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Reaction patterns in selected lymphatic tissues associated with sudden infant death (SID)

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Abstract In 50 cases of sudden infant death cervical, paratracheal and lung hilar lymph nodes, the thymus and the spleen were investigated by histology and immunohistochemistry (CD 20, 21, 45RO). The cases were divided into 3 groups based on autopsy findings including extensive histology: A – without pathological changes (N = 12), B – with minimal to intermediate inflammation (N = 23) and C – with severe inflammation (N = 15). In accordance with previous results the frequency of "pathological" lymph node changes, such as paracortical lymphoid hyperplasia and variegated hyperplasia of the pulp increased from group A to group C. The B-cell antigens reacted accordingly. A pronounced lymphodepletation of the thymus as a sign of a long lasting stimulation of the T-cell system was also observed increasingly from group A to C. In summary, in none of the cases results obtained were indicative of a defect of the T- or B-cell system. The results in group A seem to indicate that changes in the reaction pattern of the lymphoid tissues could be a more sensitive method of detection of early stages of inflammation than local histology.

Key words Sudden infant death · Lymph nodes · Thymus · Histology · Immunohistochemistry

Introduction

In a series of 56 sudden infant death (SID) cases Entrup & Brinkmann [1] described different types and/or grades of inflammatory lung changes. Correlations to the various reaction pattern of the lymphatic tissues [2] showed that 77% of cases with pulmonary inflammation had different varieties of the florid type of reaction compared to only 17% of control cases. Immunological and histological investigations carried out in SID cases [3, 4, 5] gave no evidence for disturbances of the humoral immunsystem in these infants. The questions arose whether these associations could be confirmed by immunohistochemistry and wether the distribution patterns of B- and T-cells in these tissues showed deviations indicating disturbances of the immune reaction.

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Materials and methods

Thorough post mortem examinations (including histology on 28 organs and tissues, bacteriology, virology and full toxicological screening) were carried out on 50 SID cases at the Institute of Legal Medicine in Münster between 6 and 46 h postmortem (on average 27 h) using a standardized autopsy protocol similar to that of the SIDS Global Strategy Workshop [6]. The cases were subdivided into 3 groups as follows [1, 7] (Table 1):

- A: no pathological findings, no previous history of illness (SIDS cases, N = 12),
- B: minimal to intermediate changes ("SIDS+" [8, 9, 10], N = 23);
- C: pathological changes relevant to the cause of death (non-SIDS, N = 15);

The weight of the thymus was recorded at necropsy. The lymphatic tissues were derived from both lobes of the thymus, the spleen (cross section) and cervical, paratracheal and lung hilar lymph nodes, fixed in buffered formalin and embedded in paraffin. Sections (6 mm) were cut and stained with Haematoxylin-Eosin, Giemsa and Alcian Blue-PAS. Lymphocytes in lymph nodes (nl) and spleen were further characterized by the antibodies CD20, CD21 and CD45R0 (Dakopatts) using paraffinembedded specimens and, in frozen sections of the thymus by the antibodies CD3, CD4 and CD8 (Dakopatts) using the ABC-technique [11].

Histology

Lymph node (nl) changes were classified as follows [2, 12, 13]. If combination patterns between the defined reaction patterns were observed, the most prominent one was chosen for classification.

– *Follicular hyperplasia* (FH). Pronounced enlargement and numerical increase of germinal centres, exhibiting a high mitotic activity and numerous macrophages with tingible bodies.
– *Paracortical lymphoid hyperplasia* (PLH). The paracortical areas showing a rapid and excessive increase of large lymphoid cells with prominent nucleoli and a basophilic cytoplasm (Giemsa staining – immunoblasts).
– *Variegated hyperplasia of the pulp* (VHP). The extrafollicular cortex, the paracortex, and the medulla are characterized by the occurrence of abundant immunoblasts which show increasing differentiation to plasma cells towards the hilus.
– *Sinus histiocytosis* (SH). Pronounced numerical increase of histiocytes within sinuses.

Thymus

To classify the reaction patterns [14, 15] only the predominant feature was taken. Transition forms were also recorded.

– *Resting stage* (RSt). Clear cortex/medulla distinction, high density of lymphocytes in the cortex without lymphophagocytosis.
– *Acute stress reaction* (ASR). Dispersion of the cortex with increase of macrophages with a starry-sky aspect, blurring of medullo-cortical boundaries, hyperemia, septal oedema with varying lymphocyte content, early signs of cortex shrinkage.
– *Adaptation reaction* (AR). Reduction of cortical width, enlargement of the medulla, advanced lymphophagocytosis, foci of lymphodepletion, numerical hyperplasia of Hassall's corpuscles. Septal infiltration by blasts, myelocytes, and few eosinophilic granulocytes, increasing separation of thymic lobules.
– *Inversion stage* (ISt). Collagenised septa, shrinkage and separation of lobules, more pronounced lymphodepletion of the cortex leading to a "reverse" picture of lymphocyte density in the medulla and the cortex, loss of distinction between cortex and medulla.

Spleen. Acute reactive hyperplasia of the spleen due to infection is characterized by a hyperplasia of the myeloid and lymphoid cells of the red pulp and sometimes by congestion with erythrocytes. The lymphoid follicles are usually hyperplastic with large reactive centres showing phagocytic activity [16]. The size of the follicles (small, intermediate, large), the number of follicles (far, several, many) and the activity of germinal centres (no activation, weak to intermediate activity, strong activity) were evaluated and each graded from 1–3. The average score was calculated from the three parameters for each case and for the whole group.

Immunohistochemistry

The properties of the antigens used are:

– *CD20* reacts with most B-lymphocytes (blood, lymphatic tissues) especially in the germinal centres and with B-immunoblasts while other haemopoetic cells do not react [17, 18].
– *CD21* reacts with an antigen on the majority of B-cells and follicular dentritic cells [19, 20].
– *CD45R0* reacts with most thymocytes, with mature activated T-cells and with a T-cell subpopulation carrying the antigens CD 4 and CD 8 [21, 22].

The intensity of the immunohistochemical reaction of lymphocytes in lymph nodes and spleen were scored semiquantitatively in relation to standard slides (grade 1 = < 25%, grade 2 = 25%–50%, grade 3 = 50%–75%, grade 4 = > 75% positive cells) and the arithmetic means of these grades were calculated for the groups.

Table 1 Categories of sudden infant death and pathological findings in the cases of the defined groups. IP – interstitial pneumonia, grading according to Entrup & Brinkmann [1], Bajanowski & Brinkmann [31]

Disease	Group A $N = 12$	Group B $N = 23$	Group C $N = 15$
Rhinitis	0	3	1
Pharyngitis	0	4	3
Tracheitis	0	7	5
Bronchitis	0	3	3
IP grade 1	0	7	0
grade 2	0	0	3
grade 3	0	0	8
Bronchopneumonia	0	0	4
CMV inclusion disease	0	2	5
Tonsillitis	0	8	5
Enteritis	0	2	1
Nephritis	0	1	0
Carditis	0	0	6[a]

[a] Borderline type after Aretz [36] – $N = 3$; and lymphocyte infiltration with sarcolysis, no fibrosis – $N = 3$

Table 2 Reaction patterns of lymph nodes in the three groups. "Physiological" and pathological reactions are summarized

	Group A		Group B		Group C	
	N	%	*N*	%	*N*	%
Inconspicuous	3	25	0		0	
FH	4	33	9	39	3	20
PLH	3	25	9	39	8	53
VHP	2	17	2	9	4	27
SH	0		3	13	0	
Total number	12		23		15	
Normal (inconsp. + FH)	7	58	9	39	3	20
Pathological (PLH + VHP + SH)	5	42	14	61	12	80

FH follicular hyperplasia, *PLH* paracortical lymphoid hyperplasia, *VHP* variegated hyperplasia of the pulp, *SH* sinus histiocytosis

Results

1. Histology

Lymph nodes (Table 2). Germinal centre reaction was observed in all cases except three of group A which were young infants (Table 2). Thus FH (Follicular hyperplasia) was a regular and the most predominant finding in the cases listed (Table 2). The pathological features showed an increase from group A to C which is significant if "physiological" and "pathological" findings are combined (Table 2).

Thymus (Table 3). Transition forms were present in 11 cases. Resting stages were only observed in group A. ASR and AdR showed no major differences between the groups while ISt was nearly doubled from group A to C.

Table 3 Reaction patterns of the thymus in the three groups. The number of transition forms is given in brackets between the lines

	Group A		Group B		Group C	
	N	*%*	*N*	*%*	*N*	*%*
RSt	3	25	0		0	
ASR	1	8	7	30	2	13
			(5)		(1)	
AdR	6	50	11	48	7	47
			(2)		(3)	
ISt	2	17	5	22	6	40
Total	12		23		15	

RSt resting stage, *ASR* acute stress reaction, *AdR* adaptation reaction, *ISt* inversion stage

Table 4 Comparison of nl and thymus reaction patterns

nl	Thymus			
	Rst	ASR	AdR	ISt
Inconsp.	1	1	1	0
FH	2	3	9	2
PCH	0	3	10	7
VHP	0	2	3	3
SH	0	1	1	1

Table 5 Spleen. Average score of the size and the number of follicles and the activity of germinal centres graded from 1 to 3. Number of specific findings in the different groups

Spleen	Group A	Group B	Group C
Number of follicles	2.36	2.23	1.93
Size of follicles	2.45	2.32	2.20
Activity of follicles	2.36	1.95	1.73
Mean value of the group	2.29	2.17	1.95
Late stage of acute reactive hyperplasia	1	7	1
Immature lymphocytes	0	0	2
Sinusgranulocytosis	0	0	2
Massive iron deposits	1	0	1

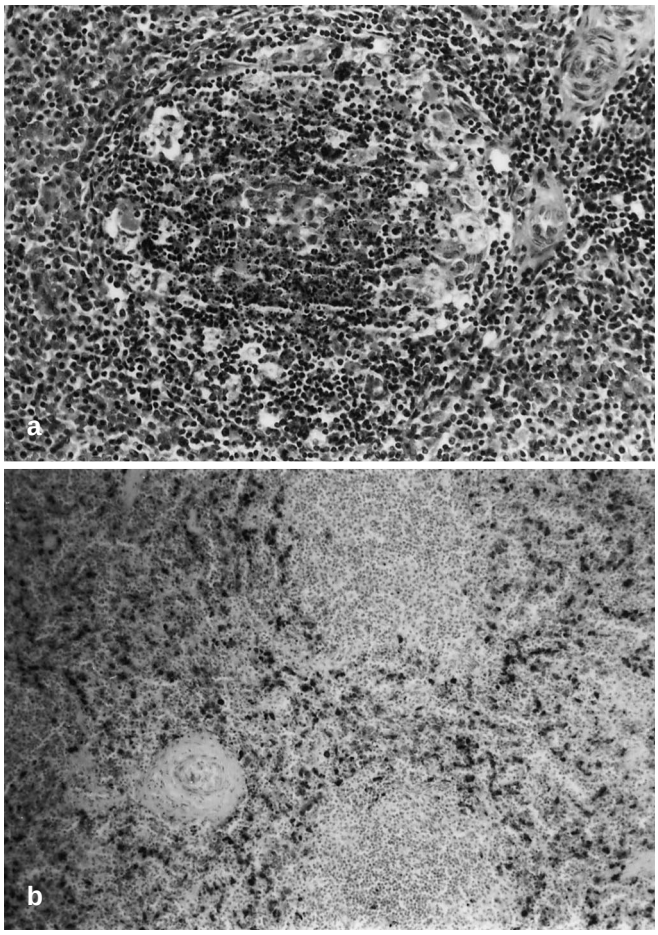

Fig. 1 Histology **a** Late stage of reactive hyperplasia of the spleen with remnants of cells and nuclei in a germinal centre. HE, 250 ×. **b** Intensive iron storage in the red pulp of the spleen detected by Berliner blau staining. 100 ×

The comparison of nl and thymus findings showed that RSt of the thymus was associated with "normal" reaction patterns of nl and that AdR and ISt could be observed in association with pathological reaction patterns of nl (Table 4).

Spleen. Follicles and germinal centres were present in all cases. The evaluation of the size, the number of follicles and the activity of germinal centres resulted in only small differences between the groups. The mean values for all three parameters were quite similar (Table 5) suggesting that there is no correlation between the grade of inflammatory disease and the histological reaction patterns of the spleen. In addition, numerous polymorphonuclear leukocytes and a high number of phagocytic cells containing ingested debris from leukocytes and erythrocytes (late stage of acute reactive hyperplasia; Fig. 1a, Table 5), a large number of atypical or immature lymphocytes, sinus granulocytosis and massive iron deposits (Fig. 1b, Table 5) were observed in some cases.

2. Immunohistochemistry

nl. With two expections, all antigens were detectable in all cases. In these two cases CD20 gave negative results although all other markers were normally expressed. CD20 showed the strongest expression in group C while CD21 and CD45R0 were weakest in group C (Fig. 2a + b).

Inconsistent or negative reactions were obtained in the *thymus* using CD3, 4 and 8 which could not be graduated and may be due to the long time interval between death and autopsy and to the storage of the specimens over some months at –20° C before investigation.

The immunohistochemical reactions of the *spleen* were closely associated to the histological findings. In cases with large follicles and activated germinal centres the number of cells positive for CD20 and CD21 was rela-

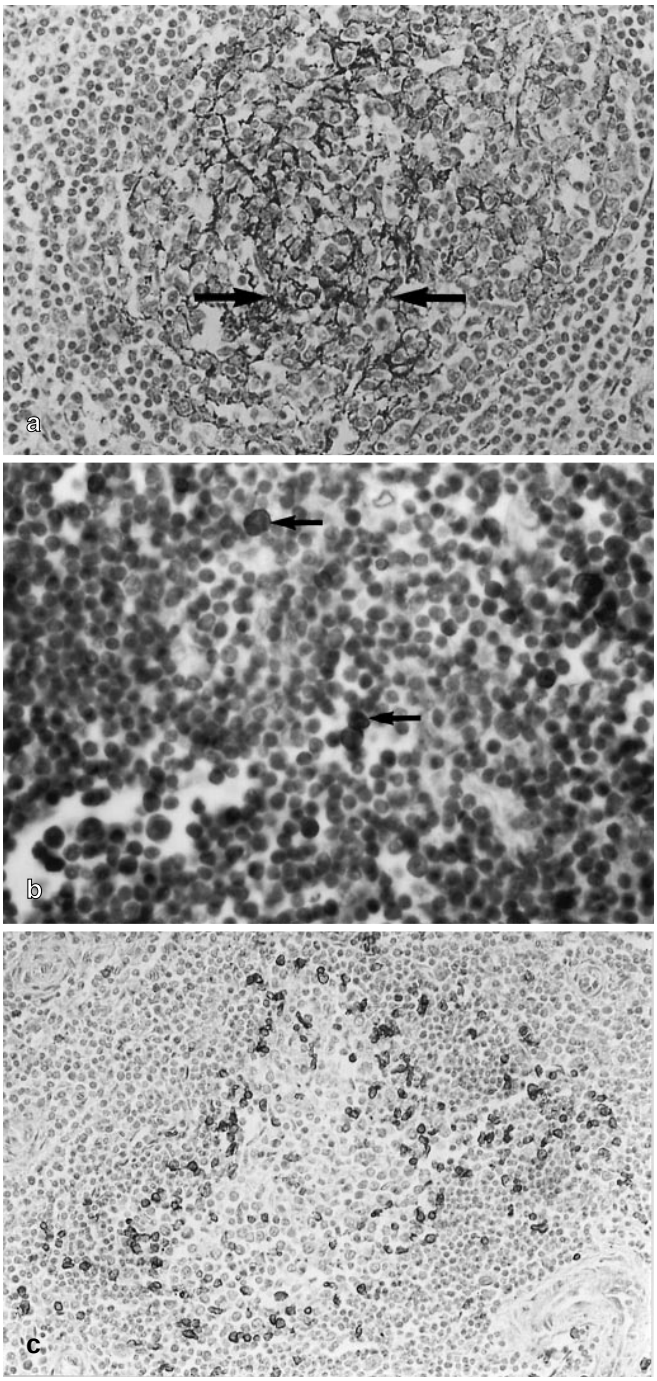

Fig. 2 Immunhistochemistry **a** Follicular hyperplasia of a lymph node. Strong reaction with CD20 (→) in a germinal centre. 100 ×. **b** Diffuse lymphatic hyperplasia. Weak reaction of the T-cell antigen CD45R0 (→) in the paracortical area of a nl. 400 ×. **c** Spleen. Germinal centre with positive T-cell reaction (CD45R0) in the periphery of the follicle. 250 ×

tively high. The reaction strength for CD 21 and CD45R0 (Fig. 2c) showed no group specific differences. The reaction strengths for CD20 and CD45R0 in the groups A and B were also very similar but lower in group C (Table 6).

Table 6 Antigen strength in lymph nodes and thymus in the three groups

Organ	Antibody	Group A	Group B	Group C
Lymph node	CD20	2.0	1.85	2.33
	CD21	1.69	1.69	1.53
	CD45R0	2.0	1.95	1.67
Spleen	CD20	3.25	3.30	2.87
	CD21	2.33	2.4	2.4
	CD45R0	2.66	2.7	2.54

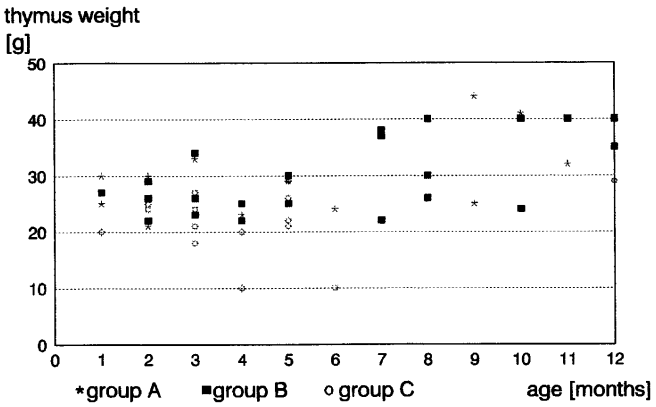

Fig. 3 Thymus weights and ages in the cases of groups A, B and C

Age distribution and *thymus weight*. The age distribution of group C obviously differed from the other 2 groups (Fig. 3) because the infants in group C were with 1 exception younger than 7 months, while group A and B show a more continuous distribution. But the age distribution in group C was also typical for SIDS cases.

The thymus weight increased during the first year of life. In most cases of group C the thymus weights were lower compared with age-matched victims in group A and B (Fig. 3) independent of sex.

Bacteriology and virology. In 2 cases from group A no bacteria could be detected. In 4 cases with long postmortem intervals (time between the presumed death and autopsy longer than 30 h) bacteria which occur physiologically in the intestine were found (e.g. escherichia coli) in swabs originating from the airways. *Pseudomonas aeroginosa* and *bacteroides* species could be cultured in the material from the airways in a further 4 cases and in 2 cases without histological signs of inflammation, *pneumococci* and *klebsiella pneumoniae* were found in the middle ear. Bacteria could not be detected in 6 cases from group B. In 9 cases bacteria were found in the swabs from the airways indicating postmortem contamination and in 9 cases (39%) *pneumococci* (N = 3), *meningicocci* (N = 1), *klebsiella pneumoniae* (N = 6), β-haemolysing streptococci (N = 2) were cultured, partially in combination. In group C pathogenic bacteria were found in 7 cases (47%; *pneumococci*, N = 3; *klebsiella pneumoniae*, N = 2; *stapphylococcus aureus*, coagulase positive, N = 1, β-*haemolysing*

streptococci, *N* = 2). Virological investigations after culture and electron microscopical examination were negative in the swabs from the respiratory system in all 50 cases. Using PCR [23] cytomegalovirus could be deteted in the lung parenchyma in 1 casec of group C.

Discussion

Pathogenic bacteria could be found in increasing frequency from group A (17%) to B (39%) and C (47%). The significance of the positive results of bacteriology has to be considered for each single case, taking the autopsy findings, the results of histology and the possibility of postmortem contamination into consideration.

Lymph nodes. FH is a common form of germinal centre reaction and was regularly found in the SID series except for 3 cases (very young infants aged 4, 5 and 7 weeks). FH is associated with proliferation of specifically antigen reactive, immunocompetent B memory cells [24] and indicates chronic stimulation by antigens in a secondary or in a later phase of primary immune response. It basically requires a specific interaction between B- and T-cells. PLH is induced by a cell-mediated immune response leading to relevant changes in the paracortex. Accumulation of T-cells and immunoblasts leads to enlargement of the paracortex [25]. These cells can migrate to other lymphatic organs and cause a generalized immune response. PLH and VHP indicate very recent infection [26]. These features increased from group A to C while T-cell antigens showed normal expressions. VHP and SH seem to be especially associated with virus infection [2]. FH could be found in all nl regions investigated as a "generalized" feature while PLH and VHP if present were more often and more strongly expressed in the lung hilum. Since FH was a regular finding and associated with normal antigen distributions (CD20, CD21) it can be concluded that FH is "normal" in this age group thus indicating chronic or repeated antigen stimulation. Also a strong correlation of pathological nl changes (Table 2) to the increasing frequency and severity of inflammation in group B and C could be demonstrated. While VHP is the local type (associated with virus infection) and PLH is the general type (cell-mediated immune response), their occurrence indicates virus infection associated with the anatomical region of nl sampling (e.g. lung, upper airways).

Thymus. Dourov [27] reported that thymus involution could be a possible sign of disease and established some criteria to grade the extent of involution. Van Baarlen et al. [15] were able to demonstrate a correlation between thymic involution and duration of acute disease. The most important grading criteria was a quantification of lymphophagocytosis. – The grading scheme of Kloos and Vogel [14] additionally considers lymphocyte migration which gradually increases from a low level at the ASR through an intermediate level (AdR) – equivalent to subacute reaction – to the highest level at the inversion phases – equivalent to a long lasting or repeated stimulation of the T-cell system. In accordance with these findings normal thymus patterns (RSt) were only observed in group A and the acute type of reaction was more pronounced in group B.

The relatively low thymus weights in group C indicate a "stress-related" involution [28, 29] due to illness [27, 30]. According to Van Baarlen et al. [15] it can be concluded that in these cases a longer and more severe illness must have occurred than was known from the previous history. In 75% of the cases in group A the thymus histology also indicates previous or actual stress (Table 3). It can be supposed that pathological nl changes and signs of stress in the thymus in group A could be a more sensitive parameter than local histology indicating early stages of inflammation.

Spleen. Theoretically follicle activity should increase in accordance with the severity of inflammation. But number, size and activation stages of follicles are neither alone nor in combination discriminative parameters for the groups formed (Table 4). A possible explanation is that in the present series only cases with acute inflammation were included which did not lead to an intensive reaction of the spleen. Mild to moderate activation in group A could be due to preceding or to previous infection which is presently characterized by an activation of lymphatic tissue only (e.g. interstitial pneumonia of grade 0 – [31]). IHC confirmed in each case the results of the histology but gave no additional information.

Late stages of reactive hyperplasia (remnants of nuclei, *N* = 5) in cases of group B could be due to a previous inflammation or the acute disease diagnosed which should have much more significance than supposed by assessment of the local inflammation. An increased number of immature lymphocytes and granulocytosis in the present cases indicate a generalized immunological reaction due to an infection unknown from previous history. The iron storage can be due to fetal hemolysis in 1 case aged 9 weeks and due to inflammation with increased hemolysis in the other case (6 months old).

Since group C showed a different age distribution from groups A and B, age dependent differences in the reaction patterns of lymphoid tissues could not be verified.

In accordance with the previous study [2] and the results of others [3, 4, 5] a substantial lack of reactivity in the immune system of SID victims could not be demonstrated. The B- and T-cell antigens investigated showed normal reactivity and a correlation with the histological classifications. The different reaction patterns of nl, thymus and spleen correlate with each other and in general also with the severity of the diagnosed disease. In some cases from group A (SIDS cases) reaction patterns were observed which are normally associated with acute inflammation. The immune response characterized by these reaction patterns could be due to an early stage of inflammation showing no specific histological signs [31] or no specific focus for the infection [32]. These reaction patterns in group A indicate inflammatory stress [15] but are

obviously not compatible with a rapidly overwhelming infection leading to death. It must be supposed that not only foudroyant infection may precede a measurable immune response [33]. Also minor inflammatory changes in "typical SIDS cases" seem to be characterized by detectable immune response and may contribute to some cot deaths [34, 35].

References

1. Entrup M, Brinkmann B (1990a) Histologische Lungenbefunde beim plötzlichen Kindstod. Z Rechtsmed 103:425–433
2. Entrup M, Brinkmann B (1990b) Histologische Untersuchungen des lymphatischen Gewebes beim plötzlichen Kindstod. Z Rechtsmed 103:415–424
3. Müller W, Arend W, Kleemann WJ, Tröger HD, von der Hardt H (1987) Immunglobuline und spezifische Antikörper bei plötzlich verstorbenen Säuglingen. In: Der Minister für Arbeit, Gesundheit und Soziales des Landes NRW (Hrsg) Plötzlicher Säuglingstod. Interdisziplinäres Symposium 13. Juni 1987 in Münster, pp 89–99
4. Lemke R, Althoff H, Sünnemann S (1991) Vergleichende immunologische Untersuchungen von SIDS-Fällen und altersgleichen stationär behandelten Säuglingen. Klin Pädiatr 203:162–166
5. Lemke R, Schäfer T (1992) Histochemischer Immunglobulinnachweis bei plötzlichen Säuglingstodesfällen (SIDS). Pathologe 13:252–254
6. Brooks DR, Krous HF, Burton JL, McKinley W (1994) Results of a pilot test of the Global Strategy Workshop's International Standardized Autopsy Protocol (SAP) in Georgia. In: Third SIDS international conference 1994, program and abstracts, Holstad Grafisk, p 155
7. Taylor EM, Emery JL (1990) Categories of preventable unexpected infant deaths. Arch Dis Child 65:535–539
8. Wennergren G, Norvenius G, Alm B (1995)What symptoms amd signs can we accept within the SIDS diagnosis? A clinical view of the new use of the SIDS definition. In: Rognum TO (ed) Sudden infant death syndrome. New trends in the nineties. Scandinavian University Press, Oslo Copenhagen Stockholm Boston, pp 26–18
9. Huber J (1995) The pathologist's contribution to the prevention of cot death, and why it is important to abolish the concept of SIDS as a nosological entity. In: Rognum TO (ed) Sudden infant death syndrome. New trends in the nineties. Scandinavian University Press, Oslo Copenhagen Stockholm Boston, pp 46–49
10. Rambaud C, Guilleminault C, Campbell P (1995) Sudden explained, partially explained, and unexplained infant deaths: an alternative to SIDS diagnosis. In: Rognum TO (ed) Sudden infant death syndrome. New trends in the nineties. Scandinavian University Press, Oslo Copenhagen Stockholm Boston, pp 40–45
11. Hsu SM, Raine L, Fauger H (1981) A comparative study of the peroxidase-antiperoxidase method and an avidin-biotin complex method for studying polypeptide hormones with radioimmunoassay antibodies. Am J Clin Pathol 75:734–739
12. Cottièr H, Turk J, Sobin L (1973) A proposal for a standardized system of reporting human lymph node pathology in relation to immunological function. J Clin Pathol 26:317–331
13. Meyer EM (1980) Reaktionsmuster der lymphatischen Organe unter Immunstimulation, Immunsupression und während der Carcinogenese im Tierexperiment. Habilitation, Westfälische Wilhelms-Universität Münster
14. Kloos K, Vogel M (1974) Kyematopathologie. Thieme, Stuttgart
15. van Baarlen J, Schuurmann H-J, Huber J (1988) Acute thymus involution in infancy and childhood; a reliable marker for duration of acute illness. Hum Pathol 19:1155–1160
16. Battisto JR, Streili SW (1976) Immunoaspects of the spleen. Elsevier North Holland Biomed Press, Amsterdam Oxford New York
17. Norton AJ, Isaacson PG (1987) Monoclonal antibody L 26: an antibody that is reactive with normal and neoplastic B lymphocytes in routinely fixed and paraffin wax embedded tissue. J Clin Pathol 40:1405–1412
18. Takami T, Ishii Y, Yuasa H, Kikuchi K (1985) Three distinct antigen systems on human B cell subpopulation as defined by monoclonal antibodies. J Immunol 134:828–834
19. Nadler LM (1985) B cell leukaemia panel workshop: summary and comments. In: Reinherz EL, Haynes BF, Nadler LM, Bernstein ID (Eds) Leucocyte Typing II. Vol 2: Human B lymphocytes. Springer, Berlin Heidelberg New York Tokyo, pp 3–43
20. Mason DY, Ladyman H, Galler KC (1985) Immunhistochemical analysis of monoclonal anti-B cell antibodies. In: Reinherz EL, Haynes BF, Nadler LM, Bernstein ID (eds) Leucocyte typing II. Vol 2. Human B lymphocytes. Springer, Berlin Heidelberg New York Tokyo, pp 245–255
21. Smith SH, Brown MH, Rowe D, Callrads RE, Beverly PCL (1986) Functional subsets of human helper-inducer cells defined by new monoclonal antibody, UCHL 1. Immunology 58: 63–70
22. Akbar AY, Terry L, Timms A, Beverly PCL, Janossy G (1988) Loss of CD45R and gain of UCHL 1 reactivity is a feature of primed T cells. J Immunol 140:2171–2178
23. Cecchi, R, Bajanowski T, Kahl B, Wiegand P (1995) CMV-DNA detection in parenchymatous organs in cases of SIDS. Int J Legal Med 107:291–295
24. Thorbecke G, Lerman SP (1976) Germinal centers and their role in immune responses. In: Reichard SM, Escobar MR, Firedmann H (eds) The reticuloendothelial system in health and disease. Adv Exp Med Biol, Vol 73A. Plenum Press, New York London, pp 83–95
25. Fitch FW, Hunter RL jr (1978) Histology of immune responses. In: Sauter M, Talmage DP, Rose B, Austen KF, Vaughan JH (eds) Immunological diseases, vol 1. Little, Brown and Cie, Boston, pp 81–104
26. Lennert K, Schwarze EW, Krüger G (1981) Lymphknotenveränderungen durch Virusinfektionen. Verh Dtsch Ges Pathol 65:161–171
27. Dourov N (1982) L'examen microscopique du thymus au cours de la période périnatale. Ann Pathol 2:255–261
28. Boyd E (1932) The weight of the thymus gland in health and in disease. Am J Dis Child 43:1162–1170
29. Van Haelst U (1967) Light and electron microscopic study of the normal and pathological thymus of the rat. II. The acute thymic involution. Z Zellforsch 80:153–158
30. Schuurman H-J, van Baarlen J, Huber J (1988) The thymus in the acquired immune deficiency syndrome. In: Kendall MD, Ritter MA (eds) Thymus update I. The microenvironment of the human thymus. Harwood Academic, London, pp 171–180
31. Bajanowski T, Brinkmann B (1995) Pulmonary viral infection in SIDS. In: Rognum TO (ed) Sudden infant death syndrome. New trends in the nineties. Scandinavian University Press, Oslo Copenhagen Stockholm Boston, pp 203–206
32. Byard RW (1994) Infectious conditions. In: Byard RW, Cohle SD (eds) Sudden death in infancy, childhood and adolescence. Cambridge University Press, pp 95–130
33. Berry CL (1989) Causes of sudden natural death in infancy and childhood. In: Mason JK (ed) Paediatric forensic medicine and pathology. Chapman & Hall Medical, London, pp 165–177
34. Blackwell CC, Saadi AT, Raza MW, Weir DM, Busuttil A (1993) The potential tole of bacterial toxins in Sudden infant death syndrome. Int J Leg Med 105:333–338
35. Kleemann WJ, Hiller AS, Tröger HD (1995) Infections of the upper respiratory tract in cases of sudden infant death. Int J Legal Med 108:85–89
36. Aretz HT (1987) Myokarditis: the Dallas criteria. Hum Pathol 18:619–624