" (47%) in centres using both methods.

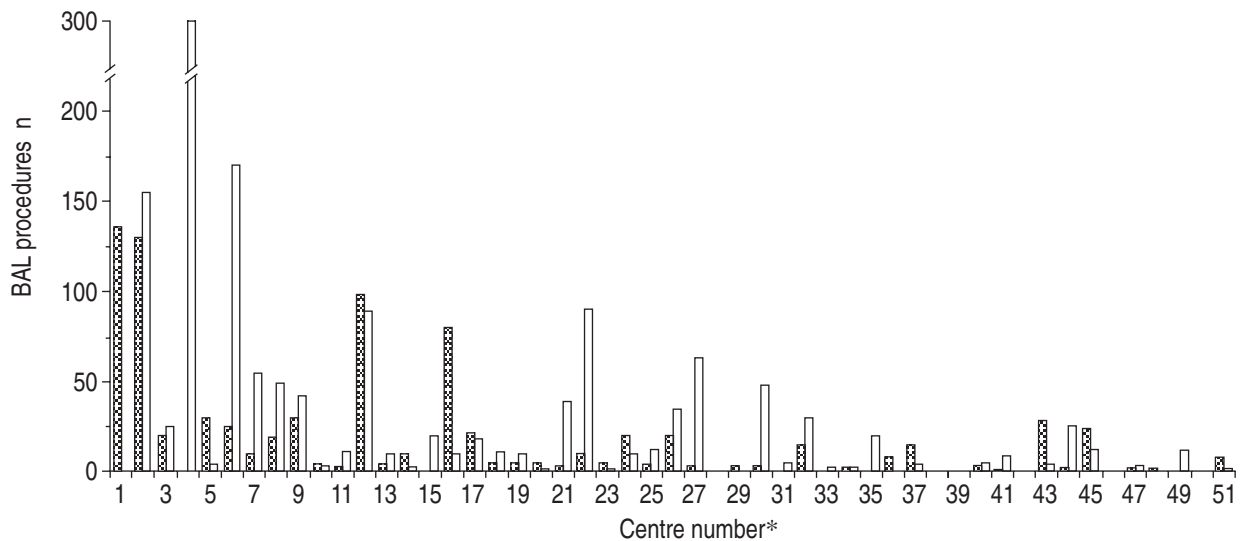


Fig. 1. – Number of bronchoalveolar lavage (BAL) procedures performed in each centre in immunocompetent (□) and immunocompromised (▨) children. *: the numbers correspond to the centres listed in the appendix.

Table 4. – Side effects during and after rigid bronchoscopy and fiberoptic bronchoscopy

	Centres reporting side-effects n					
	Rigid bronchoscopy			Fiberoptic bronchoscopy		
	<5% of cases	5–10% of cases	>10% of cases	<5% of cases	5–10% of cases	>10% of cases
During bronchoscopy						
Bleeding	25	1	1	33	2	-
Bronchospasm	25	3	-	34	2	2
Laryngospasm	22	4	-	35	-	1
Reactions to drugs	27	-	-	32	2	1
Others	20	1	-	21	1	-
After bronchoscopy						
Bronchospasm	25	2	-	34	2	-
Cough	7	14	7	16	19	2
Fever	22	4	1	30	5	3
Laryngospasm	21	6	-	33	1	-
Others	18	1	-	23	1	-

Table 5. – Diagnostic yield from bronchoscopic procedures, based on indications for bronchoscopy in centres using fiberoptic bronchoscope (FB), rigid bronchoscope (RB) or both

Indications	FB				RB				FB + RB			
	n	Median %	Mean %	SD	n	Median %	Mean %	SD	n	Median %	Mean %	SD
Stridor	191	100	81	36	191	90	67	49	227	100	91	21
Suspected lung malformation	91	60	64	32	15	80	63	47	75	80	73	25
Persistent atelectasis	224	71	66	26	29	80	68	39	141	72	69	30
Pulmonary tuberculosis	144	82	68	35	11	nc	nc	nc	45	100	87	24
Recurrent/persistent pneumonia	363	67	61	27	38	88	66	40	170	60	62	23
Interstitial pneumonia	172	60	55	36	6	nc	nc	nc	94	80	75	25
Foreign body inhalation	112	43	45	31	39	75	67	38	115	100	93	10
Other indications	91	45	45	31	0	-	-	-	27	nc	nc	nc
Haemoptysis	49	68	66	35	2	nc	nc	nc	25	90	70	40
Wheezing that does not respond to appropriate therapy	335	52	53	32	13	20	27	21	108	80	72	28
Chronic cough	128	50	49	25	0	-	-	-	90	50	47	25
Total	1900				380				1117			

nc: impossible to calculate the median percentage, mean percentage and SD.

Discussion

The questionnaire, which was forwarded to the 125 European paediatric centres where ERS-registered paediatric pulmonary specialists operate, was completed by 51 centres (40.8%).

At these 51 European centres, the flexible instruments appeared to be the most frequently used: only five centres used rigid instruments alone to perform bronchoscopy in children, whereas flexible instruments were routinely used at 46 centres, either alone (17 centres) or as an alternative to the rigid bronchoscope (29 centres). The most commonly used instrument was the flexible paediatric bronchoscope with a 3.5–3.6 mm outer diameter.

The indications for using the bronchoscope in children were fairly similar at the various centres and were consistent with the medical literature [4, 5].

The best diagnostic yields differed, according to whether the centres used the rigid or the flexible bronchoscope, or both. The diagnostic yield emerging from the questionnaire differed from reports in the literature, probably because it was calculated on the basis of results coming from such a large number of centres [6]. A successful diagnosis can also be reached for the indications reported here using other methods that are less invasive, less expensive and safer than bronchoscopy. However, diagnosis is only one aspect of bronchoscopy, which is used not only to view the lesion, but also to attempt its treatment using techniques such as bronchial or bronchoalveolar lavage, broncho-aspiration and biopsy, that would otherwise be impossible and that have sometimes had remarkably positive effects on the patient's lung pathology.

The most common site for the procedure was the equipped room when flexible instruments were used, whereas for rigid bronchoscopy the most common site was the operating theatre. This is consistent with the type of sedation used, *i.e.* general anaesthesia during the use of rigid instruments, and sedation and local anaesthesia when using flexible instruments [7]. The consumption of oxygen also depended on the method used, proving more frequent for rigid than for flexible bronchoscopy [8, 9].

Midazolam was by far the most frequently used sedative [10, 11], either alone or in association. It was used at 23 centres, followed by meperidine [12, 13], which was used at seven centres. In some European countries midazolam is still not commercially available.

The bronchoscope is also often used at the NICU [14, 15]. In fact, a considerable number of the bronchoscopies performed in a year were carried out at the NICU, although only five centres performed 40–80 bronchoscopies per year in the newborn.

BAL is gaining ground as a diagnostic technique and a considerable number of these procedures were performed both in immunocompetent and in immunodepressed patients. It is reportedly used more in immunodepressed patients, proving essential for a more accurate aetiological definition in cases of interstitial pneumonia or acute pneumopathy [16, 17]. In immunocompetent patients, BAL was used for acute and chronic pneumopathies [18, 19]. Clearly, improvements in technique are expanding the use of this method, though our questionnaire revealed that only 12 Centres perform over 50 BALs per year.

Among the side-effects [5, 20], fever and bronchospasm are the most frequent, after fibreoptic bronchoscopy, in our survey. BAL also produces fever [18, 21], but there was no correlation between the incidence of this side-effect and the frequency with which BAL was performed at the various centres. The analysis of side-effects demonstrates that rigid or flexible bronchoscopy is, on the whole, a safe procedure, but calls for the use of highly trained staff and must be performed in a hospital environment (not in a physician's office) because of the likelihood, however slight, of side-effects that carry a certain risk in paediatric cases.

In conclusion, this study cannot be seen as a complete survey of European centres that perform bronchoscopies, as we were no doubt unable to reach some centres that perform bronchoscopies where there are no members of our Assembly, and also because most people did not reply. In fact, if we compare the centres that answered our questionnaire with the ones listed by the Long Range Planning Committee of the Paediatric Assembly [22], we can see that 23 of the 34 centres declaring that they are able to offer a full programme of training in paediatric respiratory medicine or allergology actually answered our questionnaire. On the other hand, our questionnaire was answered by only six of the 27 centres reporting that they had special expertise in some, but not all, aspects of paediatric respiratory medicine or allergology. Such inconsistencies may be explained by the fact that most people merely did not reply, or that some centres are actually unable to perform bronchoscopy in children.

This questionnaire-based epidemiological study on the topographical distribution of highly specialized paediatric pneumology centres in Europe has led to a better understanding of the approximate number of bronchoscopies performed per year at each centre and to an evaluation of the risks involved in using this technique and of the results obtained. This sort of study should be repeated every 4–5 yrs to establish what progress has been made and whether the use of advanced diagnostic and therapeutic methods has become more widespread in Europe.

Appendix: European centres performing bronchoscopies in children

Austria

- 13. Graz, University Kinderklinik
- 40. Salzburg, Kinderspital
- 25. Vienna, University Kinderklinik
- 22. Vienna, Donauspital Kinderinterne

Belgium

- 4. Brussels, Academisch Ziekenhuis VUB
- 18. Gasthuisberg, Leuven-University Hospital
- 34. Yvoir, UCL-Mont Godinne

Czech Republic

- 11. Praha, Pediatric Pulmonology, University Hospital, Motol
- 1. Praha, ENT, Clinic for Children

Denmark

- 45. Copenhagen, National University Hospital

France

5. Lille, Hôpital Calmette
8. Lyon, Centre Hospital, Lyon Sud
9. Nancy, Hôpital d'enfants
2. Paris, Hôpital des Enfants Malades
21. Paris, Hôpital St Vincent de Paul

Germany

35. Aachen, University Kinderklinik
19. Berlin, University Kinderklinik
28. Berlin, University Klinikum Charité
10. Bochum, St. Josef Hospital
15. Dresden, University Carl Gustav Carus
41. Essen, Ruhrlandklinik Zentrum
31. Giessen, University Kinderklinik
6. Frankfurt, University Zentrum der Kinderheilkunde
3. Munchen, University Kinderklinik

Greece

39. Thessalonika, Dept of Paediatrics University

Italy

26. Genova, Istituto Gaslini
51. Milano, Ospedale Luigi Sacco, Clinica Pediatrica, University
12. Padova, Dipartimento Pediatria, University
44. Perugia, Clinica Pediatrica, University
37. Torino, OIRM, St Anna

Yugoslavia

7. Novi-Beograd, Mother and Child Health Institute

Netherlands

23. Groningen, Beatrix Children's Hospital
32. Rotterdam, Sophia Children's Hospital
36. Utrecht, Wilhelmina Children's Hospital
33. Zwolle, Ziekenhuis de Weezenlanden

Poland

42. Warsaw, Centrum Zdrowia Dzecka

Portugal

14. Lisboa, Hospital de Santa Maria

Slovak Republic

17. Banka, Bistrika, ENT Dept
20. Bratislava, University Comenius Hospital

Slovenia

27. Ljubljana, University Klinicni Center

Spain

24. Malaga, Hospital Materno Infantil
48. S. Sebastian, Hospital Materno Infantil

Sweden

38. Göteborg, Children's Hospital
47. Linköping, ENT Dept, University

Switzerland

29. Basle, University Kinderklinik
49. Davos, Alpine Children's Hospital
46. St Gallen, Ostschweizerisches Kinderspital

United Kingdom

16. Birmingham, Children's Hospital
43. London, Great Ormond Street Hospital, Cardiothoracic Unit
50. London, Great Ormond Street Hospital, ENT Dept
30. Southampton, University, Child Health

The centres are numbered in the order in which replies were received. The numbers correspond to those used in figure 1 and table 3.

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