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Book of the Quarter

SUDDEN DEATH IN INFANCY, CHILDHOOD AND ADOLESCENCE

Roger W. Byard and Stephen B. Cohle, Cambridge University Press, New York and Melbourne, 1994, pp. 545, £60.00.

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From a strictly epidemiological point of view the amount of coverage given to cot deaths in the medical literature (>1500 papers from 1960–1983) and the media is disproportionate to the number of sudden deaths from other causes during infancy, childhood and adolescence. As cot deaths decline so does their relative contribution to total sudden deaths in these age groups. Drs Byard and Cohle seek to redress this perceived imbalance by considering sudden death up to the end of the period of adolescence. They recognise a difficulty in defining 'sudden' and 'unexpected' and consider that a definition of 'sudden' based on any rigidly fixed period between the onset of symptoms and death is too arbitrary; similarly not all sudden deaths are 'unexpected'. They define sudden death as death occurring *within a few hours* of the onset of symptoms; this includes those who die suddenly having been completely well; those who had apparently only minor illness prior to sudden death and those who die suddenly against a background of stable major illness.

Byard and Cohle's study covers the first 20 years of life except the first week because of the 'relatively unique nature of the neonatal period'. Sudden unexpected death is a common problem in the first week of life; birth disorders and injury may also be relevant to sudden death occurring weeks or months later and the omission of the first week of life from consideration is a significant defect in a book which seeks to be comprehensive.

In 1992 there were 530 cot deaths in Great Britain.[1,2] The number of sudden deaths from 'natural' causes during the first 20 years of life would probably be at least twice that[3,4] and the number of sudden deaths from accidents comprising traffic accidents, falls, burns, drowning, poisoning and other non-cot deaths three times that.[1,2,5] Cot deaths probably now account for under a fifth of sudden deaths during infancy to adolescence. In keeping with the authors' aim of giving adequate representation to sudden death occurring beyond infancy 16 per cent of the book is devoted to cot death and 84 per cent to the period beyond.

Byard and Cohle are respectively a paediatric pathologist from Australia and a forensic pathologist from the United States. Byard contributes eleven and a half chapters and Cohle one and half. The book incorporatates much of their own work and at the same time quotes from the relevant particularly North American literature extensively. It provides a comprehensive in-depth examination and critical analysis of the pathology of sudden death although short summaries of clinical features accompany most of the conditions described. The prime focus is on the autopsy and such morbid anatomy and histology as that reveals. Where autopsy in any particular condition would fail to reveal an aetiology but clinical

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history and/or *in vivo* investigations could possibly do so, the clinical approach is discussed, but much less comprehensively and critically.

Byard and Cohle define the following three categories of sudden death from infancy to adolescence, each encompassing a wide range of clinico-pathological entities:

(1) *In a well child* cardiac arrest followed by collapse and death can occur; examples include cot death, congenital heart disease, cerebral haemorrhage, trauma, poisoning and drowning.
(2) *Mildly unwell children* may be in the early stages of a serious disease from which they may die suddenly; examples include viral myocarditis, bacterial meningitis and epiglottitis; a separate minor illness coinciding with an unrecognised lethal one; a major disease or disorder which is deliberately ignored; non-accidental injury or other forms of child abuse; multiple pathology the summation of which results in sudden death, for example, a coronary artery anomaly may only result in sudden death when complicating anaemia leads to myocardial hypoxia.
(3) *Children with significant apparently stable long-term illness* such as asthma or epilepsy may also die suddenly.

The commonest age-related disorders in the first 20 years of life are cot deaths in the first year; congenital abnormalities, infections, malignancy and accidents in the middle years and accidents in the later years. As cot deaths and accidents occur most commonly in boys, sudden death has a male preponderance.

Based on a descriptive and aetiological structure the authors examine and categorise the range of disorders causing sudden death among infants, children and adolescents. They begin with a consideration of accidents and child abuse and end with cot death. Sandwiched between these topics, and occupying 65 per cent of the book, is an examination of the pathology of the different organs and systems which may result in sudden death.

ACCIDENTS AND NON-ACCIDENTAL INJURIES

As forensically orientated pathologists Byard and Cohle devote one fifth of their book to accidents.

In the first dependent year of life fatal accidents are uncommon but infants are peculiarly vulnerable to non-accidental death at the hands of abusing adults. As early childhood is entered limiting understanding, increased mobility and curiosity lead to a rising toll of fatal accidents in the home, at play and in the street. In young manhood and womanhood acceptance of risk, a spirit of adventure and the irresponsibility of youth result in a high liability to motor car, motor cycle and sporting accidents. In Great Britain in the 0–20 age group there are about 1,450 accidental deaths per year of which 60 per cent occur in the 16–20 age group. Sixty per cent of accidents in this latter group are the result of road traffic accidents.[1,2,5] In the same group emotional lability is common and suicide not infrequent.

These risks are reflected in the described pathology of sudden accidental death and in addition to the purely anatomical and histological findings many of the circumstances leading to them are described. This information is of value not only to the pathologist but also to those who deal medically with children and adolescents whether in the hospital, the community or the home.

A few examples selected from the book illustrate relationships between pathology and mechanisms of sudden death following accidents. The child's narrow trachea and narrow main bronchi are easily blocked by inhaled foreign bodies and the lesser bronchi and bronchioles by water (drowning): the greater mobility of the child's head means that acceleration or deceleration including that resulting from vigorous shaking can easily cause lethal intracranial haemorrhages—of further forensic relevance is the fact that 'whip lash' injuries caused by abusive shaking are uniquely associated with retinal haemorrhages; solid organs like the spleen are more vulnerable to impact than hollow organs like the stomach; in a fire 50% saturation of haemoglobin with carbon monoxide is lethal; infants lying face down on polystyrene mattresses may rebreath CO_2 and die; suffocation or poisoning may be the end points of the strange disorder called 'Munchausen's syndrome by proxy' in which a parent or other attendant causes illness or injury to a child and then brings this to the attention of the medical profession in order to obtain ill-understood self-gratification.

ORGAN AND SYSTEM-RELATED DISORDERS

While pathologists may well see Byard and Cohle's book as a text-book in a branch of their subject clinicians are more likely to see it as an interpretation of pathology which supplements clinical understanding, emphasises clinico-pathological relationships and at times provides a special pathological dimension to clinical problems.

As cardiac disorders are dealt with medicaly and surgically at earlier and earlier ages the need to understand and recognise those predisposing to sudden death increases. Cardiomyopathy, aortic stenosis, total anomalous pulmonary venous drainage, Ebstein's anomaly and certain types of aberrant coronary arteries are important in this context. Such disorders are significant not only in the child in whom they are known to exist but also in the apparently healthy young athlete who drops dead in the middle of his exertions. The possible roles of disturbed conduction pathways within the heart or autonomic imbalance as causes of fatal arrythmias remain something of an enigma.

The pathologist can often point to inconclusive histological evidence which will require to be complemented by lifetime cardiovascular studies if the true meaning of that evidence is to be understood. The nature of Kawasaki disease is unclear but it has now probably replaced rheumatic heart disease as the major cause of acquired heart disease in childhood. The damage which it does to the coronary arteries can result in sudden death not only in the acute or healing phase but also years after the disease has apparently subsided. Sudden death from myocarditis is a particular threat when infection from the Coxsackie virus occurs in early childhood. A connective tissue disorder such as Marfan's disease may result in sudden death as a result of a dissecting aortic aneurysm.

One sixth[6] to one third[3] of sudden deaths in children and adolescents are due to respiratory disease. The authors discuss the incompletely understood mechanisms of sudden death in asthma in conjunction with observable autopsy changes such as mucus plugging of the airways, hyperinflation of the lungs, bronchial wall oedema and pneumothorax. The possible contribution of beta-adrenergic bronchodilator drugs to death from cardiac arrhythmia of hypokalaemia is described as is the possible role of adrenal suppression as a result of prolonged steroid usage. The increasing survival of infants with congenital anomalies such as

tracheomalacia, or bronchopulmonary dysplasia in low-birthweight infants may be factors in later sudden respiratory death. Fulminating bronchopneumonia, acute epiglottitis and laryngotracheo-bronchitis are not uncommon causes of sudden death in early childhood; probably less common is bronchiolitis in infancy associated with the respiratory syncitial virus.

Within the neurological system intracranial bleeding can cause sudden death and is likely to be due to rupture of congenital arterial defects such as aneurysms. Necropsy may reveal that meningococcal infection or encephalitis have caused sudden death before diagnostic features have revealed themselves. Cerebral tumours may cause death due to acute disturbance of cerebral blood or cerebro-spinal fluid flow. In epilepsy, apart from suffocation during an attack, autonomic instability with sympathetically induced cardiac arrythmias or respiratory arrest resulting from an epilepsy-related central nervous system abnormality may result in death.

Common gastro-intestinal disorders which may cause sudden death and which require an appreciation of the pathology include intussusception, volvulus and perforation. The severe electrolyte disturbance which can complicate gastro-enteritis may likewise prove fatal.

Sudden death can occur in malignancies, one of the commonest being cerebral haemmorhage associated with platelet deficiency in acute lymphatic leukaemia.

Metabolic disorders in the main do not figure prominently in sudden death but Byard and Coyle cover a few which do, such as medium-chain acyl CoA dehydrogenase deficiency, glycogen storage disease, maple syrup urine disease, diabetes and congenital adrenal hypo- or hyperplasia.

COT DEATH (SUDDEN INFANT DEATH SYNDROME)

Although much of the book is devoted to sudden death beyond the cot death period, cot death is adequately covered.

The most comprehensive formal definition of cot death is that of the US National Institute of Child Health and Human Development quoted in the book, 'the sudden death of an infant under one year of age which remains unexplained after a thorough case investigation, including performance of a complete autopsy, examination of the death scene, and review of the clinical history'. This is a purist definition of cot death and excludes cases where an abnormality is found at autopsy. The authors discuss 'pure' cases but as pathologists with a wider view of sudden death they appropriately extend their appreciation of the subject of cot death to cover cases where a pathological abnormality is discovered and into that 'grey' area where something is found which *may* be relevant.

Cot death was only recognised as a death certificate diagnosis in the United Kingdom in 1971 and as a separate coding in the World Health Organisations's International Classification of Diseases in 1979. However, as Byard and Cohle point out sudden death in infancy has been a recognised phenomenon since biblical times. In the Registrar General's reports up to 1971 many cases of 'overlaying' and 'inhalation' in infancy were probably cot deaths.

Byard and Cohle emphasise the importance of a very careful study of the death scene as an essential component in seeking understanding of the individual case.

If the understanding of the aetiology of a disease in inversely proportional to the number of aetiologial theories propounded about it cot death must be one of

the least understood diseases. It probably is. Byard and Cohle identify in a table 47 possible mechanisms and in the text discuss some of these at greater length. Respiratory tract theories include obstructive apnoea due to aspiration, anatomical abnormalities of the respiratory system, immaturity of autonomic control of the larynx, apnoea due to abnormal neural control of respiration particularly during REM sleep, and reduced lung surfactant. Cardiovascular theories on aetiology put the blame on arrythmias such as prolongation of the QT interval, the Wolff–Parkinson–White syndrome and heart block. Neurological dysfunction arising from brain-stem gliosis, axonal changes, white matter changes, neurotransmitter abnormalities and chemoreceptor changes have been incriminated. Reflux of the acid contents of the stomach has been postulated as a triggering factor for apnoea and bradycardia. Infection with the respiratory synctial virus and the cytomegalovirus, immunological deficiency, vaccination with diphtheria–tetanus–pertussis vaccine, in-born errors of metabolism, trace metal deficiencies, hyperthermia and vitamin deficiencies have all come in for their share of blame. At a simple clinical level there are those who point to the abandonment of the practice of the tight abdominal binder and excessive clothing as reasons for recent improvement in cot death mortality on the basis that the former has allowed more freedom of respiration and the latter has reduced the risk of hyperthermia.

To this list can be added many other aetiological factors including male sex predominance, a maternal age of less than 20 years, lower socioeconomic status, maternal smoking, artificial feeding, cold climate and the past existence of a sibling who suffered cot death.

Over the years the sleeping arrangements for babies have been the subject of much controversy. In the animal kingdom the young usually sleep with their mothers and for centuries the human animal adopted this practice. In the early part of the present century 'overlaying' of the infant by the mother when the two shared a bed was considered a frequent cause of sudden infant death due to suffocation. In Scotland, a century ago, there were those who advocated making it illegal for infants and young children to sleep in bed with their parents,[7] especially so if the mother had consumed alcohol

In more recent years the relationship of the sleeping position to cot death has aroused much interest. In 1943 Bristol was an 'American' city in that a large number of American servicemen were stationed there, some with wives. I remember seeing a pram complete with sleeping infant parked outside a shop while the mother was shopping inside. Attached to the pram was a notice, 'This is an American baby and he sleeps face downwards'. This practice was due to the belief that a baby sleeping on his back might regurgitate feed and aspirate it with fatal results. In time this risk was largely discounted and for a variety of reasons, including the possibility that cot death was more likely in the prone position and that a prone baby might be at risk from rebreathing CO_2 or suffocate the practice became discouraged. In Britain a 'back to sleep' campaign was launched in 1991 and formally endorsed by the UK Government Chief Medical Officer's Expert Group in 1993.[8]

The incidence of disease can wax and wane for unexplained reasons and the coincidence of waning with any particular measure may induce a misplaced confidence in the effectiveness of that measure. While there had been some reduction in the incidence of cot death in the years up to 1990 the increasing emphasis on keeping babies sleeping on their backs since 1991 does seem to have

had a beneficial effect in reducing the number of such deaths. There were 1337 cot deaths in England and Wales in 1989 and 442 in 1993.[9] Similar reductions in incidence have been seen in New Zealand and the Netherlands following campaigns emphasising that babies should sleep on their backs.

Although published in 1994 Byard and Cohle's textbook has antedated the recent suggestion that in the conditions of warmth and humidity created by urine and faeces *Scopularis brevicaulis* in contact with plastic covers could react with the polyvinylchloride and the antimony incorporated in it as a fire retardant to produce the toxic gas stibene. It remains to be seen whether this theory has any validity[10] but a premature presentation on television caused great anxiety to mothers.

Byard and Cohle consider that cot death may be the fate of a heterogeneous group of physiologically vulnerable infants who do not all exhibit the same kinds of functional impairment or developmental delays. The system compromised to the point of initiating a lethal result may vary from infant to infant resulting in variability in the mechanisms responsible for death. They conclude that "this hypothesis may partially explain the tangle of contradictory data in the literature that has built up around that enigmatic 'non-diagnosis' which we have chosen to call SIDS".

CONCLUSION

Sudden death is a circumstance which is of little use to the practising clinician in the diagnosis and care of an individual patient. The hope must be that the information in a book on sudden death may be of value to him in preventing or predicting future episodes. The paediatrician and the adult physician with an interest in the adolescent may well be helped by Byard and Cohle's book in that way but they may be somewhat overwhelmed by the amount of pathological detail.

As with most single topic expositions the book is something of a catalogue but none the worse for being that. Tables of causes, characteristics, pathological features and comparisons figure prominently but the matching text does justice to this presentation. The book makes a unique and important contribution to organising and setting out in a structured way the somewhat scattered information available on sudden death during infancy, childhood and adolescence. The extensive illustrations are virtually all pathological although not all of them clearly show the lesions indicated in the captions.

Sudden death in infancy, childhood or adolescence carries for the clinician a special responsibility as counsellor and supporter both of patients who suffer from any disorder which carries the risk of sudden death and grieving parents who have lost a child from such an event. Counselling, for example, of parents who have suffered a cot death and ethical issues such as organ transplantation after sudden death are not covered in this book.

For the paediatric pathologist the book is likely to be essential reading; for the physician it is more likely to be an option for his library or, at a lesser level, for a library visit. The chapters are extensively referenced and the number of references which refer to clinical aspects of sudden death make the book a good source for such references.

A number of Appendices deal with autopsy protocols.

REFERENCES

[1] Registrar General for Scotland, Annual Report, 1993. Edinburgh: HMSO.
[2] Office of Population and Censuses and Surveys. Mortality Statistics, 1992. London: HMSO.
[3] Molander P. Sudden natural death in later childhood and adolescence. *Arch Dis Child* 1982; **57:** 572–6.
[4] Denfield SW, Garson A. Sudden death in children and young adults. *Pediatr Clin North Am* 1990; **37:** 215–31.
[5] Forfar JO. Accidental death in childhood: In Forfar JO, Arneil GC eds. Textbook of Paediatrics. Edinburgh: Churchill Livingstone 1973, 1983.
[6] Siboni A, Simonsen J. Sudden unexpected natural death in young persons. *Forensic Sci Int* 1986; **31:** 159–66.
[7] Templeman C. Two hundred and fifty-eight cases of suffocation of infants. *Edinb Med J* 1892; **38:** 322–9.
[8] Chief Medical Officer's Expert Group. The sleeping position of infants and cot death, 1983. London: HMSO.
[9] Court C. Cot deaths. *Br Med J* 1995; **310:** 7–8.
[10] Fleming PJ. Cooke M, Chantler SM *et al.* Fire retardants, biocides, plasticisers, and sudden infant death. *Br Med J* 1994; **309:** 1594–5.

THREE WEEKS IN MALAWI: A LOCUM CONSULTANT EXPERIENCE

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My first arrival in Africa in 1976 had felt very different. Chauffeured with my young family from Kilimanjaro International Airport by a friend, I had pinched myself to make sure I was not dreaming as we passed Masai tribesmen striding beside the road and climbed into the foothills at the base of the mountain where I was to take up the post of medical specialist at a consultant referral hospital just outside Moshi. We reluctantly left in 1982 after six difficult but rewarding years. Now I was back again in Africa, although for the first time in Malawi.

Malawi is a comparatively small land-locked country in central Africa, and shares borders with Tanzania, Mozambique, Zambia and Zimbabwe. Twenty per cent of its area is covered by Lake Malawi and other water masses and in the 1990 census it had a population of 8·4 million, 88 per cent of whom live in rural areas. It has a high infant mortality rate and life expectancy is only 48 years. Only just over half the population have access to a safe water supply and there are 61,405 people per doctor.[1] Lilongwe, located close to Lake Malawi, is the administrative capital but Blantyre, a colonial style city with a population of 500,000, is the commercial centre and lies in the south of the country.

Queen Elizabeth Central Hospital (QECH), the largest hospital in Malawi has 892 beds and acts as the district hospital for Blantyre and regional referral hospital for the south of the country.[2] It is also the main teaching institution for the University of Malawi College of Medicine which opened in 1990. Four years previously the first batch of Malawian students who were to complete their final year in the new medical school started training at several medical schools in UK,[3] returning to Malawi in 1991 and graduated the following year. The preclinical school academic staff started to arrive in 1993 and their first intake of students commenced studies in September 1994. The hospital, on a substantial site, comprises single storey bungalow style wards connected by covered corridors. Scattered through the complex are smart, but not inappropriately plush, new university departments of medicine, paediatrics, obstetrics and gynaecology, and surgery. Establishment staff in these departments include four or five consultants of whom two carry the rank of professor. A few of these are Malawian with other posts filled by British, Dutch, Canadian, American and African expatriates.

The standard of clinical teaching in the department of medicine was excellent and it was a privilege to both observe and participate in the student teaching programme. A separately staffed and funded Malawi Research Project has an excellent programme of research, currently focussed on qinghaosu derivatives for treating cerebral malaria. By contrast with my previous experience in Tanzania, however, there are no consultants in the departments of radiology, pathology, and microbiology, and diagnostic facilities utilising these services are very limited. There is a curious mix of excellent and very poor equipment, with no opthalmoscopes on the medical wards (two of these had recently 'walked', probably to private clinics), no side room microscopes, no rigid sigmoidoscope or even

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