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NATIONAL SURVEY ON CAUSES AND CIRCUMSTANCES OF INFANT AND CHILD DEATHS

(E. C. C. D.)

FINAL REPORT

(translated from the french original draft report)
(not to be quoted or cited without permission)

RABAT

31 AUGUST 1989

ABSTRACT

The National Survey on Causes and Circumstances of Infant and Child deaths (ECCD) was conducted in Morocco 1988-1989. This survey was based on a representative sample of 382 deaths from children under 5 years of age. These deaths were registered between the third and the fifth round of the National Multi-Round Demographic Survey which occurs every 6 months. They are representative of a whole year of infant and child mortality in the country.

Causes and circumstances of deaths were assessed using the verbal autopsy technique. A questionnaire was specially designed for this survey and it was tested before hand on a sample of 17 deaths. An in-depth validation study was also conducted prior to the survey by comparing the causes of 64 deaths assessed by verbal autopsy to the causes of these deaths registered at the hospital. In 95% of cases both diagnoses were identical.

The field interviews were conducted by female nurses especially trained for this survey. Those who completed the questionnaire poorly or incompletely were re-interviewed by the national supervisor. All questionnaires were read and analyzed by at least two independent physicians. The coding of the causes was standardized.

The analysis showed that for neonatal deaths (less than 28 days) main causes of deaths were: tetanus (21%), birth injury (20%), prematurity (20%) low birth weight (8%) and pneumonia (9%). Malformations accounted for only 3%. 12% of neonates were twins. Prematurity and low birth weight were conditions present in 44% of deaths.

In other deaths below age 5, causes were more diverse: diarrhea accounted for 31%, dysentery for 5%, typhoid for 3%, pneumonia for 12%, laryngitis for 2%, meningitis for 6%, measles for 2%, pertussis for 1%, tuberculosis for 3% and hepatitis for 2%. Rarer causes included: anemia, epilepsy, flu, acute abdomen and acute nephritis. Also present in the sample were congenital defects (4%) and accidents (3%). Malnutrition was present in almost a third of the deaths, diarrhea in 39% of cases and pneumonia in 16%. Among the severely malnourished there was a high percentage of kwashiorkor (80%).

The study of the circumstances of the deaths revealed the weaknesses of the health system: low frequency of referral to modern medicine, insufficient care taken during pregnancy and delivery, insufficient care of the new-born, lack of infrastructure to effectively treat diarrhea and malnutrition, inappropriate usage of drugs. In addition several cases of therapeutic errors were found.

The study made various recommendations to reduce mortality of children below age 5. It also proposed to set-up a surveillance system of causes of death at the national level.

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CHAPTER 1 : INTRODUCTION

1.1 MORTALITY OF CHILDREN

Level of mortality

The level of mortality of children is relatively well known in Morocco: sources are the various demographic surveys, in particular the National Survey of Family Planning and Fertility (WFS, 1979) and the National Survey on Health and Population (DHS, 1987) [1,2,3,4]. The level of mortality has decreased dramatically over the last 20 years, as shown in the following table:

Table 1.1 : Probabilities of death (per 1000) by age and period

age at death	1962-66	1967-71	1972-77	1977-81	1982-86	% decline
0 - 27 days	58.1	47.4	48.8	48.8	41.1	-29%
28 d - 11 months	60.1	55.3	55.6	43.6	32.2	-46%
1 - 4 years	96.2	79.4	68.3	48.0	31.2	-68%
total 0-4 years	203.0	174.0	165.2	136.0	102.0	-50%

Source : DHS report p 79.

Mortality of children below age 5 has been halved in the last 20 years. From age 1 to 4 the decline has been the largest (68%) whereas the neonatal period has had the smallest decline (29 %).

Mortality differentials

Mortality is roughly the same for both males and females except for the neonatal period where it is 12% higher for males. However, mortality is much higher in rural areas (137/1000 between 0 and 5 years in 1977-86) than in urban areas (81/1000). Mortality also strongly varies between geographical areas approximately defined by altitude and latitude. In particular, two areas seem to have a much higher mortality than the others: an area of 13 southern provinces (El Kalaa, Agadir, Guelmin, Figuig, Tan-Tan, Tiznit, Taroudant, Errachidia, Azilal, Ouarzazate, Tata, Marrakech, Essaouira) for which the mean level of infant mortality was estimated to be 115/1000, and an area of 6 northern provinces (Taza, Al Hoceima, Sidi Kacem, Tétouan, Taounate et Chechaouen) for which the mean level of infant mortality was 116/1000. The remaining provinces had an average level of infant mortality one third lower at 75/1000, (table 1.2).

Table 1.2 : Moroccan Provinces according to population (*1000), natality, infant mortality (/1000), the number of death surveyed and the sampling rate (/10.000) (1988 data).

	Province	Population	% urban	nb births	IMR	infant deaths	deaths surveyed	sample rate
S	Agadir	726	48	27101	95	2574	13	50
S	Azilal	416	8	16945	124	2101	15	71
S	El Kalaa	656	16	26286	95	2497	1	4
S	Errachidia	481	17	19247	124	2386	7	29
S	Essaouira	425	13	17147	139	2383	5	20
S	Figuig	110	39	4195	105	440	0	0
S	Guelmim	155	43	5856	198	1159	3	25
S	Marrakech	1455	38	55618	131	7285	22	30
S	Ouarzazate	616	10	25022	128	3202	27	84
S	Tan-Tan	55	89	1861	106	197	0	0
S	Taroudannt	632	11	25591	112	2866	3	10
S	Tata	108	3	4447	130	578	4	69
S	Tiznit	362	14	14584	110	1604	3	18
N	Al Hoceima	355	23	14010	105	1471	18	122
N	Chefchaouen	350	9	14241	141	2007	10	49
N	Sidi Kacem	580	26	22745	109	2479	13	52
N	Taounate	589	5	24168	122	2948	7	23
N	Taza	690	19	27482	97	2665	12	45
N	Tétouan	818	54	30102	121	3642	12	32
	Beni Mellal	842	42	31890	75	2391	6	25
	Ben Slimane	197	21	7805	64	499	0	0
	Boujdor	9	55	330	100	33	0	0
	Boulemane	148	12	5978	113	675	2	29
	Casablanca	2805	94	93565	61	5707	7	12
	El Jadida	882	21	34994	60	2099	9	42
	Essemara	23	91	773	100	77	0	0
	Fes	960	67	34275	91	3119	3	9
	Ifrane	113	46	4233	112	474	2	42
	Kenitra	855	43	32248	81	2612	11	42
	Khemisset	456	34	17573	76	1335	6	44
	Khenifra	419	41	15909	104	1654	3	18
	Khouribga	513	61	18597	66	1227	7	57
	Laayoune	132	86	4497	100	449	2	44
	Mekres	718	61	25978	86	2234	4	17
	Mohamedia	195	66	6983	68	474	0	0
	Nador	726	23	28675	60	1720	6	34
	Oued Eddahab	24	87	815	100	81	0	0
	Oujda	916	65	32862	66	2168	3	13
	Rabat	625	100	20562	50	1028	8	77
	Sale	544	77	18955	79	1497	0	0
	Skhirat/Tamara	176	40	6684	74	494	0	0
	Safi	809	42	30623	82	2511	6	23
	Settat	769	23	30382	64	1944	11	56
	Tanger	523	71	18488	86	1589	4	25
13	south prov.	6197	24	243900	120	29272	103	35
6	north prov.	3382	26	132748	114	15212	72	47
25	other prov.	14379	59	523674	72	38091	100	26
	total	23958	45	900322	91	82575	275	33

Although mortality has reached a moderate level, it is still much higher than that of European countries and also higher than the level in some countries with a lower income per capita such as China, Sri-Lanka, and the state of Kerala in India. This suggests that many public health problems still remain unresolved in the country.

1.2 KNOWLEDGE ON CAUSES OF DEATHS

Current knowledge on causes of deaths in Morocco remains very sketchy. There is no official publication on detailed causes of death at the national level. The coverage of deaths by vital registration is acceptable only in cities; furthermore most vital registration forms that reach the ministry are not analyzed. The only statistical table that is available at the level of the ministry of health dealing with deaths of children under age 5 refers to a sample from urban areas in 1985 that appears in tho National Plan of Orientation for Economic and Social Development:

Table 1.3 : Distribution of causes of deaths among children less than 5 years in urban areas, 1985 sample.

rank	group of causes of death	N	%
1	causes of morbidity and premature deaths	297	32.4
2	ill defined symptoms and morbid states	219	23.9
3	infectious and parasitic diseases	196	21.4
4	diseases of the respiratory system	55	6.0
5	accidents and trauma	38	4.1
6	diseases of the circulatory system	31	3.4
7	diseases of the nervous system and sense organs	25	3.7
8	diseases of nutrition and metabolism	16	1.7
9	congenital abnormalities	14	1.5
10	diseases of the digestive system	8	0.1
11	tumors	7	0.8
12	mental disorders	6	0.6
13	diseases of the urinary system	3	0.3
14	diseases of blood and related organs	2	0.2
15	diseases of the skin and subcutaneous tissues	1	0.1
16	complications of pregnancy and delivery	0	0.0
17	diseases of osteitic system and conjunctival tissues	0	0.0
	all	918	100.0

Source : National Plan of Orientation for Economic and Social Development, 1988-92.

The only real practical source of information comes from hospital registers and from the doctoral dissertations of medical students. However deaths occurring in hospitals are a biased sample of all deaths. It will be shown later that in this national sample only 10% of all deaths under age 5 occurred in hospitals and therefore these cannot be considered representative of the national problems.

Furthermore, hospital registers are not kept for statistical analysis and often only the final condition appears in the file which again strongly biases the analysis of causes of death. For instance, while the questionnaire was being

tested, the death of a malnourished child was well described by the mother but there was no mention of the poor nutritional status of the child in the hospital file; it was only after a detailed analysis of all documents relating to this child that was discovered that this one year old child weighed 4 kg (about 8 pounds).

Diseases requiring notification

Another source of information comes from diseases requiring notification. This information represents only morbidity; however it gives a clue as to which diseases may play roles in mortality of children. In addition, knowledge of trends in diseases requiring notification facilitates the interpretation of some data on mortality. Following are some of the available data:

Table 1.4 : Notification of certain infectious diseases, by year (incidence)

infectious diseases	1981	1982	1983	1984	1985	1986	1987	1988
tuberculosis	28637	28095	26944	22279	26790	27553		
measles	109486	63180	80806	11484	4216	15333		
typhoid	13292	17735	16849	15770	12322	11190		
schistosomiasis	9626	6582	10645	6338	5165			
hepatitis	3389	4646	5264	5676	5158	3492		
pertussis	7359	12330	9142	5101	1772	1163		
malaria	98	62	75	318	713	597		
meningitis (CS)	715	677	943	886	616	324		
tetanus	100	161	162	171	171	181		
poliomyelitis	58	67	49	22	15	12		
diphtheria	39	48	33	20	11	7		

Source : National Plan of Orientation for Economic and Social Development, 1988-92.

1.3 THE VERBAL AUTOPSY TECHNIQUE

The verbal autopsy technique is old, but it has recently been used in a systematic way in certain research projects on public health in developing countries, including in Senegal [5,6]. Recently, in March 1989, a seminar was held at Johns Hopkins University in Baltimore, MD (USA), which summarized current knowledge on this technique and recommended its wider usage [7].

The technique gathers from the relatives of a deceased person all possible information that may helping assessing the cause of death. The principal information gathered is based upon the history of the illness and on the signs and symptoms that were present during the course of the illness as well as their sequence. Other information on treatments is also gathered as well as copies of prescriptions and drugs that were taken, which often help the diagnosis or at least reinforce it.

The technique is obviously not precise and one obtains only "probable causes of death". However it works well for a small number of frequent causes. It has only a statistical interest. When applied to a representative sample of deaths

it produces a frequency distribution of major causes of death in a population. Furthermore, associated with information on circumstances of deaths it enables one to pinpoint the weaknesses of the health system.

To be effective it first requires personnel well trained in the interview technique, often a difficult job requiring high levels of accuracy; second it requires that all questionnaires are analyzed independently by at least two physicians and that all debatable cases are discussed in detail; and third it requires that a strict coding system is adopted, as was in this survey.

1.4 HEALTH POLICY

Since independence, The Ministry of Public Health has conducted a policy designed to improve public health throughout the country. This policy has had various orientations during the successive plans of economic and social development. Among the main objectives for the 1981-1985 period was the reduction of infant and child mortality to less than 100/1000 before the end of 1985. The Plan of Orientation for the Economic and Social Development 1988-1992 of the Ministry of Public Health continues giving priority to a similar objective in the framework of Primary Health Care (PHC) and has a new target of 90/1000.

To meet these objectives, various orientations are employed and certain programs are started: according to the report of the commission on "health, nutrition and family planning" set-up for the Plan of Orientation for the Economic and Social Development 1988-1992, objectives are:

1. expanding the sanitary coverage following a new strategy based on detailed modalities adapted to the field conditions. This strategy can be summarized as follow:

-fixed mode, by building a sanitary facility of PHC of a given category, in a place accessible to all people living in a given geographical area;

-mobile mode, by classical itinerant team with a meeting point;

-decreasing the percentage of the unprotected population, ie those located beyond 6 km of a facility (about 4 miles);

-improving the staff level;

2. implementing the maternal and child health programmes which aim at reducing infant mortality. Among these programs are:

-EPI: the Expanded Programme on Vaccination was reinforced in 1987 by the national days of immunization. Its aim is to increase the vaccine coverage among children below age 5 and as a consequence to reduce the incidence of target diseases.

-Diarrheal disease program, following the oral rehydration strategy.

-Programme against protein-energy malnutrition.

-Programme against nutritional deficiencies. This programme primarily targets rickets and anemia and includes the systematic supplementation of children's diets with vitamin D and the supplementation of pregnant women's diet with iron.

-Programme for monitoring pregnancies and deliveries. The objective of

this programme is to improve as quickly and as effectively as possible the availability, the accessibility and the usage of health facilities to reach an acceptable level of infant and child health and to help reduce maternal and perinatal mortality.

These efforts account for an important part of the budget of the state and of foreign aid.

However the statistical importance of the problems targeted by these programs and their impact remain largely unknown. Studying the causes of death among children age 0-4 years, the main target of these programmes, and the circumstances associated with these deaths may be a major contribution to assess the importance of the problems and the impact of the interventions. This is where the ECCD (Enquête nationale sur les Causes et Circonstances des Décès infanto-juvéniles) comes: it is attempting to bridge the gap in knowledge of what are the main causes of deaths among children age 0-4 years as well as the circumstances of these deaths.

CHAPTER 2 : THE E.C.C.D. SURVEY

2.1 SURVEY OBJECTIVES

IMMEDIATE OBJECTIVES

The first objective of the ECCD is to estimate the frequency of major causes of infant and child deaths at the national level. The second objective is to analyze the circumstances of these deaths and in particular to identify the weaknesses of the health system.

As a lesser objective the ECCD's analysis has tried to evaluate how various socioeconomic, demographic and cultural factors could account for the frequency of certain causes.

LONG TERM OBJECTIVES

Long term objectives of ECCD are to elaborate, from the results of this study, a methodology for the continuous registration of data on mortality of young children and to prepare for the implementation of a system of surveillance of causes of deaths and of evaluation of main health programmes.

2.2 INSTITUTIONAL AND FINANCIAL FRAMEWORK

The ECCD was conducted by the agreement for Family Planning and Demographic Activities between the Ministry of Public Health and the CENTERS FOR DISEASE CONTROL (CDC, Atlanta, GA) with the financial help of USAID. The total budget for this survey was 952.450 DH (about 115,000 $) with a contribution of 683.250 DH from USAID and 269.200 DH from the Ministry of Public Health.

The Director of Technical Affairs (Directeur des Affaires Techniques, DAT), Dr Mechbal Abdelhay, was the national director of the survey and was responsible for its management.

Dr BELOUALI Radouane, head of the Working Group for the creation of the National Institute for Research and Training in Public Health and Sanitary Administration (Institut National de Formation et Recherche en Administration Sanitaire et Santé Publique (INFR.AS/SP) was responsible for the design of the questionnaire.

Mr AZELMATE Mustapha, head of the Unit of Surveys and Health Information (Service des Etudes et de l'Information Sanitaire, SEIS) was responsible for field work and computer analysis.

The staff mentioned above were assisted by a survey bureau (bureau de l'enquête): a public health physician (Dr DARKAOUI NADA), an engineer (Mr EL GANDASSI) and a statistician-nurse (cadriste statisticien: Mr ZGUIER).

This team was lead by Dr DARKAOUI NADA who monitored and supervised the field work. She was assisted by a pediatrician, a computer programmer and a secretary. Another pediatrician of the Rabat Children Hospital (hôpital d'enfants de RABAT) was added to the survey bureau at each round (Dr R. BAKKALI et B. BELMEJDOUB).

For the duration of the survey and the analysis, technical assistance has been provided by Mr GARENNE Michel, head of the Research Unit Population and Health (UR Population et Santé) at ORSTOM, the French Institute of Research for Development in Cooperation.

All together about 50 professional and clerical employees have participated in the ECCD survey under the authority of the National Director (see annex A-5).

2.3 SURVEY METHODOLOGY

A) THE SAMPLE

The ECCD survey was based on a representative sample of deaths of children age 0-4. This sample has been bought from the Ministry of Planning/department of Statistics (Direction de la Statistique du Secrétariat Général au Plan: SGF/DS). That department had recently conducted a Multi-Round Demographic Survey (Enquête Démographique à Passages Répétés: EDPR), on a representative random sample of about 30,000 households. This multi-round survey was conducted over two years, with five rounds every 6 months. All deaths below age 5 that occurred between the third and fifth rounds, ie which have been detected during the fourth and the fifth round have been considered for the ECCD and have been surveyed. This is why the ECCD has also been conducted in two rounds.

Geographical distribution

All together 382 deaths below age 5 have been surveyed over the two rounds, in 35 of the 44 provinces of Morocco. The mean sample rate computed by dividing the number of infant deaths by the number of expected infant deaths for the country, given birth rate and IMR, was 33/10.000 (table 1.2). This sample rate varies from province to province and there has been a very high number of deaths in El Hoceima and Ouarzazate provinces, although the various geographical areas are well represented in the sample. However, the proportion of deaths in urban areas (17%) was lower than expected from available statistical data (28%). Hence the rural areas have been over-represented in the sample. This may be due to a lower mortality rate in urban areas in 1988 than figures available from 1978-87, as illustrated in the following table:

area	1988 popul.	CBR /1000	1988 births	q(5) /1000	deaths 0-4 y.	% deaths	survey deaths	%	Sample /10.000
urban	10.920	32.9	354.695	81	28730	28.2	65	17.0	22
rural	13.038	41.5	546.855	137	74919	71.8	317	83.0	42
all	23.958	37.6	901.038	115	103649	100.0	382	100.0	37

Age distribution

Deaths have been grouped in 3 age groups:

- neonatal: ie 0 to 27 days;
- infant (post-neonatal): ie 28 days to 11 months;
- childhood: ie 12 to 59 months.

In this report the word "infant" refers to post-neonatal mortality only and not to mortality 0-11 months as usual. In the EDPR sample of deaths there were also 11 still-births, a child still alive, a child death above age 5 and 6 eligible deaths that could not be found in the field (table 2.1). The distribution of deaths according to age at death reveals some differences of small magnitude. In particular, among the deaths below age 1, there were proportionately more post-neonatal deaths than neonatal deaths (see following table).

age group	DR /1000	1988 deaths	%	survey deaths	%	Sample /10.000
neonates	41.1	36.943	39.3	128	33.5	35
infants	32.2	29.013	30.8	147	38.5	51
children	32.2	29.013	30.8	107	28.0	38
all	37.6	94.068	100.0	382	100.0	41

B) THE RESPONDENT

In this study the choice of the respondent was of prime concern. Every time it was possible, mothers of deceased children were interviewed since mothers often notice with accuracy symptoms as well as changes that have occurred to the health of the child. In 87% of cases the interviewee was the mother, in 3% of cases it was the father and in 10% of cases another relative.

DELAY SINCE DEATH

The quality of the data depends to a large extent upon the delay between the date of death and the date of the interview: mothers should not be interviewed too early (risk of refusal) or too late (risk of omission). The most appropriate time for the interview seems to be from 3 to 9 months after the deaths. This is what has been done here: 7.8 months on the average in the first round (2 to 17 months, SD=2.4 months) and 8.9 months at the second round (4 to 17 months, SD=2.6 months). All together 91 % of all deaths have been surveyed less than a year after the death (see table 2.1).

Table 2.1 : general situation of the survey

	first round	second round
date of demographic round	18/04/88-15/07/88	20/10/88-31/01/88
date of ECCD survey	17/10/88-01/11/88	16/05/89-02/06/89
min and max dates of death	01/10/87-15/07/88	15/12/87-18/01/89
number of deaths not in 1988	32	3
mean date of deaths	13/04/88	29/08/88
nb of field workers	15	12
nb of supervisors	7	6
total nb of questionnaires	221	180 *
among which:		
- not found or not eligible	5	3
- still births	8	3
- nb of eligible questionnaires	208	174
- number of accidents	1	6
- nb of non accidental deaths	207	168
mean delay between death and interview	7.8 months	8.9 months
min and max delay between deaths and interview	2 - 17 months	4 - 17 months

* of which 5 should have been interviewed at the first round.

first round: questionnaires A001-A221
second round: questionnaires A223-A227 and B001-B175

2.4 DESIGNING THE QUESTIONNAIRE

The questionnaire was designed to gather data on all symptoms that occurred during the illness leading to death as well as on various variables that could have contributed to death. Designing the questionnaire included the following steps:

A) FIRST STEP

First, target causes of death were listed. This was done separately for neonates (less than 28 days) and for other infants and children (28 days up to 5 years). Causes in the list were chosen from prior knowledge of main causes of death in the country gathered mostly for hospital registers. These were:

* For neonates (<28 days)
  - tetanus
  - prematurity
  - low birth weight
  - pneumonia
  - icterus
  - birth trauma
  - hemorrhage

* For other infants and children (28 days to 4 years)
  - diarrhea
  - dysentery
  - typhoid
  - pneumonia
  - laryngitis
  - meningitis
  - septicemia
  - malaria
  - malnutrition
  - measles
  - pertussis
  - tuberculosis
  - poliomyelitis
  - varicella
  - hepatitis
  - epilepsy
  - congenital defect
  - accidents

B) SECOND STEP

A detailed semiologic study of these diseases has been conducted: only signs that could be easily recognized by mothers were kept after a test in the field. This list is given in the questionnaire.

All the signs corresponding to the causes of death were listed. This allowed one to list the diagnosis that will be possible from the questionnaire. This list is given in annex (A-4). However the final diagnosis depends as much on the presence of these signs as on their sequence and duration.

C) THIRD STEP

The questionnaire also encompasses various questions on circumstances of death and on main risk factors. These include:

* socioeconomic factors

  - geographical factors: urban-rural, province;
  - demographic factors: parity, birth order, mother's and child age, sex of the child;
  - other socioeconomic factors: mother's education, mother's marital status, father's and mother's occupation, type of housing, (number of residents, number of rooms, presence of running water, electricity, sewage, nature of housing and occupancy status).

* health system related factors

  - factors related to pregnancy and delivery circumstances;
  - nutritional status of deceased child;
  - level of health care during illness leading to death.

2.5 TESTING THE QUESTIONNAIRE

The testing of the questionnaire occurred between april 23 and 26 1988. The test was based upon 17 deaths detected during a vaccine coverage study.

This first test in the field showed that interviews lasted from 45 to 60 minutes . Families of deceased children did not show any reluctance to talk about the death. The fact that the interviewer was a female physician was probably helpful in establishing effective communication with the families. This is why female field workers were later chosen to collect the survey data.

Most mothers answered accurately to the questions they were asked. Sometimes it was necessary to use circumlocutions.

After this test, various modifications were made to the questionnaire, such as:

- restructuring the questions,
- changing the order of the questions,
- suppressing some questions,
- introducing new questions,
- transforming open questions into closed ones and conversely,
- changing filters for the questions
  (filters were conditions to ask a question)

2.6 TRANSLATING THE QUESTIONNAIRE

The questionnaire has been fully translated into colloquial arabic. Furthermore since the words for certain symptoms were varying from one region to the next, a list of terms specific to the regions was set-up. A person from each of the various regions of the country was designated during the training of the field workers to assist in this task.

2.7 VALIDATING THE QUESTIONNAIRE

Validating the questionnaire was done by comparing the diagnosis obtained from the questionnaire after the interview with the family with the diagnosis made from the medical file established in the hospital where the child died. This test was conducted in three parts:

* in Kenitra medical province, from the deaths that occurred in EL IDRISSI hospital;
* in Rabat - Salé medical province, from the deaths that occurred in the children hospital (test of the questionnaire)
* during the two survey rounds, each time this was possible (ie when the death occurred in an hospital and the file was found)

The objectives of the validation included:

- to test the reliability of the questionnaire for each cause of death;
- to evaluate the skill of the field workers during the training;
- to search for most frequent associations of causes reported by families for each cause of death;
- to improve the quality of the diagnosis from verbal autopsies.

Main results appear in the following tables (2.2 and 2.3). They indicate that among the 64 matched deaths only 3 causes were changed after analyzing the hospital file (4.7%): a case of prematurity found to have died from hypothermia and infection; a case of meningitis that was interpreted as a case of pneumonia of the new born from the questionnaire and a case of congenital defect with associated pneumonia that was undetermined from the questionnaire. It should be noted that 7 causes undetermined from the questionnaire were also undetermined from the hospital file. Lastly, 2 cases appear as more complete from the questionnaire: a case of neonatal tetanus for which only "could not suckle" was written at the hospital and a measles case with a pneumonia complication for which only the terminal pneumonia was registered at the hospital.

Table 2.2 : Results of the validation study according to the age at death

Age at death	Nb of cases	Dg confirmed	Dg rejected	% rejected
neonates	36	35	1	2.7
infants	15	14	1	6.6
children	13	12	1	7.6
total	64	57	3	4.6

Table 2.3 : Results of the validation study according to the cause of death

probable cause of death	quest. diag.	hosp. diag.	Nb discrep	Observations questionnaire/hospital
tetanus	18	17	1	Q : Tetanus H : Difficulty in suckling
birth trauma	8	7	1	Q : Birth trauma H : Meningeal hemorrhage
NN infection	6	7	1	Q : Premature *H : Hypothermia and infection
diarrhea	6	6	0	
pneumonia, ARI	3	2	1	Q : Malnutrition+ARI H : Malnutrition+septicemia
icterus	1	1	0	
meningitis	3	4	1	Q : ARI *H : Meningitis+ARI
septicemia	1	2	0	Q : Malnutrition+ARI H : Malnutrition+septicemia
cong. defect	2	3	1	Q : NSP + ARI *H : Congenital defect+ARI
epilepsy	1	1	0	
accident	3	3	0	
prematurity	2	1	1	Q : Prematurity H : Prematurity + Septicemia
peritonitis	1	1	0	
measles	1	0	1	Q : Measles + ARI H : ARI
bronchi expansion	1	1	0	
undetermined	7	7	0	

Q = cause determined from the questionnaire
H = cause determined from the analysis of the hospital file
* cause of death corrected from the hospital file.

2.8 LAYING OUT THE QUESTIONNAIRE

The ECCD questionnaire was divided into 9 sections on specific topics:

1) Section I : geographical area and identification of the household to be surveyed.

2) Section II : socioeconomic characteristics of the household: number of residents, number of rooms, running water, electricity, toilet facilities, type of housing, occupancy status, husband occupation and occupation of head of household.

3) Section III : demographic characteristics of the mother: level of education, literacy, date of birth, marital status, occupation and parity.

4) Section IV : characteristics of the deceased child: date of birth, sex and birth order.

5) Section V : history of the illness leading to death and the death circumstances:

- history of the illness
- cause declared by the family
- duration of illness
- place of death
- nutritional status of the child
- child care during the illness
- reasons for no referral (when applicable)
- treatment given in case of referrals

6) Section VI : questionnaire for neonates :

- circumstances of pregnancy and delivery
- signs and symptoms from birth until death (skin color, tonicity, body temperature (fever or cold), difficulty in suckling, icterus, hemorrhage, discharge for umbilical cord).

7) Section VII : general questionnaire:

In this section are all signs and symptoms that can be found among neonates and other children below age 5 (fever, cough, troubles in breathing or in urinating, vomiting, diarrhea, dehydration, paralysis, convulsions and spasms, stiff neck, opisthotonos, oedema, icterus, congenital defect and poor health).

8) Section VIII : probable causes of death

9) Section IX : diagnosis from two independent physicians, cause of death from health facility register (if any).

2.10 DESIGNING THE SURVEY MANUALS

The manuals were designed by the survey bureau; they were a useful tool for the survey personnel. They consisted of: the field workers manual, the supervisors manual and the training teachers manual.

2.11 RECRUITING THE FIELD WORKERS AND THE SUPERVISORS

The 7 supervisors were public health physicians; the 23 female field workers were fully licenced nurses (infirmières diplômées d'état) who had the following characteristics:

	field workers	supervisors
level	fully licenced nurse	GP physician or pediatrician
Sex	female	both sexes
seniority	at least 3 years	at least 2 years
experience	in relation with one of the following activities: * MCH programme * health post MCH * service of child health	working in a general hospital or in a district hospital

2.12 TRAINING THE FIELD WORKERS AND THE SUPERVISORS

Theoretical training

The training session lasted 14 days (from August 29 to September 12, 1988). The theoretical training lasted 8 days during which the field workers and the supervisors were taught the survey targets, the sample and the interview technique. All sections of the questionnaire were studied with detailed explanations of each of the question by the training teachers; this was followed by a working group which drew out the problems of each question. After each question simulations of interviews were performed and personnel listened to prerecorded interviews. The "sign and symptom part" was illustrated with dias showing the various signs that the field worker should look for (dehydration, spasm, icterus, rash ...).

Field training

The field training lasted 6 days. 30 households with a recent death of a child 0 to 4 years (in 1988) were chosen. All these deaths came from the Rabat Children Hospital. This study has also been used as a further validation of the questionnaire, to evaluate the limits of the questionnaire and to assess the value of the field workers. The deaths to be interviewed were chosen to include a sample of the most frequent causes of death targeted by the questionnaire: meningitis, diarrhea, neonatal tetanus, acute respiratory infection (ARI) etc.

Administrative organization

The training session for the supervisors was conducted at the same time as the training of the field workers. It also included the various administrative tasks to be performed by them: field work organization, travel arrangements and welcoming in the provinces and monitoring the progress of the field work on registers.

Second round

For the second round a new training session was held for 3 days (from May 10 to May 12, 1989). The survey instructions were repeated and the problems encountered during the first round were discussed.

2.13 FIELD WORK ORGANIZATION

The national territory was divided into 7 survey areas and 2 supervision areas. Each survey area consisted of 3 to 5 provinces depending on the number of deaths; each survey area had a team with two 4WD vehicles (see annex). The supervisory tasks can be summarized in 6 main points:

1. Contact with the people in charge of the survey at the national level.

2. Contact with the physician head of the province for information about the timing of the survey and the help needed from the field workers during their stay in the province.

3. Planning and dispatching the interviews

4. Supervising the field work

5. Making a diagnosis

6. Re-interviewing in the field if the questionnaire was poorly filled-out.

The field workers were in charge of locating the households, of identifying the person best able to answer the questions and to complete the questionnaires according to the training instructions.

Since the ECCD is based upon the deaths of the fourth and fifth rounds of the demographic survey the timing of the field work is closely linked with that of the EDPR: the ECCD rounds took place about 3 months after those of the EDPR. Rounds lasted for about 15 days (see table 2.1).

All together 221 deaths nationwide were surveyed at the first round and 180 at the second round. This implied thorough organization and planning of the interviews. In fact, even within the same province, the teams had to face major problems in remote places. The mean number of interviews rarely exceeded one per field worker per day. The timing of the survey for each field worker was set-up before hand with the help of a road map and the supervisor. This was done to save time, gas, field workers energy and above all to allow the supervisor to locate the teams in the field at any time.

Completed questionnaires were analyzed by the supervisors who went back to the field when necessary to complete missing information. At the end of each round questionnaires were sent back to the bureau of the survey.

The bureau of the survey made the final diagnosis with the help of the pediatrician and of the consultant.

All questionnaires were later coded, data was entered in a micro-computer and tables were produced following a pre-conceived plan.

2.14 DIFFICULTIES ENCOUNTERED

a- Difficulties related to field work:

Difficulties related to field work were mostly attributable to location. In fact, 83% of all deaths occurred in areas difficult to reach by car. Reaching some of the households required 2 days of traveling. All means of transportation were employed and the most popular method of transport was walking. As previously stated the mean number of interviews per day per field worker was only one.

b- Difficulties related with errors in the sample:

- in the name of the families,
- in the first name of the deceased child,
- in addresses of households in urban areas.

c- Difficulties related with the interview:

Some of the questions were extremely intricate, in particular:

- the exact determination of age at death when there were no official documents (vital registration, death certificate etc.).

- the history of the illness: this question required a special effort from the field workers who had to learn how to conduct an unstructured interview to gather the most information possible.

d- At the confrontation level

- Confronting the questionnaires with the hospital registers was hard because of a lack of precise information in the hospital file (for example a tetanus deaths was only registered as heart failure).

- the hospital files were sometimes not located.

2.15 DISCUSSION

The quality of the work varied according to the field worker and the geographical area. Quality was evaluated at least in part by computing the percentage of undetermined causes. This percentage varied from 0% (0/25) to 29% (4/14) depending upon the field worker. The three field workers who had more than 20% undetermined at the first round were not used for the second round. For the remaining field workers, the mean percentage of undetermined cause of death was 11% (40/347).

percentage undetermined	number of field workers
0 - 9 %	5
10 - 19 %	7
20 - 29 %	3

In addition there were more undetermined causes of death in the north (Tétouan, Chechaouen, Sidi Kacem) and in the south (Marrakech, Ouarzazate et Kelaa) than in the rest of the country:

provinces	% undetermined
Tétouan - Chechaouen - Sidi Kacem	22 %
Marrakech - Ouarzazate - Kalaa	14 %
Rest of the country	11 %

However, it seems that the average quality of the interviews was high since higher percentages of undetermined causes of death are frequently seen in similar studies.

CHAPTER 3 : CAUSES OF DEATHS

3.1 ASSESSING THE CAUSES OF DEATHS

The questionnaire targeted a limited number of causes of deaths: their list is given in the following table: 8 causes among the neonates, 18 among infants and children less than 5 years of age.

List of causes targeted by the questionnaire according to the age at death

Neonates	infants and children	
tetanus	diarrhea	measles
prematurity	dysentery	pertussis
hypotrophy	typhoid	tuberculosis
pneumonia	pneumonia	poliomyelitis
congenital defect	laryngitis	varicella
icterus	meningitis	hepatitis
birth trauma	septicemia	epilepsy
hemorrhage	malaria	congenital defect
	malnutrition	accident

In addition to the causes targeted by the questionnaire, several others were identified from the history of the illness, the signs and symptoms are from information given by the health infrastructure. These are the six following cases:

- a case of anemia: a little girl, just above one year old, who used to eat dirt, very meager with an abdominal swelling (hepato-splenomegaly), seen by a physician who gave her an iron supplementation treatment;
- two cases of flu: these were deaths within three days with fever, cough and nasal discharge; in one of the cases all the family had got the same symptoms;
- a case of acute nephritis: diagnosed by a physician, the mother described a tonsillitis followed by generalized oedema and trouble in urinating;
- two cases of intestinal occlusions: the first case had a hernia that was supposed to be later on operated; he had a fever, a swollen abdomen and biliary vomiting; he died one hour after admission to hospital;
- the second case, also referred too late to the hospital, died after 4 days of constipation with fecaloid vomiting.

It should be noted that no case of chicken-pox or poliomyelitis were found in the sample.

Outside of these special cases, causes of deaths have been assessed from the method previously described (see 2.4); others details are given in annex (A-4). All questionnaires have first been read by two physicians, the regional supervisor and the national supervisor. The questionnaires of the first round were later analyzed by a panel of Rabat pediatricians gathered for this purpose. This cumbersome procedure has not been renewed for the questionnaires of the second round. By and large the diagnoses produced by the two physicians were compatible. However there were several cases of discrepancy that are discussed hereafter.

The case of neonatal tetanus

The main discrepancy here was a reluctance to attribute a death to neonatal tetanus when the signs were not all present. In 18 cases both diagnoses were identical, in 6 cases only one of the physician had ascribed the death to tetanus and in 4 cases both physicians had written "neonatal infection" without any further detail. After a careful analysis of the questionnaires, all cases where at least a major sign of tetanus was present (trismus, opisthotonos, stopping breast-feeding, convulsions) were kept. The following table indicates that in 86% of the cases there was at least two major signs. Among the four cases for which only one major sign was present, 3 were unanimously assigned to tetanus by the physicians; for the last case, the mother did not answer to the questions on trismus, opisthotonos and convulsions, but she correctly described that the child has stopped breast-feeding on the third day.

Number of major signs in neonatal tetanus cases:

4 major signs	n = 2
3 major signs	n =12
2 major signs	n =10
1 major sign	n = 4
all	n =28

In addition, age at death is also one of the main features of neonatal tetanus. The following table gives the distribution of cases according to the age at death:

Distribution of neonatal tetanus cases according to the age at death:

0 - 2 days	n = 0
3 - 5 days	n =10
6 - 8 days	n = 8
9 - 11 days	n = 4
12 - 14 days	n = 1
15 - 17 days	n = 1
18 - 20 days	n = 3
21 - 27 days	n = 1
all	n =28

Four cases suspected by physicians to be tetanus were finally disregarded because they had no major sign: one low birth weight, one congenital defect and two unknowns, among them one was only one day old. Hence there is little doubt on the quality of data concerning neonatal tetanus in this study.

The case of pertussis

The second discrepancy between the final diagnosis and the causes assessed by the physicians is related with pertussis. In 4 cases the diagnosis of pertussis was disregarded and each time for the same reason. Cough and vomiting were described with a whoop but these symptoms lasted only 1, 2, 3 and 8 days;

on the opposite in the case of pertussis the whoop comes only around the fifteenth day and death by apnea rarely occur prior to that date. These cases were more likely to be bronchopneumonia and this is the way they have been coded. The question in arabic was accurately stated:

> "ouach kan kaidir behal chi ferrouj kay issrakh"
> (was the child doing like a hen that sings?)

In future surveys one should be more careful with this question which seems to be interpreted by the family in a sense different from the medical sense. Furthermore a case of pertussis well described by the family was attributed to pneumonia by the physicians: the child had a cough with mucous spitting, vomiting, apnea, cyanosis, epistaxis and weight loss for more than a month; the whoop was not well described by the mother but she mentioned a "harsh voice" which was probably a problem in the translation from arabic; there were another similar case in the family.

The case of birth trauma

The questionnaire did not have enough questions on the delivery and in particular on its duration. Birth trauma have been determined either from mother's description of the history of events or from the conjunction of a respiratory distress with a death in the first days of life. A case attributed to birth trauma by the physicians was eventually attributed to an infection because the neonate had fever and two cases attributed to prematurity by the physicians were attributed to birth trauma as the main cause, prematurity being considered only as an associated cause.

Other cases

The other cases of discrepancies were mostly an inaccuracy in the coding by the physicians. For instance a measles case was considered as a fever with rash; three tuberculosis cases were classified as respiratory infections; a typhoidal meningitis case was considered as a meningitis but was finally coded as typhoid. Lastly, a meningitis case well described with neck stiffness, was attributed by one physician to diarrhea and by the other to pneumonia because the two conditions were contributing causes.

Diagnosis confirmation

Only a small number of deaths: 18 (4.7%) were later found in the hospital registers. 17 diagnoses were confirmed; the one posing problem was a neonate, dead after half an hour of life, who was registered as a still birth on the hospital register. Another case could have been misleading: this was a case of ARI: on the hospital register it was registered as a gastro-enteritis followed by inhalation of the gastric liquid and hypoxia: the mother did not mention diarrhea in the interview.

Family declaration of causes

Frequencies of causes of death as they were declared by the family are given in another document (B-6). Families rarely gave spontaneously the exact cause of death. Families frequently attribute neonatal tetanus cases to supra-

natural causes: the diseases that kills neonates (7), devils or evil-eye (8), the cord (3), flu (1), fever (1), prematurity (1), unknown (4); only 3 out of 28 cases were identified as tetanus by the families. Tuberculosis cases were declared in 3 out of 7 cases; in other cases it was attributed to cough (1), diarrhea (2) and fever (1). The 5 measles cases were all properly assessed by the families. Pertussis was identified in only 1 out of 3 cases, other interpretations being cough and diarrhea. Hepatitis was reported as such in 3 out of 7 cases, other interpretations being diarrhea (2), cough (1) and fever (1). Cases of diarrhea and dysentery were properly reported by families as the main cause of death in 51 out of 84 cases for which these causes were coded as the main cause of death.

Some of the reported causes deserve a more in depth analysis since they reveal aspects of the perception of diseases by the population. In particular the concept of "insufficient weight" (7 cases) that correspond either to low birth weight or to malnutrition as well as "breast-feeding during pregnancy" that is interpreted as the ultimate cause of diarrhea and malnutrition among children (5 cases). The population is very conscious of some forms of malnutrition. Lastly, it should be noted that diarrhea is rarely identified as the sole cause of death; on the opposite it is almost always attributed to another symptom: fever, cough or vomiting.

It is possible that in certain cases the family may have correctly identified the cause of death where the questionnaire erred. This might be the case of two reported cholera cases: based on the duration of illness and on the symptoms of diarrhea and vomiting they could have been considered as such; furthermore they occurred in a region and in a period where cholera was effectively reported. However in both cases mothers reported fever and they have been considered as cases of acute febrile diarrhea instead: it is in fact possible that the families tended to interpret these cases as cholera only because of rumors of the disease circulating in the region.

Associations between diagnosis and symptoms

Table 3.1 displays the associations between symptoms and diagnosis, separately for neonates and for infants and children.

Main associations relate symptoms with causes of death (see annex A-4). Very few symptoms appear as pathognomonic in this study: spitting blood for tuberculosis and bent knees for meningitis, even if spiting blood can be seen in abscess of the lung. The fact that some of the symptoms which should be pathognomonic were not, could come from various sources: first a vague recording in the questionnaire: this is the case for instance for the whoop and for certain rashes that were mixed with skin diseases. Second that several conditions can induce similar symptoms, for instance body stiffness in certain birth trauma. Third, associations that do not show-up in this simplified table: for instance tuberculosis meningitis which appears here under tuberculosis but where the meningeal syndrome is present; the same is true for typhoidal meningitis. The straight use of these symptoms, for instance in a computer programme, could not be adequate to assess the causes; this a-posteriori justifies the use of judgment from two independent observers.

Table 3.1 : associations between major signs and symptoms and the main causes of deaths

A) Neonates

sign and symptom	tetanus	birth trauma	prema -ture	low birth weight	pneumo -nia
cyanosis	14	11	9	2	9
hypothermia	10	16	20	6	6
opisthotonos	12	1	0	0	0
hypotonia	4	15	12	4	7
trismus	23	4	1	1	0
stopped suckling	22	5	2	4	0
difficult delivery	5	8	5	1	2
multiple birth	2	1	6	6	0
premature	1	7	26	0	1
low birth weight	5	0	25	9	3
nb of cases	28	26	26	10	12

B) Infants and children

sign and symptom	diar rhea	dysen tery	typh oid	tubercu -losis	per- tussis	septi cemia	meas- les	hepa titis	pneumo nia	larin gitis	menin gitis
diarrhea	74	1	1	3	1	8	3	0	10	0	4
dysentery	5	6	0	0	0	1	1	1	0	0	0
dehydration	82	7	3	3	1	9	4	1	9	0	4
fever	43	5	8	3	2	12	4	5	24	0	4
rash	0	0	0	1	0	3	5	1	2	0	0
red eyes	0	0	0	0	0	0	5	0	0	0	0
cough blood	0	0	0	2	0	0	0	0	0	0	0
cough+vomit	1	1	0	5	1	1	0	2	6	1	0
contamination	0	0	0	3	3	0	4	0	1	2	0
whoop	0	0	0	0	2	1	0	0	3	1	0
harsh cough	1	0	1	4	2	5	1	2	8	5	1
diff. breath	15	3	2	6	2	9	0	1	17	2	2
fast breath	6	2	2	5	2	6	0	1	11	1	1
dyspnea	9	2	3	4	2	6	0	1	15	1	2
pal. nostril	9	2	2	4	2	3	1	0	8	0	2
insuction	3	0	2	4	1	3	0	0	6	1	1
paralysis	1	0	0	0	0	2	0	0	1	0	0
convulsions	6	0	1	0	1	5	0	0	2	0	1
stiff neck	0	0	0	1	0	1	0	0	0	0	6
head bent bw	0	0	0	1	0	1	0	0	0	0	7
bent knees	0	0	0	0	0	0	0	0	0	0	1
swollen font.	0	0	0	0	0	0	0	0	0	0	0
local oedema	8	1	2	2	0	6	0	1	5	0	1
genr. oedema	3	1	0	0	0	1	0	2	1	0	0
icterus	0	0	0	0	1	0	0	6	0	0	0
vomiting	48	4	2	4	1	7	1	4	13	5	8
cong. defect	1	0	0	0	0	0	0	0	0	1	0
constipation	1	0	4	2	0	0	0	1	2	0	1
skin lesion	2	0	0	0	0	7	0	0	0	0	0
nb of cases	51	28	8	7	3	19	5	6	30	6	15

3.2 CODING THE CAUSES OF DEATH

Once the final diagnosis is agreed upon by the national supervisor with the help of the consultant causes are coded. To handle the problem of multiple causes of deaths the classification of "main cause", "immediate cause" and "associated cause" was established. The main cause is the cause that initiated the disease leading to death; the immediate cause, when it exists, is the condition resulting in death; the associated cause is a condition which contributed to the death. A classic example is that of measles (main cause) inducing a death from diarrhea (immediate cause) in a malnourished child (associated cause). This classification allows one to produce simple tables according to the main cause, then to produce separately the associations among causes.

This has necessitated that rules for coding be devised. With respect to neonates, low birth weight is not coded when prematurity since this condition is necessarily included in the main condition; when a premature baby dies of another cause targeted by the questionnaire such as tetanus, pneumonia of birth trauma, that last cause is coded as the main cause and prematurity is coded as an associated cause; the same rule applies for low birth weight among mature babies; lastly multiple pregnancies have been considered as an associated cause when present.

With respect to death of infants and children, malnutrition has always been coded as an associated cause in this study, even though cases of severe malnutrition could be considered as main causes. Furthermore it is likely that some of the malnutrition described as moderate by the mother could have been classified as severe if anthropometric criteria had been used. It was considered reliable to classify all cases of malnutrition separately to better illustrate the role of malnutrition. Associations between diarrhea and pneumonia were coded the following way: in case of double infection from diarrhea and pneumonia the first condition to have occurred has been considered as the main cause and the second condition as the immediate cause; in the case of another disease followed by diarrhea or pneumonia, these last conditions were coded as immediate cause; in case of triple infection (diarrhea+pneumonia+other infection) only septicemia was coded. Septicemia always appear as a main cause and includes other infections either from a skin origin or from another origin (see below).

Table 3.2 : main causes of death according to the type of death

Neonates			Infants and children				
Cause	freq	N	Cause	freq	N	freq	N
tetanus	21.1	28	diarrhea acute	22.4	33	16.8	18
birth trauma	20.3	26	diarrhea chron.	11.6	17	10.2	11
premature	20.3	26	dysentery	2.0	3	8.4	9
low birth weight	7.8	10	typhoid	2.0	3	4.6	5
ARI	9.4	12	ARI	14.2	21	8.4	9
congenital defect	3.1	4	laryngitis	3.4	5	0.9	1
diarrhea	2.3	3	meningitis	6.1	9	5.6	6
hemorrhage	0.8	1	septicemia	6.8	10	8.4	9
icterus	2.3	3	measles	1.3	2	2.8	3
other infection	3.1	4	pertussis	0.6	1	1.8	2
undetermined	8.6	11	tuberculosis	2.0	3	3.7	4
			hepatitis	0.6	1	4.6	5
total	100.0	128	anemia	0.0	0	0.9	1
			epilepsy	0.0	0	0.9	1
			acute abdomen	0.0	0	1.8	2
			acute nephritis	0.0	0	0.9	1
			congenital defect	4.0	6	2.8	3
			accident	1.3	2	4.6	5
			undetermined	20.4	30	9.3	10
			total	100.0	147	100.0	107

NB : malnutrition is considered separately (see table 3.4).

Table 3.3 : causes of death according to age at death (detail)

A) Neonates

cause of death	0-2 days freq	0-2 days N	3-13 days freq	3-13 days N	14-27 days freq	14-27 days N	total freq	total N
tetanus	0.0	0	18.0	23	3.9	5	21.1	28
birth trauma	14.8	19	5.5	7	0.0	0	20.3	26
premature	8.6	11	8.6	11	3.1	4	21.1	26
low birth weight	0.8	1	3.9	5	3.1	4	7.8	10
ARI	0.0	0	2.3	3	7.0	9	9.4	12
congenital defect	0.0	0	2.3	3	0.8	1	3.1	4
diarrhea	0.0	0	0.8	1	1.6	2	2.3	3
hemorrhage	0.8	1	0.0	0	0.0	0	0.8	1
icterus	0.0	0	0.8	1	1.6	2	2.3	3
other infection	0.8	1	1.6	2	0.8	1	3.1	4
undetermined	0.0	1	4.7	6	3.1	4	8.6	11
total	27.2	34	48.4	62	25.0	32	100.0	128

CHI2(16)=72.8 P=1.4E-09 (***)

B) Infants and children

cause of death	1-5 months freq	1-5 months N	6-11 months freq	6-11 months N	1-2 years freq	1-2 years N	3-4 years freq	3-4 years N	total freq	total N
diarrhea acute	9.4	24	3.5	9	6.7	17	0.4	1	20.1	51
diarrhea chron.	3.5	9	3.1	8	4.3	11	0.0	0	11.0	28
dysentery	0.0	0	1.2	3	3.1	8	0.4	1	4.7	12
typhoid	1.2	3	0.0	0	0.8	2	1.2	3	3.1	8
ARI	4.7	12	3.5	9	3.5	9	0.0	0	11.8	30
laryngitis	1.6	4	0.4	1	0.0	0	0.4	1	2.4	6
meningitis	2.3	6	1.2	3	1.2	3	1.2	3	5.9	15
septicemia	2.8	7	1.2	3	3.1	8	0.4	1	7.5	19
measles	0.0	0	0.8	2	0.8	2	0.4	1	2.0	5
pertussis	0.4	1	0.0	0	0.0	2	0.0	0	1.2	3
tuberculosis	0.0	0	1.2	3	0.8	2	0.8	2	2.8	7
hepatitis	0.0	0	0.4	1	1.6	4	0.4	1	2.4	6
anemia	0.0	0	0.0	0	0.4	1	0.0	0	0.4	1
epilepsy	0.0	0	0.0	0	0.4	1	0.0	0	0.4	1
flu	0.4	1	0.4	1	0.0	0	0.0	0	0.8	2
acute abdomen	0.0	0	0.0	0	0.8	2	0.0	0	0.8	2
acute nephritis	0.0	0	0.0	0	0.0	0	0.4	1	0.4	1
congenital defect	2.0	5	0.4	1	0.8	2	0.4	1	3.5	9
accident	0.4	1	0.4	1	1.6	4	0.4	1	2.8	7
undetermined	7.9	20	4.3	11	2.0	5	1.6	4	15.4	40
total	36.2	93	21.6	56	32.3	84	9.8	21	100.0	254

CHI2(54)=80.83 P=.0105 (**)

Table 3.4 : main associations between causes (main, immediate, associated)

A) Neonates		
1) PREMATURITY		
	premature + birth trauma	= 7
	premature + tetanus	= 1
	premature + ARI	= 2
	premature + other cases	= 27
	total prematurity	= 37
2) LOW BIRTH WEIGHT		
	low birth weight + twins	= 6
	low birth weight + diarrhea	= 3
	low birth weight + ARI	= 3
	low birth weight + icterus	= 1
	low birth weight + birth trauma	= 1
	low birth weight + tetanus	= 1
	low birth weight + other cases	= 4
	total low birth weight	= 19
3) MULTIPLE BIRTHS		
	twins + premature	= 6
	twins + low birth weight	= 6
	twins + tetanus	= 2
	twins + birth trauma	= 1
	total multiple births	= 15
B) Infants and children		
1) MALNUTRITION		
	kwashiorkor + diarrhea, dysentery	= 6
	kwashiorkor + ARI	= 2
	marasmus + diarrhea, dysentery	= 1
	marasmus + other (septicemia)	= 1
	other PEM + diarrhea, dysentery	= 29
	other PEM + ARI	= 7
	other PEM + meningitis	= 3
	other PEM + septicemia	= 1
	other PEM + measles	= 1
	other PEM + other cases	= 4
	total malnutrition	= 55
2) DIARRHEA (not dysentery)		
	diarrhea + ARI	= 15
	diarrhea + measles	= 5
	diarrhea + other cases	= 79
	total diarrhea	= 99
3) ARI		
	ARI + diarrhea	= 15
	ARI + other cases	= 26
	total ARI	= 41

Table 3.5 : causes of death according to duration of disease

cause of death \ duration :	< 1 day freq	N	1-6 days freq	N	7-28 days freq	N	> 28 days freq	N
Neonates								
tetanus	7.1	2	75.0	21	17.9	5		
birth trauma	50.0	13	46.2	12	3.8	1		
premature	30.8	8	50.0	13	19.2	5		
low birth weight	10.0	1	30.0	3	60.0	6		
ARI	0.0	0	58.3	7	41.7	5		
congenital defect	0.0	0	0.0	0	100.0	4		
other cause	27.3	3	54.5	6	18.2	2		
undetermined	18.2	2	36.4	4	45.4	5		
total	22.7	29	51.6	66	25.0	33		
Infants-children								
diarrhea acute	5.9	3	45.1	23	37.3	19	11.8	6
diarrhea chronic	0.0	0	3.6	1	14.3	4	82.1	23
dysentery	0.0	0	25.0	3	41.7	5	33.3	4
typhoid	0.0	0	25.0	2	50.0	4	25.0	2
ARI	0.0	0	36.7	11	46.7	14	16.7	5
laryngitis	0.0	0	83.3	5	16.7	1	0.0	0
meningitis	6.7	1	40.0	6	46.7	7	6.7	1
septicemia	5.3	1	26.3	5	15.8	3	32.6	10
measles	0.0	0	20.0	1	40.0	2	40.0	2
pertussis	0.0	0	33.3	1	66.7	2	0.0	0
tuberculosis	0.0	0	0.0	0	14.3	1	85.7	6
hepatitis	0.0	0	0.0	0	50.0	3	50.0	3
congenital defect	0.0	0	33.0	3	0.0	0	66.7	6
other cause	100.0	8	0.0	0	0.0	0	0.0	0
accident	42.9	3	57.1	4	0.0	0	0.0	0
undetermined	7.5	3	46.2	18	23.1	9	25.6	10
total	7.5	19	32.7	83	29.1	74	30.7	78

NN : CHI2(12)=43.63 P=1.7E-05 (***)

I+C: CHI2(42)=208.8 P=1.3E-12 (***)

3.3 NEONATAL CAUSES

Causes of death strongly vary according to age at death, especially during the neonatal period. Hence deaths of neonates have been considered separately (0 to 27 days of life) from other deaths of infants and children (28 days to 5 years). Causes will be presented the way they have been coded (see 3.2) according to age at death and with associations of causes in each category.

Tables 3.2 and 3.3 display the distribution of deaths in the survey according to detailed main causes of death and various age groups. For neonates, 3 age groups were considered to allow separation of some of the causes: less than 3 days, 3 to 13 days, 14 to 27 days.

The causes

Among the 128 neonatal deaths 3 causes appear as leading causes and of the same magnitude: neonatal tetanus (28 cases), birth trauma (25 cases) and prematurity (26 cases). These three causes already account for 63% of neonatal deaths. Then are two causes also of statistical importance: low birth weight among mature babies and pneumonia of the new born the both of which account for 13% of the deaths. Then come less frequent causes: congenital defects (4), among them a stenosis of pylorus, 1 meningocele, a digestive defect and another of unknown origin; also diarrhea (3), icterus (3), other infections (4) and 1 case of umbilical hemorrhage. In 11 cases (9%) the cause of death could not be identified by the questionnaire. It is of interest to note the high frequency of conditions related to lack of appropriate care during pregnancy (tetanus and prematurity) as well as during delivery and the first days of life (birth trauma, low birth weight) . This will be developed more at length (see 4.3).

Age at death

There is a strong correlation between ages at death and causes of death (P=1.4E-09): tetanus are concentrated between 3 and 13 days (81%), some cases surviving until the third week of life (see details in 3.2). Birth trauma, premature and low birth weight died within the first few days of life. Pneumonia usually occurs during the last two weeks of the neonatal period.

Associations

The analysis of associations between main causes, immediate causes and associated causes reveal better the role of each cause in neonatal mortality (table 3.3). For instance, prematurity appears as a leading factor of neonatal deaths since it occurs in 37 cases (29%). Even though tetanus to a premature child can be considered as a random effect, prematurity was most likely a contributing factor to other causes with which it was associated, ie birth trauma and infections, together accounting for 36 deaths (28%). Low birth weight among mature babies plays the same role: it is present in 19 deaths (15%). In 6 cases these are twins and it should be noted that premature twins are not counted here. Multiple births also play an important role: there were 14 twins and 1 triplet and these account for 12% of the deaths. The three conditions together (multiple births, prematurity and low birth weight) account for more than half of the neonatal deaths (53%), which indicates that they can easily be used as an indicator of high risk to the neonates since their frequency is higher among the deaths than in the population in general. The three cases of maternal deaths could also been mentioned at this point since the survival of the mother is also a major factor of child survival. The issue of feeding the neonate is analyzed in the next chapter (see 4.8).

3.4 INFANTS AND CHILDREN CAUSES

Causes of death among infants and children are displayed in the same way in the bottom part of tables 3.2 and 3.3.

Causes

The 254 deaths of children above 27 days and below 5 years of age are distributed among about 20 identified causes that can be grouped in large categories. By and large diarrheal diseases rank first: 50 acute diarrhea (20.1%), 28 chronic diarrhea (11.0%), 12 dysentery (4.7%) and 8 typhoid (3.1%); all together diarrheal diseases account for 39% of all deaths of infants and children; it will be seen later with the study of associations that this percentage is even higher. Ranking second are the group of acute respiratory infections (ARI), mostly pneumonia-bronchitis (30 cases, ie 11.8%) and laryngitis (6 cases, ie 2.4%). The third group is a composite group of various infectious diseases which account for 22% of the causes: 15 meningitis, 19 septicemia, 5 measles, 3 pertussis, 7 tuberculosis and 6 hepatitis. The peculiar case of septicemia is discussed below. Last come various other diseases: 1 anemia, 1 epilepsy, 2 flu, 2 cases of acute abdomen and 1 acute nephritis. In addition there were a high number of congenital defects (9 cases) among them 1 meningocele, 2 hydrocephaly, 1 urinary defect, 2 heart defects, 1 blood defect syndrome, 1 digestive defect and 1 case interpreted as thorax defect but that may have been rickets. Lastly, there were 7 cases of accidents: 3 traffic accidents, 2 scorpion bites, both of which received an anti-venomous serum and 2 cases of poisoning, one with an herb from the desert area known under the local name of "addad" (Atractivis-Gunimisera) and the other one with a rotten apple.

Age at death

Here again the correlation with age is striking and highly significant (P=.0105). Acute and chronic diarrhea appear early in life and are rare after age 3 years. On the opposite dysentery and typhoid are proportionately more frequent beyond age 2 years. Pneumonia-bronchopneumonia and laryngitis are mostly causes of death of the infants and toddlers, the same is true for pertussis whereas diseases like measles, tuberculosis and hepatitis strike mostly later in life. Meningitis and septicemia strike uniformly at all ages.

The role of malnutrition

Association between causes show the major role played by malnutrition. As mentioned above (3.2) malnutrition has not been coded as a main cause of death but always as an associated cause for practical reasons even in cases where it seemed to be the main cause. Severe malnutrition, marasmus or kwashiorkor described by the family as the gross muscle wasting or oedema, occurred in 10 cases and moderate malnutrition, described by the family as a significant weight loss, also occurred in another 45 cases, all together 22% of all deaths of infants and children. If one considers that 35 cases of diarrhea are also clearly associated with some kind of malnutrition, malnutrition appears as the leading cause of death (55 cases) followed by diarrhea of all kinds but without any clear evidence of malnutrition (49 cases); and if one considers that chronic diarrhea (more than 15 days) is in fact "disguised" malnutrition, then malnutrition could end-up being responsible of a third of all deaths of infants and children, acute diarrhea accounting only for 10% of all deaths. This assessment of the major role that malnutrition seems to play in Morocco is probably underestimated, and in any case is lower that other estimates from various countries in Africa, Latin America and Asia where it is commonly found that two thirds of deaths are statistically attributable to malnutrition.

The diarrhea-ARI complex

The diarrhea-ARI complex also deserves special discussion. In fact these two infections are often associated as indicated in table 3.3. Diarrhea is present in 99 cases (39%) and ARI in 41 cases (16%). In 15 cases there was a mixed infection diarrhea+ARI which suggests an immune deficit often associated with malnutrition. To account for all cases of association between diarrhea and ARI one should add the cases of septicemia where these two conditions are present (3 cases). Lastly, in the 5 measles deaths, the immediate cause was diarrhea and in one case the child was malnourished. This statistical association between diarrhea and ARI does not infer any causality: however some ARI can appear after inhalation in cases with diarrhea and vomiting and some ARI can induce a diarrhea by various mechanisms.

Septicemia

Septicemia has been coded as a cause of death either when there were a third infection in addition to the diarrhea-ARI complex (3 cases: 1 meningeal syndrome, 1 stomatitis, 1 other infection), or in the case of acute skin infection inducing septicemia (13 cases) and in cases of post-vaccination abscess (2 cases) as well as in 1 case of septicemia with an associated subcutaneous hemorrhage syndrome. Among the cases of septicemia induced by a skin infection there were two cases of associated urinary tract infections.

Therapeutical accidents

Four cases of therapeutical accidents were detected among the 254 deaths of infants and children (1.6%). These were three cases of post-vaccination abscesses inducing a septicemia in children 2, 5 and 20 months of age and one case of allergic reaction to antibiotics in a child 14 months old who was treated for diarrhea and vomiting. In addition a death occurred shortly after vaccination, which was interpreted by the mother as a case of severe post-vaccination reaction that could have caused death by hyperthermia some 12 hours after the injection with a strong local reaction at the injection point. However this case would necessitate a careful investigation before reaching any conclusion on the definite cause of death.

Table 3.6 : causes of death according to area of residence.

cause of death	urban freq	urban N	rural freq	rural N
Neonates				
tetanus	25.0	7	75.0	21
birth trauma	30.8	8	69.2	18
premature	30.8	8	69.2	18
low birth weight	50.0	5	50.0	5
ARI	33.3	4	66.7	8
congenital defect	25.0	1	75.0	3
other cause	18.2	2	81.8	9
undetermined	18.2	2	81.8	9
total	28.9	37	71.1	91
Infants-children				
diarrhea acute	19.6	10	80.4	41
diarrhea chronic	7.1	2	92.9	26
dysentery	0.0	0	100.0	12
typhoid	0.0	0	100.0	8
ARI	13.3	4	86.7	26
laryngitis	0.0	0	100.0	6
meningitis	6.7	1	93.3	14
septicemia	5.3	1	94.7	18
measles	0.0	0	100.0	5
pertussis	0.0	0	100.0	3
tuberculosis	14.3	1	85.7	6
hepatitis	33.3	2	66.7	4
congenital defect	11.1	1	88.9	8
other cause	12.5	1	87.5	7
accident	0.0	0	100.0	7
undetermined	12.5	5	87.5	35
total	11.0	28	89.0	254

NN : CHI2(6)= 2.97 P=.8121 (NS)
I+C: CHI2(14)=11.4 P=.6516 (NS)

Table 3.7 : causes of death according to sex

cause of death	male freq	male N	female freq	female N
Neonates				
tetanus	57.1	16	42.9	12
birth trauma	69.2	18	30.8	8
premature	61.5	16	38.5	10
low birth weight	40.0	4	60.0	6
ARI	58.3	7	41.7	5
congenital defect	75.0	3	25.0	1
other cause	72.7	8	27.3	3
undetermined	45.5	5	54.5	6
total	60.2	77	39.8	51
Infants-children				
diarrhea acute	54.9	28	45.1	23
diarrhea chronic	50.0	14	50.0	14
dysentery	41.7	5	58.3	7
typhoid	50.0	4	50.0	4
ARI	46.7	14	53.3	16
laryngitis	66.7	4	33.3	2
meningitis	33.3	5	66.7	10
septicemia	68.4	13	31.6	6
measles	0.0	0	100.0	5
pertussis	0.0	0	100.0	3
tuberculosis	42.9	3	57.1	4
hepatitis	33.3	2	66.7	4
congenital defect	55.6	5	44.4	4
other cause	50.0	4	50.0	4
accident	42.9	3	50.0	4
undetermined	52.5	21	47.5	19
total	49.2	125	50.8	129

NN : CHI2(6)= 3.67 P=.7214 (NS)
I+C: CHI2(14)=14.69 P=.3998 (NS)

Table 3.8 : causes of death according to birth order

cause of death	rank 1 freq	N	rank 2-7 freq	N	rank 8+	
Neonates						
tetanus	21.4	6	75.0	21	3.6	1
birth trauma	19.2	5	53.8	14	26.9	7
premature	23.1	6	65.4	17	11.5	3
low birth weight	10.0	1	80.0	8	10.0	1
ARI	25.0	3	66.7	8	8.3	1
congenital defect	25.0	1	75.0	3	0.0	0
other cause	0.0	0	100.0	11	0.0	0
undetermined	27.3	3	63.6	7	9.1	1
total	19.5	25	69.5	89	10.9	14
Infants-children						
diarrhea acute	23.5	12	66.7	34	9.8	5
diarrhea chronic	10.7	3	71.4	20	17.9	5
dysentery	25.0	3	66.7	8	8.3	1
typhoid	0.0	0	50.0	4	50.0	4
ARI	3.3	1	76.7	23	20.0	6
laryngitis	16.7	1	66.7	4	16.7	1
meningitis	13.3	2	73.3	11	13.3	2
septicemia	26.3	5	26.3	5	47.4	9
measles	0.0	0	100.0	5	0.0	0
pertussis	33.3	1	66.7	2	0.0	0
tuberculosis	0.0	0	100.0	7	0.0	0
hepatitis	33.3	2	66.7	4	0.0	0
congenital defect	0.0	0	77.8	7	22.2	2
other cause	12.5	1	75.0	6	12.5	1
accident	14.3	1	71.4	5	14.3	1
undetermined	30.0	12	47.5	19	22.5	9
total	17.3	44	64.6	164	18.1	46

NN : CHI2(12)=14.75 P=.2520 (NS)
I+C: CHI2(28)=45.94 P=.0177 (**)

Table 3.9 : causes of death according to season of death

cause of death	dec-jan-feb freq	N	mar-apr-may freq	N	jun-jul-aug freq	N	sep-oct-nov freq	N
Neonates								
tetanus	27.0	7	39.3	11	21.4	6	14.3	4
birth trauma	26.9	7	30.8	8	11.5	3	30.8	8
premature	50.0	13	19.2	5	7.7	2	23.1	6
low birth weight	30.0	3	60.0	6	10.0	1	0.0	0
ARI	33.3	4	41.7	5	8.3	1	16.7	2
congenital defect	50.0	2	25.0	1	25.0	1	0.0	0
other cause	18.2	2	36.4	4	18.2	2	27.3	3
undetermined	18.2	2	36.4	4	45.5	5	0.0	0
total	31.2	40	34.4	44	16.4	21	18.0	23
Infants-children								
diarrhea acute	19.6	10	19.6	10	21.6	11	39.2	20
diarrhea chronic	21.4	6	17.9	5	17.9	5	42.9	12
dysentery	8.3	1	25.0	3	33.3	4	33.3	4
typhoid	25.0	2	37.5	3	25.0	2	12.5	1
ARI	33.3	10	40.0	12	3.3	1	23.3	7
laryngitis	33.3	2	33.3	2	16.7	1	16.7	1
meningitis	26.7	4	20.0	3	26.7	4	26.7	4
septicemia	42.1	8	31.6	6	21.1	4	5.3	1
measles	0.0	0	20.0	1	60.0	3	20.0	1
pertussis	100.0	3	0.0	0	0.0	0	0.0	0
tuberculosis	28.6	2	42.9	3	28.6	2	0.0	0
hepatitis	0.0	0	33.3	2	16.7	1	50.0	3
congenital defect	44.4	4	11.1	1	33.3	3	11.1	1
other cause	0.0	0	37.5	3	37.5	3	25.0	2
accident	14.3	1	42.9	3	0.0	0	42.9	3
undetermined	25.0	10	27.5	11	17.5	7	30.0	12
total	24.8	63	26.6	68	20.1	51	28.3	72

NN : CHI2(18)=15.65 P=.6170 (NS)
I+C: CHI2(42)=54.11 P=.0997 (*)

Table 3.10 : causes of death according to mother's literacy

cause of death	literate freq	literate N	not literate freq	not literate N	unknown freq	unknown N
Neonates						
tetanus	7.1	2	92.9	26	0.0	0
birth trauma	0.0	0	92.3	24	7.7	2
premature	0.0	0	96.2	25	3.8	1
low birth weight	10.0	1	90.0	9	0.0	0
ARI	0.0	0	100.0	12	0.0	0
congenital defect	0.0	0	100.0	4	0.0	0
other cause	0.0	0	100.0	11	0.0	0
undetermined	0.0	0	100.0	11	0.0	0
total	2.3	3	95.3	122	2.3	3
Infants-children						
diarrhea acute	3.8	2	94.2	49	1.9	1
diarrhea chronic	0.0	0	100.0	28	0.0	0
dysentery	0.0	0	100.0	12	0.0	0
typhoid	0.0	0	100.0	8	0.0	0
ARI	0.0	0	100.0	30	0.0	0
laryngitis	0.0	0	100.0	6	0.0	0
meningitis	6.7	1	93.3	14	0.0	0
septicemia	5.3	1	94.7	18	0.0	0
measles	0.0	0	100.0	5	0.0	0
pertussis	0.0	0	100.0	3	0.0	0
tuberculosis	0.0	0	100.0	7	0.0	0
hepatitis	0.0	0	100.0	6	0.0	0
congenital defect	0.0	0	100.0	9	0.0	0
other cause	12.5	1	75.0	6	12.5	1
accident	0.0	0	100.0	7	0.0	0
undetermined	5.0	2	92.5	37	2.5	1
total	2.8	7	96.1	244	1.2	3

NN : CHI2(6)= 6.60 P=.3591 (NS)
I+C: CHI2(42)= 9.60 P=.7902 (NS)

Table 3.11 : causes of death according to mother's marital status

cause of death	mother married freq	N	other cases freq	N
Neonates				
tetanus	92.9	26	7.1	2
birth trauma	96.2	25	3.8	1
premature	92.3	24	7.7	2
low birth weight	100.0	10	0.0	0
ARI	91.7	11	8.3	1
congenital defect	100.0	4	0.0	0
other cause	100.0	11	0.0	0
undetermined	90.9	10	9.1	1
total	94.5	121	5.5	7
Infants-children				
diarrhea acute	100.0	51	0.0	0
diarrhea chronic	89.3	25	10.7	3
dysentery	91.7	11	8.3	1
typhoid	100.0	8	0.0	0
ARI	100.0	30	0.0	0
laryngitis	100.0	6	0.0	0
meningitis	86.7	13	13.3	2
septicemia	100.0	19	0.0	0
measles	100.0	5	0.0	0
pertussis	100.0	3	0.0	0
tuberculosis	100.0	7	0.0	0
hepatitis	100.0	6	0.0	0
congenital defect	100.0	9	0.0	0
other cause	100.0	8	0.0	0
accident	100.0	7	0.0	0
undetermined	97.5	39	2.5	1
total	97.2	247	2.8	7

NN : CHI2(6)= 2.27 P=.8934 (NS)
I+C: CHI2(42)=19.70 P=.1397 (NS)

Table 3.12 : causes of death according to mother's age

cause of death	mother < 20 freq	N	mother 20-39 freq	N	mother >= 40 freq	N
Neonates						
tetanus	3.6	1	85.7	24	10.7	3
birth trauma	3.8	1	88.5	23	7.7	2
premature	11.5	3	80.8	21	7.1	2
low birth weight	20.0	2	60.0	6	20.0	2
ARI	8.3	1	91.7	11	0.0	0
congenital defect	0.0	0	100.0	4	0.0	0
other cause	0.0	0	100.0	11	0.0	0
undetermined	18.2	2	81.8	9	0.0	0
total	7.8	10	85.9	110	6.2	8
Infants-children						
diarrhea acute	9.8	5	84.3	43	5.9	3
diarrhea chronic	0.0	0	82.1	23	17.9	5
dysentery	0.0	0	100.0	12	0.0	0
typhoid	12.5	1	62.5	5	25.0	2
ARI	6.7	2	86.7	26	6.7	2
laryngitis	0.0	0	83.3	5	16.7	1
meningitis	13.3	2	80.0	12	6.7	1
septicemia	0.0	0	94.7	18	5.3	1
measles	0.0	0	80.0	4	20.0	1
pertussis	0.0	0	100.0	3	0.0	0
tuberculosis	0.0	0	100.0	7	0.0	0
hepatitis	0.0	0	100.0	6	0.0	0
congenital defect	0.0	0	100.0	9	0.0	0
other cause	0.0	0	87.5	7	12.5	1
accident	0.0	0	100.0	7	0.0	0
undetermined	2.5	1	92.5	37	5.0	2
total	4.3	11	88.2	224	7.5	19

NN : CHI2(12)=10.76 P=.5499 (NS)
I+C: CHI2(28)=24.02 P=.6801 (NS)

Table 3.13 : causes of deaths according to referral

cause of death	hospital freq	N	health post or dispens. freq	N	private practition. freq	N	no referral or other freq	N
Neonates								
tetanus	7.1	2	3.6	1	14.8	4	75.0	21
birth trauma	26.9	7	3.8	1	3.8	1	65.4	17
premature	15.4	4	0.0	0	3.8	1	80.8	21
low birth weight	10.0	1	20.0	2	10.0	1	60.0	6
ARI	0.0	0	25.0	3	16.7	2	58.3	7
congenital defect	25.0	1	0.0	0	0.0	0	75.0	3
other cause	27.3	3	18.2	2	9.1	1	45.5	5
undetermined	9.1	1	0.0	0	9.1	1	81.8	9
total	14.8	19	7.0	9	8.6	11	69.5	89
Infants-children								
diarrhea acute	9.8	5	19.6	10	15.7	8	54.9	28
diarrhea chronic	3.6	1	35.7	10	17.9	5	42.9	12
dysentery	16.7	2	25.0	3	8.3	1	50.0	6
typhoid	12.5	1	12.5	1	12.5	1	62.5	5
ARI	6.7	2	23.3	7	16.7	5	53.3	16
laryngitis	0.0	0	0.0	0	0.0	0	100.0	6
meningitis	0.0	0	33.3	5	6.7	1	60.0	9
septicemia	31.6	6	26.3	5	5.3	1	36.8	7
measles	0.0	0	20.0	1	0.0	0	80.0	4
pertussis	0.0	0	33.3	1	0.0	0	66.7	2
tuberculosis	42.9	3	28.6	2	14.3	1	14.3	1
hepatitis	33.3	2	16.7	1	16.7	1	33.3	2
congenital defect	22.2	2	33.3	3	11.1	1	33.3	3
other cause	0.0	0	12.5	1	0.0	0	87.5	7
accident	42.9	3	14.3	1	14.3	1	28.6	2
undetermined	5.0	2	10.0	4	15.0	6	70.0	28
total	11.4	29	21.7	55	12.6	32	54.3	138

NN : CHI2(18)=24.26 P=.1468 (NS)
I+C: CHI2(42)=46.10 P=.3065 (NS)

Table 3.14 : causes of deaths according to reasons for no referral

cause of death	underestimate severity freq	N	remoteness freq	N	no referral or other cases freq	N
Neonates						
tetanus	21.4	6	21.4	6	27.1	16
birth trauma	11.5	3	26.9	7	61.5	16
premature	15.4	4	30.8	8	53.8	14
low birth weight	20.0	2	40.0	4	40.0	4
ARI	25.0	3	25.0	3	50.0	6
congenital defect	25.0	1	25.0	1	50.0	2
other cause	0.0	0	18.2	2	81.8	9
undetermined	18.2	2	36.4	4	45.5	5
total	16.4	21	27.3	35	56.2	72
Infants-children						
diarrhea acute	21.6	11	15.7	8	62.7	32
diarrhea chronic	17.9	5	17.9	5	64.3	18
dysentery	16.7	2	16.7	2	66.7	8
typhoid	25.0	2	25.0	2	50.0	4
ARI	23.3	7	20.0	6	56.7	17
laryngitis	50.0	3	33.3	2	16.7	1
meningitis	20.0	3	20.0	3	60.0	9
septicemia	5.3	1	15.8	3	78.9	15
measles	0.0	0	60.0	3	40.0	2
pertussis	33.3	1	33.3	1	33.3	1
tuberculosis	0.0	0	14.3	1	85.7	6
hepatitis	0.0	0	0.0	0	100.0	6
congenital defect	11.1	1	11.1	1	77.8	7
other cause	12.5	1	0.0	0	87.5	7
accident	28.6	2	0.0	0	71.4	5
undetermined	22.5	9	32.5	13	45.0	18
total	18.9	48	19.7	50	61.4	156

NN : CHI2(12)= 7.79 P=.8010 (NS)
I+C: CHI2(28)=29.25 P=.3998 (NS)

Table 3.15 : causes of death according to antenatal care (neonatal deaths)

cause of death	3 visits freq	N	1-2 visits freq	N	no visit, unknown freq	N
Neonates						
tetanus	0.0	0	14.3	4	85.7	24
birth trauma	11.5	3	15.4	4	73.1	19
premature	3.8	1	19.2	5	76.9	20
low birth weight	0.0	0	10.0	1	90.0	9
ARI	8.3	1	16.7	2	75.0	9
congenital defect	0.0	0	25.0	1	75.0	3
other cause	0.0	0	0.0	0	100.0	11
undetermined	0.0	0	0.0	0	100.0	11
total	3.9	5	13.3	17	82.8	106

NN : CHI2(12)=10.07 P=.6094 (NS)

3.5 DIFFERENTIAL ANALYSIS

The questionnaire also included question on socioeconomic and demographic characteristics of the deceased children. With this information it is possible to analyze the distribution of the causes of deaths according to these characteristics. Results are displayed in tables 3.5 to 3.15. In each case neonatal deaths were analyzed separately from other deaths of infants and children. For each table a CHI-2 statistics is computed which determines if there are differences in the distribution of the causes of deaths according to the characteristics under study. In some cases a test was performed to assess whether the distribution of deaths due to a cause was randomly distributed according to the characteristic. In this case a Student test was performed in situations where the number of cases was higher than 0 (ie the probability that the frequency observed in this cell is equal to the frequency in the population) or in using the binomial distribution in situations where the number of cases is 0 (ie the probability that no death occurred in this cell knowing the frequency in the population)

- Place of residence (table 3.6): no significant difference was found, neither at the global repartition of the causes nor at the detailed level. This is a rather surprising result. It means that, although levels of mortality differ widely in urban and rural areas, the proportionate distribution of causes of death is roughly the same. This is striking in the case of neonatal tetanus which accounts for 19% of the neonatal deaths in urban areas and 23% in rural areas. However, for associated causes, 96% of the cases of malnutrition are concentrated in rural areas. This concentration can be compared with the high prevalence of malnutrition found in rural areas in the DHS survey, 1987. Likewise the 10 cases of acute malnutrition in the ECCD survey are concentrated in the southern provinces (Marrakech, Taroudant, Ouarzazate, Tiznit, Azilal, El Kalaa, et Safi) and in the northern provinces (Taza, El Hoceima), where prevalence of malnutrition is highest in the DHS survey. Unfortunately a detailed analysis by province in not possible due to a lack of data. However a comparison can be done at a broader level of economic regions. Results appear in the following table (3.16).

Table 3.16 : infant mortality and prevalence of malnutrition according to economic regions (national data) and comparison with the percentage of malnutrition among the deaths of infants and children found at the ECCD

economic region	population *1000	% urban	IMR /1000	nb death	nb malnu.	% malnut	prevalence malnutrition total %	wast. %	stunt. %	w+s %
Sud	2654	24	116	75	14	26	37.6	2.9	32.7	2.0
Tensift	3345	31	113	45	6	20	39.1	2.7	34.7	1.7
Centre sud	1731	43	103	27	3	14	33.0	2.9	28.6	1.5
Centre nord	2742	33	102	62	10	22	30.6	0.9	29.3	0.4
Nord ouest	4927	53	91	88	17	25	29.3	1.8	26.7	0.8
Centre	6619	58	68	73	5	15	28.6	2.7	25.5	0.4
Oriental	1752	46	65	10	0	0	22.3	1.6	20.4	0.3
Sahara	188	5	99	2	0	-	-	-	-	-
All	23958	45	91	382	55	21	31.3	2.2	28.2	0.9

Source : ENSP, 1987 (DHS) and ECCD.

This table indicates that there is a high correlation between the level of mortality and the prevalence of malnutrition. Likewise, cases of malnutrition found in the ECCD survey come from the regions where the prevalence of malnutrition is highest according to the DHS data.

- Sex (table 3.7): there are no significant differences at the global level; however it is noticeable that all measles and pertussis deaths occurred in females (P=.0044). This is rather surprising since there is no difference in vaccine coverage by sex according to DHS 1987 data. The fact that there are twice as many cases of meningitis among girls as among boys is not significant (P=.1159).

- Birth order (table 3.8): there is a significant difference in the distributions of deaths of infants and children according to the three categories of birth order: 1, 2-7 and 8+ (P=.0177). There is proportionately more typhoid among children of a higher rank (P=.0119) as well as more septicemia (P=.0011), which seems to be difficult to interpret. In addition there is more birth trauma among high birth order infants and children (P=.0152).

- Season (table 3.9): the deaths were distributed into four seasons of three months each: December to February, March to May, June to August and September to November, which are the cold season, the humid spring, the hot summer and the dry fall. Differences are noticeable among infants and children: there are more diarrhea and dysentery occurring in the fall (P=.0239), more ARI in winter and in the spring (P=.0119), more measles in summer (P=.0810) and more septicemia in winter and in spring (P=.0312). All pertussis cases occurred during the winter season (P=.0152).

- Mother's literacy and marital status (tables 3.10 and 3.11): there was no significant difference according to mother's literacy or marital status, probably because the very small number of deaths among literate mothers (3 neonates and 7 infants and children) and to unmarried mothers (7 neonates and 7 infants and children).

- age of mother does not appear to be a determinant in this study (table 3.12) for the same reason: there are too few deaths in groups where differences could have been noticed: less than age 20 years (10 and 11 deaths) and 40 years and more (8 and 19 deaths).

- the correlation with referral (table 3.13) is also not significant. Furthermore in this case any effect would have been difficult to interpret because of the many selection biases: either the child is dead without referral or because of his/her critical condition he/she has been referred in a health post but too late to be saved. Information is missing about incidence of diseases in the population and about diseases that are more likely to be taken to a health post. At the level of individual causes, only laryngitis appears as significant, no case having been referred (P=.0256).

- With respect to reasons for no referral in a modern health facility (table 3.14), in half of the cases the mother said that she underestimated the seriousness of the disease and in the other half she said that they were living too far away, without any differential by cause of death.

- Last, the number of antenatal visits is also not correlated with the causes of death among neonates (table 3.15); here again the sample size is too small for making inferences: 4 deaths among women who had 3 visits during pregnancy and 23 deaths among women who had 1 or 2 visits.

3.6 DISCUSSION

The verbal autopsy technique on a representative sample of the Moroccan population furnished a good evaluation of the frequency of main causes of death among children less than 5 years of age in Morocco, despite the relatively small number of deaths (382). Since a small number of causes account for a large number of deaths the small sample size is really limiting only for rare causes and for differential analysis. For instance, the frequency of viral hepatitis (6 cases) estimated to be 2.4% of infant and child deaths is included in a 95% confidence interval of 0.5% to 4.3%, which is accurate enough to represent the relative magnitude of the disease in child mortality.

It could be argued that the sample representing deaths of only one year has been biased by some epidemics. According to official declaration of health facilities there were epidemics of meningitis, cholera and malaria in 1988. However cases of meningitis deaths found in the survey were not concentrated during the epidemic period (October 88 to March 89); the two cholera declared cases were not considered and no case of malaria death has been identified. Hence it can be argued that the frequency of causes in this sample is representative of an average year and in any case not biased by obvious epidemics.

Other biases could also be invoked associated with climate or economic situation. However there is no indication that 1988 was a bad year, either for the amount of rainfall or for the economic performances of the country.

The issue of the reliability of verbal autopsies has been discussed above in detail in the paragraph dealing with validation (2.7). Once again, verbal autopsies produce only "probable causes of death". Diagnosis is based upon a judgement made from the symptoms reported by the family. Whatever the quality of the criteria used for the inference, it is very likely that there were errors in reporting and errors in interpreting the cases, as was shown by the validation study.

However, from the analysis of the questionnaires, it can be argued that the quality of the data is close to that shown by the validation study and hence good enough to make recommendations for priorities to public health interventions aiming at reducing mortality of children. If some of the diseases that cause death do not show-up here, it is because they probably are rare events in the population proportionately to other causes, for instance malaria or cholera; furthermore these are well known from the epidemiological surveillance and require specific interventions.

CHAPTER 4 : CIRCUMSTANCES OF DEATHS

The ECCD questionnaire was not designed to directly analyze the risk factors of the observed deaths. In fact this would require comparing the frequency of variables associated with the circumstances of death to the frequency of the same variables among survivors. For instance one would compare the frequency of home deliveries among tetanus cases to the frequency of home deliveries among other neonates who escaped tetanus.

However two kinds of comparisons are possible: comparing the frequency of some variables for certain causes of death with that of other causes and comparing the frequency of these variables with the frequency in the population when the information is available. Some of these comparisons have already been mentioned in the previous chapter; in some instances they reveal some important risk factors.

In addition the histories of illness and treatment often contain information which can be used to analyze the circumstances of the deaths and to pinpoint the weaknesses in the health system.

4.1 NUMERICAL IMPORTANCE OF THE ISSUE

Analyses developed hereafter are made for broad categories of causes as they appear from the reading of the frequency of causes of death. Table 4.1 displays 4 broad categories according to the means of prevention or treatment. 76.7% of all death appear as potentially avoidable by referral to health facilities and use of antibiotics (25.7%), by proper care of diarrhea and malnutrition (22.0%), by proper care during pregnancy and delivery as well as proper care of the newborn (16.5%) and by improving vaccinations (12.6%). These theoretical computations assume first the availability of sound information to the population and a high consciousness of health risks for children. Even though they are arbitrary and do not take into account the socioeconomic conditions, these computations underline the numerical mportance of the issue and the potential to improve child survival (about three quarters of all deaths).

4.2 REFERRAL TO HEALTH CARE

The questionnaire included various questions on referral to health care for all deaths. Neonates are treated separately from deaths of infants and children. For neonates only 31.2% were referred at least once and among them only 10.9% were admitted to a hospital plus 3.9% others who came to the hospital but were not admitted. For the deaths of infants and children, 50% were referred, among them 7.1% were admitted to an hospital and 4.3% others who came to the hospital but were not admitted. These are very low figures considering that almost all should have been admitted to an hospital. Among those who were first referred to a health facility other than a hospital, many were poorly cared for.

Among those who were referred to a hospital, many arrived too late to be effectively treated. For all referrals, 30.8% of neonates and 9.8% of infants and children went the first day of the illness but more than half of infants and children's deaths were not referred prior to the fourth day of the illness (table 4.3).

Table 4.1 : causes of death according to the means of prevention and treatment

1) hospital care, antibiotics (dysentery, typhoid, pneumonia, laryngitis, meningitis, septicemia)	98	25.7 %
2) proper care of diarrhea and malnutrition (diarrhea other than dysentery, malnutrition)	84	22.0 %
3) pregnancy, delivery, care of the new born (premature, low birth weight, birth trauma)	63	16.5 %
4) Vaccinations (measles, pertussis, tuberculosis, tetanus, hepatitis)	48	12.6 %
all categories 1-4	293	76.7 %
5) other diseases identified	18	4.7 %
6) congenital defects	13	3.4 %
7) accidents	8	2.1 %
8) undetermined causes	50	13.1 %
all categories 5-8	89	23.3 %

Table 4.2 : referral to health facilities according to place and age at death

place of referral	neonates (128) freq	(N)	infants-children (254) freq	(N)
admitted hospital	10.9	(14)	7.1	(18)
public hospital	14.8	(19)	11.4	(29)
private clinic	0.8	(1)	0.4	(1)
health post	6.2	(8)	14.2	(36)
dispensary	4.7	(6)	16.5	(42)
private practi.	10.2	(13)	21.3	(54)
pharmacist	0.8	(1)	2.8	(7)
trad. healer	4.7	(6)	17.7	(45)
all referral	31.2	(40)	50.0	(127)

Note : categories are not additive: a child can be referred to several places

Table 4.3 : referral to health facilities according to the delay since the onset of symptoms and age at death

delay	neonates (128) freq	(N)	infants-children (254) freq	(N)
less than 1 day	30.8	(12)	9.8	(12)
1 - 3 days	51.2	(20)	31.9	(39)
4 + days	17.9	(7)	58.1	(71)
total	100.0	(39)	100.0	(122)

Referral depends upon duration of illness, at least in part: among deaths of infants and children, the percentage of referral increases from 31.7% for illnesses 1 to 6 days to 58.6% in illnesses 7 to 28 days and to 62.5% days for illnesses more than 28 days (table 4.4).

To explain the lack of referral parents invoke various reasons (table 4.5). Among the most frequent reasons are the long distance (52.3 and 59.8%), financial means (31.8 and 45.7 %) and underestimation of the severity of the disease (23.9 and 37.8 %).

4.3 PREGNANCY

The follow-up of pregnancies is definitely lacking. In the sample of neonatal deaths, 78.1% of mothers did not attend any antenatal clinic and only 3.9% had at least one visit in each of the three trimesters. This percentage compares with the national average of 75% deliveries without any antenatal care found at the DHS in 1987. This comparison suggests that at least prior to 1988 antenatal visits did not play a significant preventive role. This situation is probably changing now with the programme of tetanus toxoid immunization which started in October 1987 and the programme of screening high risk pregnancies which started in January 1988: it was too early to see any effect of these programmes in the ECCD.

In addition, the very high proportion of premature and low birth weight babies suggests that pregnant women do not rest enough during pregnancy, especially during the last month. Unfortunately there is no accurate data on this issue.

4.4 DELIVERY

Most deliveries (75%) occur outside of health infrastructures, hospital, maternity or private clinics. This percentage is identical to the national average of 78% found at the DHS in 1987. This equivalence of percentages suggests that health infrastructures do not solve all the problems. For instance among the 28 deaths from tetanus 2 mothers (7.1%) delivered in a health facility which is one third of the frequency in the population; in other words delivering in a health facility reduces the risk of tetanus only by 2/3 whereas one would hope it suppress the risk almost completely. The case of birth trauma among deliveries in health facilities (7/26) is more difficult to interpret since there could be a selection bias: women with a prolonged labor could be more likely to be referred to a health facility.

Table 4.4 : referral to health care according to duration of illness and age at death

duration of illness	neonates (128) freq	(N)	infants-children (254) freq	(N)
less than 1 day	17.2	(5/29)	41.1	(7/17)
1 - 6 days	72.2	(26/36)	31.7	(26/82)
7 - 28 days	19.3	(9/31)	58.6	(44/75)
28 + days	0.0	(0/0)	62.5	(50/80)
all referrals	31.2	(40/128)	50.0	(127/254)

Table 4.5 : reasons for no referral according to age at death

reason	neonates (88) freq	(N)	infants-children (127) freq	(N)
severity underestimated	23.9	(21)	37.8	(48)
living too far away	52.3	(46)	59.8	(76)
lack of financial means	31.8	(28)	45.7	(58)
lack of confidence	2.3	(2)	4.7	(6)
no means of transport.	5.7	(5)	4.7	(6)
climatic conditions	1.1	(1)	0.8	(1)
mother was ill	10.2	(9)	0.0	(0)
father was away	3.4	(3)	5.5	(7)
other cases	27.3	(24)	17.3	(22)

Note : categories do not total 100% : families can give several reasons

Table 4.6 : frequency of various means of cutting and healing the cord, among neonates born at home without any medical assistance.

	tetanus	other cases	all	
tool to cut the cord				
knife	8	15	23	
scissors	14	49	63	
razor blade	3	3	6	
other cases	1	3	4	
all	26	70	96	CHI2=3.47 (NS)
sterilizing the tool				
tool sterilized	4	11	15	
tool not sterilized	16	48	64	
other cases	6	11	17	
all	26	70	96	CHI2=1.39 (NS)
mean of sterilization				
alcohol	1	0	1	
fire	1	2	3	
boiling water	0	2	2	
other cases	2	7	9	
all	4	11	15	CHI2=3.60 (NS)
topic put onto the cord				
khol	7	10	17	
henna	3	11	14	
olive oil	6	13	19	
disinfectant	1	2	3	
other cases	9	34	43	
all	26	70	96	CHI2=5.19 (NS)

4.5 CARE OF THE NEW BORN

Among the 36 deaths from prematurity or low birth weight, 9 (25%) occurred in a health facility which is the same percentage as the national average. This result suggests that care of premature and low birth weight babies in health infrastructures is currently not sufficient.

Cutting and healing the cord are also important elements of the newborn care (table 4.6). This is particularly important for neonatal tetanus in case of home deliveries. In only a small number of cases the tool was sterilized 4/26 (15.3%) among neonatal tetanus cases and in 15/70 (21.4%) in cases of deaths from other causes, the difference being not significant. However methods of sterilization vary: alcohol (1) fire (3) boiling water (2) and other undetermined methods (9) that may not be effective. Among the 4 tetanus cases, 2 had the tool sterilized with alcohol and 2 with undetermined methods. Among the products the most frequently put on the cord are khol (17), olive oil (19), henna (14) and various other products (43); a disinfectant (éosine) was only rarely utilized (3) and there were no difference between tetanus cases and other causes of death. Although improvements could be made, sterilization of the tool would probably not solve all problems. In other places it has been shown that the hygiene of the birth attendant was also important, in particular that her hands could be the vector of neonatal tetanus whatever the sterilization of the tool that was utilized [8,9,10].

4.6 VACCINATIONS

The Expanded Programme on Immunization (EPI) started in 1980 and was later reinforced in 1987, 1988 and 1989 by national days of vaccination (JNV): the national vaccination coverage is now at a high level. A recent coverage study conducted in April 1988 indicates that 91 % of children in urban areas and 84% of children in rural areas are fully vaccinated. However the vaccination coverage of children in the ECCD sample is likely to be closer to the 1987 data as they appear in the DHS survey:

	urban	rural	male	female
BCG	99 %	95 %	97 %	97 %
3 DPT+P	94 %	67 %	79 %	80 %
Measles	85 %	67 %	76 %	76 %

source : DHS, Morocco, 1987.

There were only 5 measles deaths (2%) and 3 pertussis deaths (1%) in the ECCD sample which shows the impact of vaccinations when compared to commonly admitted figures of 10 to 20% of deaths due to measles among children less than 5 years of age and 5 to 10% of deaths due to pertussis in the same age group. All measles and pertussis deaths occurred among unvaccinated children living in rural areas where vaccination coverage is lowest.

Tuberculosis seems to be in a declining trend (3 % of deaths) but still remains a significant disease despite the high BCG coverage (97%). Studies conducted in India have shown that BCG did not guarantee full protection [11].

Systematic screening among patients coughing for more than 15 days and early treatment of tuberculosis should be promoted in addition to vaccination to control this disease.

The case of neonatal tetanus has already been discussed at length. We hope that tetanus toxoid immunization of pregnant women which started recently will soon have an impact on this major cause of death.

No case of poliomyelitis was found even among other causes of death; this is a rather encouraging result even though polio is a rather rare disease and chances of finding a case in a sample of 254 deaths are rather small.

The last two diseases that account for a significant number of deaths could also be at least partly prevented by vaccination: meningococcal meningitis and viral hepatitis. New vaccines against hepatitis B are know produced by cloning and are very cheap: they can be usefully integrated in the EPI schedule as has been already done in pilot projects in Senegal and the Gambia.

If all these causes are added together, one death out of 8 could be averted by improving the national EPI (table 4.1).

4.7 CARE FOR DIARRHEA AND MALNUTRITION

About half the children who died of diarrhea or malnutrition were referred either to a health post (28.2%), to a private practitioner (17.8%) or to a hospital (7.7%). These children could probably have been saved if they had received proper care, except those who were referred too late. However, when reading the questionnaires, the most frequent case is that of children who were referred several days before death and who received as treatment only a few Oral Rehydration Therapy (ORT) packets given to the mother. This is never enough when dehydration is severe. ORT requires a precise dose intake at the same time to correct for dehydration and also to avoid electrolytic shocks. In severe cases this is a treatment to be given in a hospital or a specialized health facility that can be a simple building but where qualified personnel are necessary [12]. In severe cases, mothers without medical and pharmaceutical knowledge can not be relied upon to render effective treatment. The following example illustrates this point:

"A child 13 months old, weaned two months before, developed diarrhea and vomiting. After a visit to a traditional healer on the first day of the illness, the mother took him to a private practitioner on the second day who gave a first treatment. There was no improvement and mother and child went to the same physician who prescribed: ORT packets, Aspirin, two injections of unknown origin and two type of syrups. The child died of dehydration 3 days later".

The issue of malnutrition is even more dramatic. Messages about ORT seem to have been widely spread in Morocco as shown by various KAP surveys; the opposite is true for malnutrition which seems to have been forgotten. In no case of death from severe malnutrition in the ECCD survey did the child receive proper care; if he was referred, the physician at most gave advice to the mother about feeding practices. As for dehydration, a severely malnourished child needs specific treatment to gain weight and this can be done only in specialized centers: again they can be simple buildings but qualified personnel is needed. In addition it does not seem that there is a systematic screening of malnutrition

at the level of health facilities whereas simple techniques such as taking arm circumference have been shown to be very effective in other countries. As long as these two issues are not properly approached, ie the systematic screening for malnutrition and appropriate care for malnourished children, there is little chances that this major cause of death will diminish in the short run.

4.8 FEEDING YOUNG CHILDREN

Many cases of poor feeding of young children have been spontaneously reported by the families (the questionnaire did not include detailed questions on feeding practices); they are probably a direct cause of malnutrition and eventually of death. A few examples at various ages, among neonates, infants and children include:

"A child was born with a low birth weight and the mother thought her breast milk was bad. She fed the child with goat milk half mixed with water. The child died at age 12 days".

"A child was 7 months old when the mother was admitted in a hospital. He was weaned too early and was fed with only cow's milk. He died of diarrhea soon after".

"A child was exclusively breast fed until age 7 months. He had repeated episodes of diarrhea and the mother thought that her breast milk was bad and the child was weaned suddenly; he was fed with tea and bread. He died 5 months later".

"A child was exclusively breast fed until age 20 months. At time of weaning he refused any solid food and died of diarrhea two months later".

4.9 THERAPEUTIC ERRORS

Many questionnaires indicate serious therapeutic errors. Typical examples come from diarrhea deaths; hereafter are two examples:

"A child 13 months old had diarrhea and vomiting for eight days. He was taken to a private practitioner on the eighth day and received: a yeast mixture (ultralevure) and multi-vitamins preparations (acti-5 et sirovityl). He died 10 days later of dehydration".

"A child 16 months old, severely malnourished with oedema on both feet (kwashiorkor) had repeated episodes of diarrhea. He was taken to a private practitioner on the fourth day of acute diarrhea. He was given an antidiarrheal drug (Immodium) and Aspirin. The child died three days after the visit".

Various cases of improper treatments were also reported for other diseases and the frequent case of improper care for the malnourished children has been discussed before.

In cases of Acute Respiratory Infections (ARI) private practitioner often recommended only one or two antibiotics when admission to hospital would be necessary at this stage to allow oxygenation of the child.

Last, besides cases of therapeutical accidents reported earlier there was a case of therapeutical error found in a prescription: this was the case of a 3 year old child who had an acute nephritis: he was treated with "cyclines" drugs and died shortly afterwards.

4.10 DISCUSSION

The analysis of circumstances of death show two major problems: the lack of early referral, in about half of the cases and improper care by the health system in the other half of the deaths.

Relatively little attention has been devoted to the precise socioeconomic conditions in which death occurred, mostly because of a lack of information. There is little doubt that most of the deaths occurred in an environment of poverty, ignorance and remoteness, the role of which is rather difficult to evaluate. However the importance of these factors should not be overestimated since some countries or states (China, Sri-Lanka, Kerala) achieved the control of child mortality despite socioeconomic conditions at least as severe as those of rural areas in Morocco.

The emphasis of this analysis has been put on technical errors within the health system; however psychological aspects should not be forgotten: they do not show-up in the questionnaire but they may be very important, in particular the relationship between the patient and the physician, quality of the welcoming and of the exchange of information: to a large extent these factors determine the acceptability and the credibility of health services.

The role of family planning also does not show-up in this analysis due to a lack of data. However it seems likely that many of the feeding or weaning errors are linked to a lack of fertility control.

Lastly, the analysis of these questionnaires cannot pretend to approach all the issues related to the health of children less than 5 years in the country. In particular there are many problems that should be made the target of major public health interventions but which do not aim at reducing child mortality.

CHAPTER 5 : MAIN CONCLUSIONS

AND RECOMMENDATIONS FOR A SURVEILLANCE OF CAUSES OF DEATHS

5.1 MAIN CONCLUSIONS

The detailed study of causes and circumstances of deaths among children less than 5 years of age in Morocco was conducted using the verbal autopsy method on a representative sample of deaths. The study gave good estimates of the frequency of main causes of death among children less than 5 years of age and it highlights many important public health issues that the country faces. From the reading of the questionnaires, these issues can be summarized as follow:

1) referral to modern health care is insufficient.

In 89% of cases of child death, the child was not admitted to a hospital when his status required admission and in half the cases the child was not seen by qualified health care personnel. Underestimating the severity of the disease, remoteness from health facilities and economic problems seem to be the main factors for this.

2) antenatal care is insufficient.

The high frequency of prematurity and low birth weight among neonates (44%) suggests that pregnant women have a low awareness of conditions in which a pregnancy should develop: hygiene, rest, food ...

3) delivery often takes place in a poor environment.

The high frequency of tetanus (22 %), of birth trauma (20%) and of other neonatal infections (12%) indicates that delivery often takes place in conditions of poor hygiene, welcoming and care.

4) care of premature and low birth weight babies is insufficient.

The high mortality of premature and low birth weight babies even in health facilities calls for a greater awareness of the need for better and more effective care for these high risk categories, especially in the case of multiple births.

5) vaccination can still be improved.

The national EPI for children is one of the most visible success of concerted public health actions in Morocco: the frequency of EPI target diseases among the causes of death is rather low when taking the level of mortality into account. However, immunization of pregnant women started only recently and it will be important to monitor the tetanus toxoid immunization coverage among women of childbearing age. Furthermore, the actual EPI coverage could still be improved in rural areas and the hepatitis B vaccine could usefully be added to the actual vaccine schedule.

6) current use of ORT should to be reconsidered.

The high frequency of deaths from diarrhea indicates that the current use of Oral Rehydration Therapy (ORT) is inappropriate to reduce mortality from rehydration, although it is widely known and used. This seems to be due to a lack of specific infrastructure, for instance small rehydration units at the level of health posts and dispensaries. The home based ORT solution can be used

only as a preventive measure of dehydration; it is not enough to treat acute dehydration.

7) Malnutrition is rarely screened for and rarely treated.

Clear cases of malnutrition described by the families were present is about one third of the deaths outside of the neonatal period. Even when they were referred to medical personnel these children did not receive proper care and their nutritional status has rarely prompted the physician to start a special treatment. This is unfortunate since screening can be done in a simple manner, for instance by taking the arm circumference. As for diarrhea, the treatment of malnutrition requires specific care and infrastructure, for instance small nutritional rehabilitation units. Nutritional advice is usually not enough to treat severe malnutrition. Malnutrition in Morocco seems to be concentrated in a few rural areas in the north and in the south.

8) The feeding of young children is often inappropriate.

Although the questionnaire was not designed for tackling this issue, many cases of inappropriate feeding were spontaneously reported by the families. There is obviously a serious problem, mostly at the time of weaning but also since birth in some cases.

9) Therapeutical errors.

Cases of therapeutical errors were rather frequent and they deserve a particular attention. First of all, hygiene at time of vaccination needs to be considered and this point is important for further acceptability of the EPI. Furthermore, advice concerning drugs counter-indications does not seem to be carefully followed.

5.2 OBSERVATIONS ON COMMON IDEAS

It should be noted that these observations are rather in opposition with many common ideas circulating in official services, even though they will no surprise public physicians who well know concrete issues in the field.

It is often argued that causes of neonatal death are "endogenous" and due to a large extent to congenital defects; this is an old French classification already obsolete even in Europe (see for instance the DHS survey report p 80). The opposite is true: the causes of neonatal deaths are identifiable, they are mostly infectious diseases or the result of conditions of pregnancy and delivery; they are susceptible to simple, specific and potentially effective interventions.

The same is true for causes of death among infants and children. Because prevalence of malnutrition is not as high in Morocco as in countries of South Asia, there is a tendency to ignore malnutrition whereas it is likely to be the first public health problem for the under 5 children outside of the neonatal period. Let us recall a simple computation: in the DHS report (p 98) 6.4% of children 12-23 months are below two standard deviations of median international values of weight for height whereas this proportion is 2.5% in well nourished populations: there are approximately 3.9% of wasted children (low weight for height) in this age group; mortality in this age group being 1.7% it is not surprising to find a majority of malnourished children among the deaths when one

knows that risks of deaths among malnourished children are 5 to 10 times higher than among well nourished children living in the same conditions. The same is true for stunting (low height for age): according to the same sources there are 33.0% of children 12-35 months below two standard deviations of height of age whereas this proportion averages 2.5% in well nourished populations; these 30.5% stunted children are also at higher risk of death and it is not surprising to find among them the 2.5% children who died [13,14].

5.3 RECOMMENDATIONS FOR A SURVEILLANCE OF CAUSES OR DEATHS

Cause of death registration is known to be deficient in Morocco. A surveillance of cause of deaths using the verbal autopsy technique on a representative sample of the population could allow us to have annual statistics of causes of death and to evaluate the impact of public health programmes on cause specific child mortality. To achieve this goal it will be necessary to create a bureau in charge of this task at the Ministry of Public Health and to find funds to collect the data in the field.

The Bureau of Causes and Circumstances of Death

The bureau of Causes and Circumstances of Death shall gather a physician, in charge of controlling the quality of the survey and of the coding, a nurse in charge of the coding and the filing of the questionnaires and a computer person in charge of entering the data and producing the tables. The bureau shall be equipped with a high speed micro-computer and a reliable printer.

The questionnaire

The questionnaire used for the ECCD, already very satisfactory, could be improved.

a) it could be simplified: socioeconomic questions could be reduced to these important for the analysis. One can propose to keep:
- a classification of areas of residence: sparse rural / villages / popular urban (medina, slums) / average urban / upper class urban.
- a classification of geographical areas : low lands / mountain / desert.
- literacy of mother and father;

b) it could be completed for some information:
- duration of labor for neonates;

c) some symptoms could be more accurately described:
- rashes, skin lesions, abscesses, oedema, whoop, harsh cough;

d) accurate information on vaccination status shall be gathered for both mother and child;

e) details on child feeding practices should be recorded and coded;

f) the section on referral should be prepared and coded to facilitate later analysis;

f) a section on "physician judgement" could be added to ease the analysis of the questionnaire. It could include questions directly related to public health programmes under evaluation: for instance the 9 points cited above in the main conclusions (5.1), questions to which the physician reading the questionnaire should answer if there was a failure at this level or not.

The sample

The questionnaire shall be given to a representative sample of deaths in the country. The sample could be changed each year. There are various options for drawing the sample. The simplest will be to draw a sample of itinerant health workers (agents itinérants), renewable each new year, and to ask them to record systematically all deaths below age 5 over a year among the households they visit routinely. They could receive a part time salary in addition. Cluster sampling could also be used; it could be produced twice a year and all deaths since the previous 6 months could be surveyed.

5.4 DISCUSSION

The analysis of 382 ECCD questionnaires revealed the statistical importance of main causes of deaths in Morocco and to pinpoint some of the major public health issues in the country. The survey has been conducted with simple means. It showed that it is possible to gather systematically data on causes of death at an affordable cost in a country without complete vital registration and where the coverage of health facilities is far from complete. It seems that this study is the first systematic attempt in a developing country to gather statistical data of causes of death among children. If this study has only one effect, let us hope that it will help convince decision makers that such a study is feasible and worthwhile doing.

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cause of death	major signs	minor signs
neonatal tetanus	trismus opisthotonos spasms refusal of breast (between day 2 and 27)	constipation fever slaver crying
birth trauma	feeble or no breathing (since birth) hypotonia abnormal color of skin mother's description	low temperature difficulty in suckling convulsions high birth weight first pregnancy/delivery
prematurity	pregnancy<=8 lunar months low birth weight	
low birth weight	pregnancy>=9 lunar months weight<2.5 kg or description of very little baby	
congenital defect	mother's description	
ARI	fever difficult breathing >24 h. - fast breathing - palpitating nostrils - insuction	cough noisy breathing
laryngitis	fever harsh voice	
tuberculosis 1	cough>= 3 months weight loss troubles breathing at least one of following: - treatment against TB - contamination - spitting blood	night fevers
tuberculosis 2 (miliary)	cough < 15 days contamination	fever
pertussis	cough > 15 days typical whoop vomiting, mucous spitting after whoop at least one of following: - mucous hemorrhage - contamination	fever weight loss
chicken pox	vesicular rash fever	contamination infected vesicles

cont...

cause of death	major signs	minor signs
poliomyelitis	fever paralysis of legs happened in one day	asphyxia
acute diarrhea	liquid stools < 15 days no blood in stools at least one of following - loss of skin elasticity - dry mouth, lips - sunken eyes - rare urine - sunken fontanelle	fever vomiting
dysentery	same signs as for diarrhea blood in stools	
typhoid	fever > 15 days asthenia, extreme weakness troubles in moving bowels	contamination
meningitis 1	fever vomiting at least one of following - stiff neck - swollen fontanelle - convulsions	constipation headache
meningitis 2	fever hemiplegia	
epilepsy	repeated convulsions loss of consciousness at least one of following: - biting tongue - urinating during crisis	
hepatitis, icterus	description of icterus - yellow eyes, skin - dark urine - white stools terminal coma	fever
septicemia 1	fever skin infection	asthenia
septicemia 2	fever diarrhea ARI at least one other infection - urinary infection	convulsions vomiting
malaria	high fever convulsions death in less than 48 hours	healthy before

cont...

cause of death	major signs	minor signs
kwashiorkor	weight loss oedema on feet, face	chronic diarrhea poor feeding
marasmus	weight loss gross muscle wasting old looking face	chronic diarrhea poor feeding
malnutrition	weight loss, without any particular other sign	chronic diarrhea poor feeding

A-5 LIST OF PEOPLE PARTICIPATING IN THE SURVEY

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