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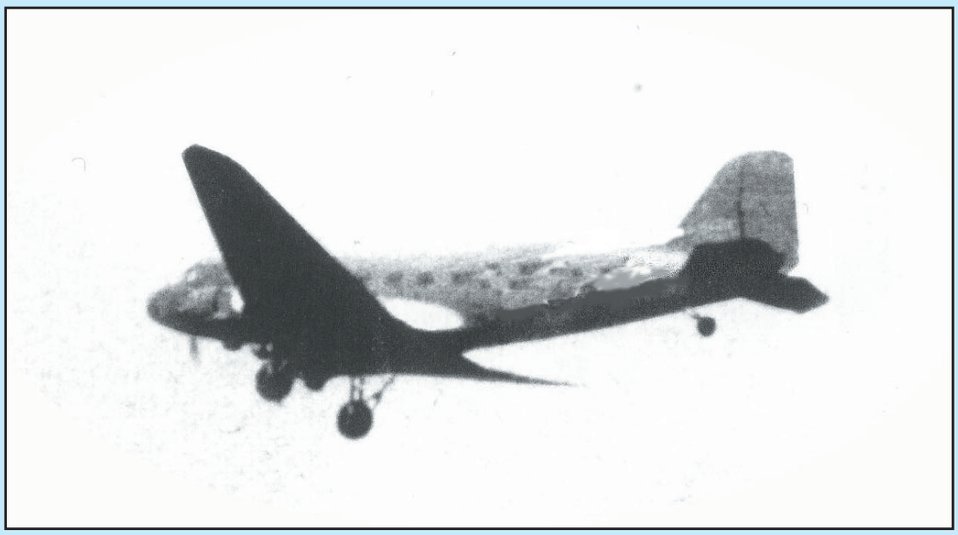

Swedish spy airplane (DC-3) shut down by Russians in 1952, recovered and crew identified, page 5.

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Official journal of the Danish, the Norwegian and the Swedish societies for forensic medicine. The journal will publish original articles, review articles, preliminary communications, letters to the editor and case reports in the different disciplines of forensic sciences: forensic pathology, clinical forensic medicine, forensic genetics, forensic toxicology, forensic anthropology, forensic odontology, forensic psychiatry and forensic science.

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Scandinavian Journal of Forensic Sciences is published by the Danish, the Norwegian and the Swedish societies for forensic medicine. It publishes original contributions and review articles in the different disciplines of forensic sciences: forensic pathology, clinical forensic medicine, forensic genetics, forensic toxicology, forensic anthropology, forensic odontology, forensic psychiatry and forensic science. The journal is also open for debate on issues concerning legal medicine and for news from the societies.

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There is no shame on turning back

(Det er ingen skam å snu)

THE EASTER HOLIDAY is here and thousands of Scandinavians will go to the mountains for skiing.
Unfortunately, every year searches have to be carried out due to bad weather or avalanches.
One of the 10 rules for good behaviour in the mountains is: there is no shame in turning back.

This sound rule to adhere to while in the mountains may also be relevant for Norwegian decision makers. There has been broad support for the idea of establishing a National Institute of Legal Medicine and Forensic Sciences. The vision of the Commissioner of Police, Bjørn Hareide, might meet most of the challenges that face forensic medicine and science in Norway. A national institute should take responsibility for the production and development of the services in legal medicine: forensic pathology, clinical forensic medicine, forensic genetics, toxicology and hopefully also forensic psychiatry. With its own board and director, as well as being a separate item in the state budget, the new national institute might constitute a powerful tool to improve legal processes.

A national institute with an objective similar to the different branches of legal medicine, i.e. to offer highly qualified service, is a very constructive idea. Today legal medicine falls between several bodies: the Department of Justice that focuses on strengthening the police, the Department of Health that is engaged in curative medicine and, the Department of Research and Education that has important challenges to improve university teaching and research.

The 60 years' history of the Institute of Forensic Medicine in Oslo clearly demonstrate the dilemma of being controlled by authorities with different objectives to the institute itself. During the continued economic crisis involving the University it has been tempting to remove academic and other positions marked for forensic medical service and research. On the other hand the large expansion in forensic genetics has become a significant source of funding for the Medical Faculty.

The new legislation on DNA registering of criminals will dramatically increase the need for the production of DNA profiles. In this situation a combination of significant ambitions with a lack of resources, threatens to destroy the vision of a new National Institute that would include all branches of legal medicine. All available resources are now mobilised to increase the capacity of DNA analyses. To maintain the monopoly on forensic genetic service, the Medical Faculty in Oslo sacrifices forensic pathology and laboratory-based research. For example, all forensic pathologists and the scientific staff are being removed from the National Hospital. They will have offices on the other side of the Ring Road and will have to walk more than one kilometre back and forth to work in the autopsy room and in the research laboratories.

It is thought-provoking that medical doctors and scientific staff who need proximity to other hospital departments, such as radiology, microbiology, pathology and paediatrics are to be banished from the University Hospital, whereas those involved in the technical production of DNA profiles – who have no need of such proximity – will remain at The National Hospital.

The last hope is that the Minister of Justice and the Medical Faculty will - like rational mountain skiers - reach the conclusion that there is no shame in turning back.

Torleiv Ole Rognum

Denmark: a dull winter but exciting developments in legal medicine

It has been a dull winter in Denmark with no snow and no winter pleasures. The children suffer, but older people enjoy it!

Life in forensic medicine, however, has not been as dull. In September 2007 we had the enormous pleasure of having Forensic Medicine recognized by the medical health authorities (Sundhedsstyrelsen) as a separate medical specialty. We have already seen some benefit from this, as there is an increasing interest by young doctors in joining us.

After the postgraduate clinical training it will take five years to become recognized as a specialist in Forensic Medicine. This comprises both Forensic Pathology and Clinical Forensic Medicine. The first year will be split into two halves, one in Forensic Medicine and one in Surgical Pathology. A regional council will administer the intake. The next two years will be spent in Surgical Pathology only, and the final two years in Forensic Medicine. There will be a written educational program that must be followed and a number of skills that must be achieved. The educational capacity of the system and the workplace needs have not yet been decided, but the largest intake is expected in the beginning, in order to fill vacancies and to secure the future, as a number in the profession are to retire in the next few years.

We are excited about this development and hope that Norway shall follow soon.

Jørgen L. Thomsen,
Odense, Denmark

In connection with Torleiv Ole Rognum's 60'ties birthday on April 9th, professor Ola Didrik Saugstad and professor Åshild Vege on behalf of Institute of Forensic Medicine, University of Oslo organise a

SEMINAR, FRIDAY 11TH APRIL, KL 10.00-13.00

(Place: Grønt Auditorium, Rikshospitalet, Oslo)

Kl. 10.00-10.10 **Welcome**
Professor dr med Åshild Vege

Kl. 10.10-10.25 **Molecular markers in colorectal cancer**
Professor dr med Ragnhild Lothe
Departmen for Cancer Prevention, Radiumhospitalet

Kl 10.25-10.45 **SIDS-research, from past to present**
Professor dr med Ola Didrik Saugstad
Institute of Pediatric Research, Rikshospitalet

Kl 10.45-11.25 **Molecular autopsy, - new methods in an old procedure**
Professor dr med Antti Sajantila
University of Helsinki, Institute of Forensic Medicine

Kl 11.25-11.40 **Pause**

Kl. 11.40-12.20 **Virtopsy – can high technology radiology replace autopsy?**
Professor dr med Michael Thali
University Forensic Institute Bern, Center Forensische Imaging and Virtopsy

Kl. 12.20-12.35 **Crash dummy – useful in estimation of violence in head trauma?**
Post doc Arne Stray-Pedersen
Institute of Forensic Medicine, University of Oslo

Identification, of four crewmembers of the Douglas DC-3 79001 Hugin by DNA analysis, *52* years *post mortem*

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ABSTRACT Four out of eight crew members of the military aircraft Douglas DC-3 79001 Hugin were found and identified 52 years *post mortem* by comparative DNA-analysis. The aircraft was discovered 51 years after being shot down at the bottom of the Baltic Sea at a depth of 100 meters. Since extremely little ante mortem data was available on the missing crew members an early decision was made that identification of possible human remains would rely on DNA-analysis. In fact, bone and dental remains were recovered with diaphyseal bones still containing marrow. DNA analysis could be performed on marrow, bone and dental tissue with mostly complete DNA profiles. Routine procedures for DNA extraction and analysis of the markers in ProfilerPlus™ and COfiler™ and the Y-chromosome minimal haplotype markers were used. Identification was done by comparison of DNA profiles of the remains with DNA profiles from a minimum of two close relatives. In some instances comparisons were also done between several bone samples to identify the number of deceased crew members. The identity of the four members found was ascertained with a statistical significance of more than 99.999% in all cases. For the four still missing the search for the truth of their destiny continues.

***Keywords*: DNA testing; Disaster victim identification; Forensic genetics; Y-chromosome.**

INTRODUCTION

On the 10th of June 2003 at 9.59 pm a DC-3 aircraft was discovered by the Deep Sea Productions (an organisation of divers interested in finding old wreckages on the sea bottom) in the Baltic Sea at a depth of approximately 100 m. The aircraft, later identified as the Douglas DC-3 79001 Hugin, had been shot down by a Russian pilot while on a surveillance mission during the cold war on the 13th of June 1952 at 11.14 am [1]. Since then the whereabouts of the 8 male crew members were hidden in darkness, but not forgotten. The aircraft was found after a 46-day search scanning more than 6,750 km2 of the sea bottom [2]. This fostered new hope to find and identify the missing men. The aircraft was found in international waters and since it was of Swedish origin, the Swedish Commission for Disaster Victim Identification became responsible for the identification. Human remains were found during a long period of time from late October 2003 to mid June 2004. The last DNA analysis was performed in March 2006. The DC-3 operation was finally closed on the 25th of May 2007 by a ceremony for the relatives and release of the official report Aircraft Accident Report TP 79 nr 001, 2007 [3,4].

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CASE HISTORY

Recovery of the aircraft: Aircraft crashes always involve a variety of forces. In this case more than 50 years had also passed since the DC-3 was missing and it was impossible to know if there were any human remains left. In late July 2003 an operation was decided on and the first meeting of the identification board was held on the 2nd of September 2003. The main goal would be to find and identify the crew members. DNA analysis and comparison with close relatives would be the main method of choice. Large bones should be the principal material for DNA analysis and would also undergo forensic medical and osteological investigation. The goal was not to identify the body affiliation of each bone fragment.

A pre-inspection with the mini submarine Mantis showed that the aircraft was much more damaged than had been expected. During such an inspection some human bones were also found in a hole in the fuselage. To not lose any parts a net-basket was constructed in which the fuselage of the Douglas DC-3 79001 Hugin was to be lifted to the surface of the Baltic Sea on the 19th of March 2004

Figure 1: The Douglas DC-3 Hugin 79001, March 19, 2004.
The badly damaged hull of the airplane on board the deck of Belos. The net basket was specially constructed for the lift from a 100 m depth at the bottom of the Baltic Sea.

Photo by Detective inspector Harras Kopsch.

Table 1: Results from the osteological measurements of long bones. The AM body length and stature are given in cm including ± SD for the stature.

Crew member	Bone	Length in mm	Stature	AM body length
A	Humerus sin	365	182.9 ± 4.05	188*)
	Humerus dex	366	183.2 ± 4.05	
	Femur sin	508	182.3 ± 3.27	
	Femur dex	508	182.3 ± 3.27	
D	Femur sin	531	187.8 ± 3.27	189
	Tibia dex	440	189.5 ± 3.27	
	Humerus dex	360	181.3 ± 4.05	
	Humerus sin	356	180.1 ± 4.05	
F	Humerus sin	340	175.2 ± 4.05	175
	Humerus dex	343	176.1 ± 4.05	
	Femur sin	473	174.0 ± 3.27	
	Femur dex	480	175.7 ± 3.27	
H	Humerus dex	356	180.1 ± 4.05	183.5
	Femur dex	510	182.8 ± 3.27	

*) possibly wrong information in passport

at 00.20 am (*Fig 1*). Due to the damages and the state of the human remains it was also obvious that material could have fallen out of the aircraft during the crash. A new cryo-technique was therefore adapted to lift the sea bottom to the surface for technical investigation. The bottom sediment 20 cm thick was frozen down to -20°C and four sections of 10 m^2 each were lifted to the surface [5].

To further search for human remains a total area of 6 km^2 of sea bottom was scanned, including a circular area with a radius of 600 m around the aircraft and north eastern corridor of 300 x 1 500 m [3,4].

Ante mortem data: Since more than 50 years had passed, and the secrecy of the airplane's surveillance mission was politically very delicate, there was very little *ante mortem* information available. Medical records were not preserved and a dental record was available in only one case. AM data for stature was available for all 8 crew members (*Table 1*). Fortunately, for all the 8 missing men large family trees could be constructed from which the genetically most informative relatives available were chosen for comparative DNA analysis.

Table 2: Relatives of the eight missing men selected for DNA analysis.

Crew member	Relative analysed
A	Son Mother of son
B	Grandson Half-brother (same mother)
C	Half-sister (same father) Son of half-brother (same mother)
D	Sister 1 Sister 2
E	Brother Son of brother
F	Sister Son
G	Sister Daughter Mother of daughter
H	Daughter Son

MATERIAL AND METHODS

DNA from relatives, AM *ante mortem* samples

Since all the missing persons were male we preferably chose male relatives from the paternal lineage when available. Blood-samples were collected from 2 relatives for 7 of the men and from 3 relatives for one man, which made a total of 17 reference samples (*Table 2*).

DNA from human remains, PM *post mortem samples*

Human remains were found on the 22nd of October 2003, the 23rd of March, the 26th of April and the 11th of June 2004. One of the men was found 435 m and another 600 m away from the aircraft. Samples selected for DNA analysis are shown in Table 3. All the remains were severely damaged and pieces of bone were recovered during a long period of time. Also in many cases only partial skeletons were recovered (*Fig 2*).

DNA extraction

Duplicate DNA extractions were done from the AM blood samples according to a KingFisher mL (LabSystems, Helsinki, Finland) method using the Genomic DNA purification kit (Tillquist Instrument AB, Spånga, Sweden). The main principle is based on binding of DNA to magnetic beads, which are transferred between 5 consecutive tubes containing different reagents by magnetic rods covered with a disposable plastic surface. Reagent volumes and incubation times were adjusted for the KingFisher procedure mainly following the manufacturer's protocol.

DNA-was extracted from PM-samples with soft tissues, marrow and brain, using the Qia-amp, MiniKit (Qiagen) according to the manufacturer's protocol. DNA extractions from bone and teeth were before 2006 done according to Malmström et al [6] using protocol C of the silica-spin column method by Yang et al [7]. From 2006 on we homogenized

Figure 2: Some human remains clearly showing the state they were in when found.
Photo by Detective inspector Harras Kopsch.

Table 3: Post mortem DNA samples collected for analyses, samples analysed and prior hypothesis are shown. The four crewmembers were identified with a probability of >99.999 %.

Year Month	Sample	Tissue analysed	DNA-extraction method	Hypothesis	Crewmember
2003 October	Bone with marrow Marrow	Marrow Marrow	Qiagen Qiagen		H H
2004 March	Marrow Tooth	Marrow Tooth	Qiagen Yang		D H
April	Brain tissue Marrow	Brain tissue Marrow	Qiagen Qiagen		A A
May	Bone with marrow Bone with marrow Femur with marrow	Marrow Marrow Marrow	Qiagen Qiagen Qiagen		D D H
June	Bone with marrow Brain tissue	Marrow Brain tissue	Qiagen Qiagen		F F
July	Femur with marrow	Marrow	Qiagen		D
September	Scull bone Lower jaw	Bone Bone	Yang Yang		D D
2005 June	Femur with marrow Marrow Marrow Marrow Bone with Marrow	Marrow Marrow Marrow Marrow Marrow	Qiagen Qiagen Qiagen Qiagen Qiagen	A? A? A? F? F?	A A A A A
2006 March	Humerus Femur Tibia	Bone Bone Bone	Freezer Mill Freezer Mill Freezer Mill	A? D? H?	A D H

bone samples frozen in liquid N_2 using a Freezer/Mill 6850-115 (SPEX CertiPrep, Gammadata Instruments, Dragør, Denmark) as described by Holmlund et al [8] with extraction of DNA mainly according to Rainio et al [9]. Se also Table 3 for samples and extraction details.

PCR amplification, electrophoresis and analysis

The Profiler Plus™ and COfiler™ (Applied Biosystems) with altogether 13 markers and later on the Identifiler™ with 15 markers (Applied Biosystems) were used for DNA-profiling. The minimal Y-chromosome STR haplotype (Biotype®, Dresden, Germany) with eight markers (nine loci) were used for Y-chromosome analysis. All marker sets were accredited within the laboratory according to ISO IEC 17025.

Amplification of all marker-sets was done according to the manufacturer's protocols except that 10 µL was used as the final reaction volume. For the freezer mill bone powders one aliquote was amplified according to the Identifiler protocol, the other by 94°C denaturation for the first 10 cycles, lowering to 90°C for the following 20 cycles according to the "forensic" protocol by Biotype, (Dresden, Germany). DNA giving partial profiles was also amplified using either the Identifiler or the Biotype protocol extended with 2 cycles. Since the project went on for several years (2003 – 2006) both an ABI 377, ABI 310 and also an ABI 3100 (all from Applied Biosystems) were used.

Evaluation of results and statistical considerations

Since there was no a priori evidence on to whom each piece of remains belonged all DNA profiles were first compared with each of the possible families to check for relatedness. The recommendations given by Gjertson et al [10] were followed for statistical evaluation. Probabilities were calculated with the statistical program Pater [11] using Swedish population frequency databases [12]. A prior probability of 0.5 was used [13]. Y-chromosome results were compared for direct matches and haplotype frequencies were derived from the http://ystr.charite.de (update July 2002, with 13,447 minimal haplotypes, including 698 from Sweden [14,15]. This was the former version of the present Y-chromosome haplotype database www.yhrd.org.

If a deceased had already been identified all consecutive new profiles were first compared to these to search for direct matches. If a direct match was found no statistical calculations were done except for a comparison with a theoretical random match probability, calculated for the most frequent profiles, for ProfilerPlus™ and COfiler™ combined. The statistical significance for a match between such profiles is always grater than 99.999 % [16].

Forensic medicine and anthropology

The main duty of the anthropologist and the forensic pathologist was to sort human remains and establish the number of diseased individuals. First a detailed inventory was done, listing bones by type and body side to search for duplicates. Second, the length of the long bones, which had no cartilage on the joint surfaces, was measured to give a so-called stature [17,18]. The remains were also examined in order to look for injuries and if possible to also find out the cause of death.

RESULTS

Only four of the eight missing members of the crew were found. They were all successfully identified with a significance for identity in all cases greater than 99.999 %. Full profiles were obtained for almost every sample, for both the autosomal and the Y-chromosomal markers, except for the teeth and a few fragmentary bones. When partial profiles were obtained they were combined from multiple extractions and/or amplifications to get full profiles.

The results (*Table 4*) from crew member H are given as a representative example (with the permission of his son and daughter). As shown, the Y-chromosomal haplotype was identical between father and son and in each autosomal locus he shared at least one allele with each of the two children. The calculated probability for H to be the presumed father of the two children was >99.999 %.

No complete skeletons were found. A lot of bones are still missing also for the two persons found away from the airplane. Also from many of the broken bones are parts still missing. In general the remains consisted mostly of only bones and in a few cases also saponified tissue. After so many years it was not possible to deduce if the injuries were *peri- or post mortal*. Only new damages caused by the mini submarine with its robotic arms could be clearly distinguished.

Table 4: Results from the identification of crewmember H. The alleles shared between father and child are highlighted in the results shown for the child. Note the identical Y-chromosomes in H and son.

Marker	H	son	daughter
Autosomal markers			
D3S1358	14, 16	**14**, 17	**16**, 18
VWA	14, 17	**14**, 19	**17**, 19
FGA	20, 24	**24**, 25	**24**, 25
D8S1179	14, 14	13, **14**	13, **14**
D21S11	28, 30	**28**, 29	29, **30**
D18S51	15, 17	**15, 17**	**15, 15**
D5S818	11, 13	**11, 13**	12, **13**
D13S317	8, 13	**8**, 11	**8, 8**
D7S820	9, 10	**9, 10**	**10, 10**
D16S539	12, 13	**12, 12**	11, **12**
THO1	7, 9.3	**7, 8**	**8, 9.3**
TPOX	8, 9	**8, 8**	**8, 9**
CFS1PO	12, 12	10, **12**	11, **12**
Amelogenin			
X,Y	X, Y	X, Y	X, X
Y-chromosome			
DYS19	14	14	
DYS389I	12	12	
DYS398II	28	28	
DYS390	23	23	
DYS391	10	10	
DYS392	11	11	
DYS393	13	13	
DYS385	14-14	14-14	

The remains of only 2 of the 8 missing crew members, that is D and H, were found inside the aircraft. Their severely shattered bones were commingled. D and H were adult males and the only way to distinguish their bones, except for DNA analysis, was the fact that their living height was different. According to the *ante mortem* information there was a clear stature difference between D (189 cm) and H (183.5 cm) (*Table 1*). DNA analyses of the bones also confirmed that the longest femur was from the tallest person D. However, their upper extremities did not show any length difference. DNA samples were, therefore, taken to confirm their body affiliation. According to the *ante mortem* data F was 175 cm tall and the calculations from the length of the *post mortem* long bones agreed with this information. Interestingly, according to ante mortem data A was 188 cm tall. The lengths of the long bones gave a shorter stature of approximately 183 cm. Comparison of the thighbone lengths showed the following stature sizes D > H > A > F between the deceased.

The cause of death of the four deceased remains uncertain and no injuries could be confirmed to have been caused by missiles. Deceased named A was identified by three separate DNA analyses and the cause of death was possibly drowning. D was identified by seven separate analyses. His skeleton showed several injures, particularly to the skull and the cause of death might be due to these injuries. F was identified by two separate DNA analyses and showed no injuries. The cause of death was possibly drowning. H was identified by three separate DNA analyses, the skeleton showed injuries to the lower part of the jaw, the left leg and the right foot. The cause of death might be due to a combination of these injuries and drowning.

In 2005 and 2006 eight additional samples were analysed to prove their body affiliation and also to exclude the possibility of additional profiles which, if found, would indicate remains from still one or more missing men (*Table 2*). In all only four DNA profiles were found.

DISCUSSION

The operation gave, in addition to the real need for identification of human remains, good experience for the Swedish DVI authorities (Disaster Victim Identification) who so far had been spared from grate disasters. In many ways it was a DVI operation, but still quite different. There was no chaotic period and there was plenty of time for planning. The operation spanned over approximately 4 years, and the DNA analysis 3 years. This reflected many changes in both routines and methods for the DNA analysis. In January 2007 recommendations for the role of forensic genetics in disaster victim identification were published by the DNA commission of the ISFG [19]. Retrospectively, we can conclude that, when applicable, they were followed:

- A national DVI organisation where forensic pathologists, odontologist and since May 2002 also forensic geneticists, already existed
- A board of expertise including geneticists was set up early
- Decisions were made at an early stage on what the main purpose of the identification should be
- The type of samples to be collected, from recognisable body parts, for DNA analyses was agreed upon
- Our laboratory (Forensic Genetics) had experience of DNA analysis from bones since the mid 1990-ies
- Pedigrees of the deceased's families were constructed and samples were collected from multiple first degree relatives, when available
- The set of markers and loci to be analysed were decided before starting the analyses
- The general routine of the laboratory for sample tracking and identification casework was used
- The identification was based on DNA analysis with multiple genetic markers namely, autosomal and Y-STR markers and also with a minimum two different samples analysed on two different occasions.

Although some of the samples required repeated DNA analysis the success rate was astonishingly good. The deep and the cold water of the Baltic Sea had in some cases also preserved both brain substance and bone marrow. Care was also taken to keep the remains in a suitable environment so as not to further damage DNA after recovery. Prior to this commission we had experience from the mid and late 1990-ies of successful identifications 24 and 29 years *post mortem*, based on DNA analysis of skeletal or saponified remains found in salt and fresh water using nuclear DNA-markers. Before that Lee and co workers [20] had already in 1989 suggested that DNA-based analysis might be used for the identification of skeletal human remains. Since then several groups have reported successful identifications of remains found in water using nuclear DNA-markers [21,22,23]. Likewise, mitochondrial DNA-analysis has been used to exclude identity approximately 50-80 years *post mortem* [24].

From a geneticist's point of view the best decision made in this operation was to use the pedigrees with information on living relatives. Surprisingly, two of the deceased had identical Y-chromosome STR profiles. This is most probably so by chance only, since the Y-chromosome haplotype in question is the most frequent one (5.9 %) in the Swedish population [14].

Ante mortem information dating back half a century with an apparently not correct body length given in a passport (in A's case 188 cm instead of 183) along with some dental data that were given as a mirror image mixing left and right in a dentist's journal (Irena Dawidson, personal communication) calls for caution when using technical AM data in general and old records in particular.

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Unindentified bodies brought to the Section of Forensic Pathology, University of Copenhagen

A retrospective study 2002-2005

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ABSTRACT During the years 2002-2005 a total of 206 deceased whose identities were yet to be established, were brought to the Section of Forensic Pathology, University of Copenhagen. Age, gender, method of identification and circumstances surrounding the discovery of the bodies were registered. Males outnumbered females (70.5% males). In most cases, the body was decomposed (40.3%) or burnt (22.8%), leaving the body unrecognisable. Other circumstances were bodies found in water (6.8%) or severely mutilated (13%). The most frequently used method of identification was forensic odontology (67%). Other methods of identification were by police verification (7.3%), recognition (5.4%), DNA (4.4%), fingerprints (4.4%) and autopsy findings (1.0%). Ca. 4% of the cases remained unidentified. Most of the cases that remained unidentified were bodies found in water (21.4%), corresponding to approximately a third of all the unsolved cases. The mandatory d cation.

***Keywords*: Unidentified bodies, identification methods, forensic odontology**

INTRODUCTION

Every year a number of unidentified corpses is brought to one of the three institutes of forensic medicine in Denmark. Until the identity of the body has been established a death certificate cannot be issued, and the corpse cannot be released for burial [1]. Verification of the identity of a deceased is important to the relatives. Not only do they want certainty and closure, but identification is also essential in legal issues, such as inheritance and insurance, which cannot be settled without a death certificate. In Denmark it is the responsibility of the police to make sure a corpse is identified [1, 2]. The identification process is usually conducted in cooperation with the institutes of forensic medicine, where, according to Danish law, all bodies which are found dead, must be subjected to a medico-legal examination [2].

The purpose of the present study was to report how many corpses were unidentified at the time of arrival at the Section of Forensic Pathology, University of Copenhagen, over a 4-year period from 2002 to 2005. We also wanted to investigate which circumstances surrounding the discovery of the body were important in terms of the lacking identification, and what methods were employed to identify the bodies.

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MATERIAL AND METHODS

All cases comprising corpses brought to our section in the period 2002-2005 and whose identity were not confirmed at the time of arrival, were obtained by searching the computerized archives at our section. This yielded 106 cases. The forensic dental archive at our institute was also searched, as some unidentified corpses are identified by the forensic odontologist during the autopsy, and therefore do not figure as "unidentified" in the main database. This resulted in an extra 100 cases. More specifically, these latter cases comprise cases where the identity of the corpse was strongly presumed, even though confirmation of the identity by the forensic odontologist was necessary.

We registered the following data: date of birth; sex; circumstances surrounding the discovery of the body; and means of identification. The information was recorded in the death certificate and/or the autopsy report. We set up five categories to describe the overall circumstances surrounding the discovery of the body: 1: decomposed; 2:burnt; 3: body found in water; 4: severely mutilated; 5: found dead under other circumstances. These categories had been chosen from the point of view that they should describe the condition of the body as well as the circumstances at which the body was found. Categories 1 and 2 were further divided into whether the body was found in a place of residence or not. There were 5 cases where information about the circumstances surrounding the finding of the body were not available in the files. Finally, the total number of medico-legal examinations at our institute was also registered for each year, in order to see if there was a change in the percentage of identification cases from year to year.

RESULTS:

The average number of identification cases for each year is 51.5 (fig.1). In the four years covered by our study there appears to be a slight increase in the number of identification cases (44 to 61); an increase not reflected in the total number of medico-legal examinations. On average identification cases comprised 2.8% of all cases in a year. Of the identification cases 3.8% remained unsolved (8 cases out of a total of 206 cases), which means that approximately 0.1% of all cases handled at our section remain unidentified after all relevant identification methods have been tried.

The males clearly outnum-

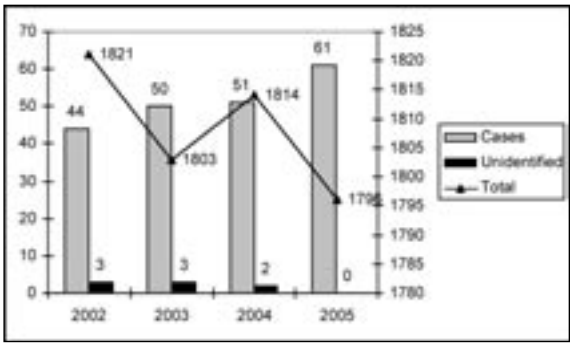

Figure 1: Number of identification cases (grey) and number of cases that remained unidentified(black) for each year. The total number of cases handled at our section is registered for each year (black line).

Table 1: Identification cases divided according to age and gender.

	Age group			
Sex	Adults	Child	Youth	Total
F	56	0	3	59
M	134	4	1	139
All	190	4	4	198

Table 2: Identification cases classified according to circumstances surrounding the discovery of the body, and gender (N/A: data not available).

	Sex		
Circumstances	F	M	Total
Decomposed	27	54	81
- At residence	24	48	72
- Other	3	6	9
Burnt	15	32	47
- At residence	14	27	41
- Other	1	5	6
Found in water	4	10	14
Severely mutilated	7	20	27
Found dead, other circumstances	6	24	30
N/A	1	3	4
Total	60	143	203

ber the females (70.5% males), when the identification cases are classified according to sex and age (Table 1: eight cases not included as either sex, age or both were not available). This tendency is also evident when classifying the cases according to circumstances surrounding the discovery of the body. (Table 2: three cases not included due to no data about gender). The tendency is most pronounced in the the category "found dead other circumstances" (80% males). Table 3 shows the identification cases divided according to which identification method was used and the circumstances surrounding the discovery of the body. The identification category "recognition" includes cases where the body has been identified by relatives. In one case the deceased was identified by photographs, and in another case the general practitioner of the deceased identified the body. The category "police" means that the specific means of identification was not registered in the files. It said simply that the identity of the deceased was verified by the police.

The most frequent category "decomposed" includes 40.3% of the cases (n = 83). The bodies included in this category were either decomposed, mummified or partially/completely skeletonised. These cases all had in common that they had been dead for a while before discovery, and that the condition of the body made recognition nearly impossible. The category "burnt" includes 22.8% of the cases (n = 47). It was very similar to the first category in regard to identification difficulties. The body was usually severely burnt which made recognition very difficult. Like the first category, this category has also been divided into cases found at the presumed residence, and those that were found elsewhere. Examples of other locations were a car, and a hotel room.

The category "found in water" was much smaller and only contained 6.8% of the cases (n = 14). This category presented several difficulties in regards to identification, and this category has a much larger percentage of unsolved cases (21.4%) than any other category. Bodies found in water made up 37.5% of the total amount of unidentified cases.

The category "severely mutilated" included 13% of the cases (n =27) and is a miscellaneous category where the cases had in common that they had been exposed to high energy trauma. The category mainly consists of victims of traffic accidents and people hit by trains, but also includes one case where a person fell from a great height.

The last category "found dead other circumstances" included 14.5% of the cases (n = 30). It is a mixed category where the place and circumstances at the discovery of the body more than the state of the body makes identification difficult. Most of the bodies were found in a public area, often outside, and mostly without any kind of personal papers on them. The body had not been there for long as the bodies in the first category, and therefore it is not very likely that the person has been reported missing. Examples from this category are bodies found on a basement staircase, outdoors on a bench, or as illegal immigrants in prison without any personal identification papers.

The most frequent identification method used in all categories was forensic odontology. The most variability in

Table 3: Identification cases classified according to circumstances surrounding the discovery of the body, and method of identification.

	Identification methods								
Circumstances	Forensic odontology	Recognition	Fingerprints	DNA	Police	Autopsy findings	Unsolved	n/a	Total
Decomposed	**59**	**1**	**3**	**6**	**5**	**0**	**2**	**7**	**83**
- residence	51	1	3	5	5	0	1	7	73
- other	8	0	0	1	0	0	1	0	10
Burnt	**37**	**0**	**1**	**2**	**1**	**2**	**0**	**4**	**47**
- residence	32	0	1	2	1	2	0	1	41
- other	5	0	0	0	0	0	0	1	6
Found in water	8	2	0	1	0	0	3	0	14
Severely mutilated	24	2	0	0	1	0	0	0	27
Found dead, other circum.	8	5	5	0	8	0	1	3	30
n/a	2	1	0	0	0	0	2	0	5
Total	138	11	9	9	15	2	8	14	206

methods of identification is seen in the category "found dead other circumstances", which reflects the variability of the cases: forensic odontology (26.7% of the cases), recognition (16.7%), fingerprints (16.7%), and police (26.7%). This is also the category with the lowest use of forensic dentistry.

DISCUSSION:

The number of corpses brought in annually to our section was constant in the four years covered by the study, but the number of identification cases increased. One explanation could be that more and more people live alone, and thus die alone. A study from 2001 from Denmark [3] showed that more people die alone in cities than in rural areas and that on average more time elapsed in the cities before the corpse was found. In Denmark people still gravitate towards the cities and this could account for the increase in identification cases. With regard to the unsolved cases, the sample is too small (n=8) to see if there is the same tendency. At first glance it would appear not, as the year (2005) with the fewest unsolved cases (0) was also the year with most identification cases. If however we were to observe an increased number of unsolved cases over the following years, then an explanation could be increased immigration to Denmark. Also, after the Schengen agreement, there is less border control and thus less knowledge of who is currently in the country.

All children go to an annual dental check in Denmark, and most continue this tradition in adult life. For some immigrants, especially the refugees, this may be so unusual, that they simply do not go to a dentist. Without dental records, identification by forensic odontology is impossible – which complicates matters as this is by far the most used identification method.

The males outnumber the females in the identification cases. In this study most identification cases comprise decomposed bodies found at the place of residence of the deceased, and it may be hypothesized that more men than women live a solitary life with little contact to the rest of society, perhaps because of alcohol or drug abuse. This could explain why more men than women had been dead for some time before they were found. The extremely uneven distribution found in the category "found dead under other circumstances" supports this theory, since many of the cases in this category most likely consist of people who live "outside" the society (homeless people, alcohol or drug abusers, and illegal immigrants). The distribution of the identification methods used in this category also indicates that a lot of these people have not been to a dentist, doctor or in other ways in contact with authorities for a long time. Forensic odontology was only used in 26.7% of the identifications, which is far less than in any other category, probably because dental records for comparison would be difficult to obtain.

Two of our categories for find circumstances (decomposed or burnt) were further subdivided into bodies found in a place of residence or not. This was done because we assumed that it would make a difference as regards the identification process. If a body is found in a place of residence it would be fair to assume that the deceased lived there, which means that a presumed identity could be established right away. This makes it easy to track down dental records, hospital charts, relatives and so on. However, if the body is found outdoors or in a public place and it is either decomposed or severely burnt, the identification process is much more difficult. In these cases the police will have to start by comparing the post mortem description with the ante mortem descriptions of missing persons, which will make the identification process more difficult and time consuming, and it would be expected that varying methods of identification would be employed. However, table 3 shows that even in these cases forensic odontology is by far the most important method of identification (81%). This again underlines how important forensic odontology is in Denmark.

The category with the largest group of unsolved bodies (21.4%) after all methods of identification have been tried, is the category "Found in water", and this category also comprises 37.5% of all the unidentified bodies in this study. The body is usually in a very bad condition because of decomposition, adipocerous change, animal bites and other injuries. In addition to this, it is usually difficult to find out where the body originated. Denmark has a very long shore line and bodies are often found along shores as well as at sea. These bodies could be from ships or from the countries that share the same water (especially the Baltic). Identification is further complicated by the fact that bodies in water might surface long after they have died and be transported great distances because of currents [4]. A study of bodies found in water in all of Denmark in the period of 1992-1996 [2] showed that 15 out of 89 bodies (16.8%) remained unidentified. This percentage is not far from the 21.4 % found in this study. In the same study it was found that only 57% of the bodies were Danish, and a total of 11 nationalities were found. In our study 8 of the 14 bodies were identified by the forensic odontologist (57%), and in total, forensic odontology was responsible for 67% of the identifications. The teeth of bodies found in water are usually in quite good condition, so the reason that forensic odontology is used less in this category than in other categories is likely to be that it is difficult to allocate a presumed identity to the body, and hence locate possible dental records for comparison.

Overall, forensic odontology is by far the most used method of identification. This is probably valid for the other forensic institutes in Denmark. A total of 138 cases were identified by forensic odontology in the four years covered by this study – i.e. 2% of all the corpses brought to the institute in this period This is most likely because of the good dentistry system and the social security system which makes it easy to trace people. When comparing the results in this study to results in similar studies from other countries it is seen that forensic odontology is far more dominant in Denmark than in these countries. For example, in a study from Fulton County, Georgia, U.S.A. [5], there was a 4.4 % rate of initially unidentified bodies over one year. Of these, 0.3% remained unidentified (compared to 0.1% in our study). The methods used were "visual identification" 49% and " fingerprints" 29%. Forensic odontology and x-rays together accounted for only 14% of the cases, unlike the present study where forensic odontology was conclusive in 67% of cases. In the U.S.A. it is often necessary to find relatives who can give information of where dental records might be found [6]. The reason that the Fulton County study has a larger percentage of initially unidentified bodies than our study is probably due to the difference in the populations in the two countries: the identity of the body was presumed to be known at the beginning of the investigation only in 21% of the cases. In our study, the identity of the body was presumed to be known in all the cases where the body was found in a place of residence (55%), and probably in a lot of the other cases as well. In another American study from Harris County, Texas, U.S.A. [7], it was found that 1.7 % of the all cases examined by Harris County Medical Examiners were identified by forensic odontology - a figure close to the 1.9% found in this study. However, the total number of identification cases is not reported in that study so the percentage of identification cases solved by forensic odontology is not registered. Closer to Denmark, German studies [8, 9] have found that recognition, dental records

and fingerprints were the main methods of identification.

In Denmark the police are responsible for the identification [1]. Forensic findings from the examination of the body, externally as well as internally, are essential to the police to help build a sufficient post mortem description to be able to compare with ante mortem descriptions from missing persons. Forensic dental examination should also be carried out even though material for comparison is not available.

Some countries have opened web pages with descriptions and pictures of unidentified deceased hoping that the public and authorities might recognize descriptions[10]. So far there has been no documented effect of these web pages, but a similar system in Denmark might be able to reduce the number of unsolved cases. However, it has to be taken into consideration that most of the unsolved cases in Denmark are bodies found in water, and a lot of these bodies probably didn't originate in Denmark. For a web page to have any effect, authorities in neighbouring countries would have to be made aware of it, and it would have to be in English. Another suggestion made in Australia [11] is to create a national database where forensic dental information is registered for all unsolved cases, and dental records are registered for missing persons allowing electronic dental comparison.

CONCLUSION

Identification cases can be divided into two types:

1 The police have a good idea of who the deceased is. Most of the 206 cases brought to the Section of Forensic Pathology, Copenhagen University in the period of 2002-2005 were of this type. They consist mainly of people found dead in a place of residence where the condition of the body (decomposed, burnt) makes identification difficult. Most of these cases are solved quickly, and the methods of identification as well as the procedures used in Denmark are sufficient to handle these cases. Finding material for comparison is usually easy, being mainly dental records, but also medical charts, DNA material, fingerprints, photographs and descriptions from relatives can be helpful.

2 The police have no idea of who the deceased is. Most of the cases in this group are bodies found in water, where the question is where the body originated, and bodies found outdoors. While the latter group probably by far consists of Danish citizens, the bodies mainly pertain to people who lived on the edge of society (homeless people, alcoholics, drug addicts, mentally ill and illegal immigrants), and they have not usually been to a dentist in years.

In all these cases the authorities have to piece together as much information as possible to be able to make an identification. Probably, the most important step to take towards bringing down the number of unidentified bodies in Denmark is to increase international cooperation. The Interpol Ante Mortem and Post Mortem forms are already used in an electronic version in many countries, and could be used as the basis for further international cooperation.

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Sudden infant death syndrome or murder?

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ABSTRACT Differentiating sudden infant death syndrome (SIDS) from suffocation may not be possible based purely on the pathological findings. For this reason there has been some confusion as to the mechanism of death in infants found prone. While prone sleeping increases the risk of SIDS, death is not due to suffocation as a variety of other external and internal factors are involved. Identifying suffocation in infants at autopsy and attempting to determine whether it may have been inflicted or accidental may also not be possible. Other types of death such as those involving drug toxicity and drowning may also have no pathognomonic features at autopsy to help with diagnosis. Established guidelines should therefore be followed for scene examination and autopsy evaluation to maximise the possibility of identifying the range of factors contributing to death. Use of standard definitions of SIDS will also improve diagnostic consistency and enable comparisons to be made between data from different areas. A "triple problem" model is proposed that demonstrates the "gray zone" of cases where it is not possible to determine whether death was due to SIDS, accident or homicide. The number of cases in the gray zone will be inversely proportional to the extent and quality of post-mortem investigations. The authors believe that occult homicides account for only a relatively small percentage of cases that have been labelled 'SIDS'.

***Keywords*: SIDS, homicide, murder, suffocation, infant death**

INTRODUCTION

"*Doubt is not a pleasant condition, but certainty is absurd*" Voltaire (1694-1778)

Sudden infant death syndrome (SIDS) is a term used when a previously apparently-well infant is found dead in his or her cot with no explanation for the death being found after review of the medical history, examination of the circumstances and the death scene, and performance of an autopsy (including ancilliary testing such as radiology, microbiology, toxicology and metabolic studies)[1,2]. Lack of diagnostic findings at autopsy means that the term can only be used once other causes of death have been excluded. This places a strong imperative on the need for extensive and comprehensive investigations of cases of suspected SIDS so that other causes of natural and unnatural unexpected infant death can be correctly recognised. The use of standardised investigative protocols in recent years[3-5] has helped to some extent with the identification of cases of sleeping accidents and underlying cardiac and metabolic conditions, however it is sometimes difficult to encourage their adoption and use[6,7].

DEFINITIONS

A variety of definitions have been promulgated, with the two most widely accepted being the 1969 Seattle definition of SIDS as "the sudden death of any infant or young child, which is unexpected by history, and in which a thorough post-mortem examination fails to demonstrate an adequate cause for death"[8], and the 1989 NICHD definition of SIDS as "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"[9]. Although not specified the term 'complete' autopsy has been taken to cover additional testing.

In 2004 several changes were proposed to the 1989 definition with the inclusion of an apparent association with sleep, and expansion of death scene examination to include an assessment of the entire circumstances of death[10]. In addition, the San Diego definition proposed stratification according to age and the rigor with which investigations had been undertaken so that published data could be evaluated and guidelines could be provided for assessing and classifying cases. This provides a gradient of certainty for diagnosis. Cases meeting all of the requirements of the general definition, with full investigations and negative investigations constitute category IA, with similar, but incompletely investigated cases being classified as IB. Category II includes all of those cases where the age range was atypical, where there had been previous non-suspicious infant deaths in the family, or where infection or mechanical asphyxia could not be definitely excluded. "USID" or unclassified sudden infant death was the term proposed for cases not meeting criteria for categories I or II but where alternative definitive diagnoses could not be made. The precise criteria for each of the subcategories have been previously published[10].

DIFFICULTIES IN DIAGNOSIS

Despite the promotion of definitions and guidelines for the uniform investigation of unexpected infant deaths, however, adherence to protocols and use of accepted definitions is not consistent. For example, in an audit of 50 papers published on SIDS in 2005, 58% of authors either had not specified the definition of SIDS that was being followed, or had used non-standard or idiosyncratic definitions[11]. Lack of a uniform approach makes comparisons of data on SIDS and other causes of sudden infant death between communities and institutions difficult.

Another problem with SIDS cases is that there are no pathognomonic features at autopsy to enable a definitive diagnosis to be made and so rigorous exclusion of other possibilities is required[12]. Because of the lack of readily apparent causal mechanisms and underlying pathology SIDS has been referred to as a 'diagnosis in search of a disease'[13] and the lack of diagnostic features with an overlap with other conditions, has led to certain authors recommending that the use of the term SIDS be discontinued[14,15]. This would seem a counterproductive step as the very purpose of the term 'syndrome' in medicine is to allow collections of symptoms, signs and epidemiological features that occur together more often than would be expected by chance to be characterized and studied[16]. Acceptance of the concept of SIDS has enabled invaluable epidemiological studies to be undertaken in many countries with the identification of predisposing factors such as prone sleeping and cigarette

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smoke exposure. Many thousands of infants' lives have been saved by following simple health messages based on an understanding of the features of the syndrome[17,18].

RISK FACTORS AND ACCIDENTAL DEATHS

1) Sleeping position

It is important to recognise that risk factors are not the same as causal mechanisms and that although sleeping face down may increase the risk of unexpected death in certain infants, the majority of infants will not be compromised by this position. Thus, infants who have died of SIDS sleeping face down have not necessarily suffocated; i.e. while many infants who firmly wedge between an adult mattress and a wall will asphyxiate, the majority of infants who are sleeping face down will survive. Unfortunately this has not always been the position taken by courts in countries such as Japan[19]. Other factors are at play in SIDS deaths, not the least of which is individual susceptibility. This has been elegantly demonstrated, for example, by researchers who have shown that certain infants who have succumbed from SIDS have defective brainstem neurotransmission[20,21] and other central nervous system abnormalities[22].

2) 'Overlaying'

Infants who suffocate may have minimal pathological findings and so may be indistinguishable at autopsy from a SIDS case. While hanging may be associated with a ligature mark around the neck and facial and conjunctival petechiae, lying on top of an infant or compressing an infant under a soft pillow may leave no traces. The case of a two-month-old girl who was found lifeless underneath her unconscious mother who had collapsed from a self-administered dose of opiates demonstrates clearly the non-specificity of findings in infants in this situation when it comes to autopsy. Despite temporary response to resuscitation, the infant died, but showed no evidence of facial plethora or skin or conjunctival petechiae, either in hospital or at autopsy to substantiate the known sequence of events[23]. This problem also occurs with cases where infants are found dead in a shared sleeping situation such as an adult bed or a sofa, as there may be no way to distinguish accidental asphyxia due to overlaying from SIDS based purely on the pathological findings[24].

3) Other circumstances

Determining mechanisms of death may be difficult in a variety of other sleeping situations where there are soft bedding and pillows. For example, waterbeds and inflatable cots have resulted in infant deaths with no distinguishing features at autopsy, again emphasizing the importance of adequate death scene investigations. The role of hyperthermia has also been debated, and evaluating cases where high environmental temperatures and excessive bedding have been found may be problematic if infant core temperatures at the scene are not available. While a vitreous sodium level may be a useful marker for dehydration under such circumstances, obtaining adequate amounts of fluid for testing may not be possible.

A range of other situations exist where pathology findings are either very subtle or not present, such as deliberate or accidental drug or poison exposure. Unless routine toxicological screening is performed on infants these cases may not be identified. Another problem concerns interpretation of results in the very young as it is possible that drug levels that may be non-toxic or therapeutic in adults may have quite different significance in those with immature homeostatic control.

MURDER

As it is not possible to distinguish infant death due to suffocation beneath a pillow or soft object from SIDS[25] this has led to a number of highly-publicised cases of serial deaths in families where inflicted suffocation was not initially identified and the deaths were incorrectly attributed to SIDS[26]. In Munchausen syndrome by proxy perpetrators have attained medical and family attention by causing apparent life-threatening episodes (ALTEs) in infants and young children by suffocating them[27]. Monitoring of such cases of 'gentle suffocation' has revealed that there is often significant terminal struggling by these infants, with a characteristic pattern of obstructive apnea with considerable body movement artefact.

Drowning is another situation where pathological findings are non-diagnostic and if the death scene is altered and the body dried and placed in a cot before the alarm is raised there may be no indication to investigators that immersion had occurred. Similar problems exist with drug toxicity as discussed above.

A series of 42 cases of homicides in the United Kingdom that were originally misdiagnosed as SIDS deaths has been published[15]. Although it was recommended that the use of the term SIDS be discontinued because of these diagnostic errors, it was conceded that a problem had been inadequacy in the initial investigations, including the quality of the autopsies. Because of the problems presented by cases where homicides have been missed the now infamous triad of "three strikes and you are out" was proposed i.e. the first death in a family is considered SIDS, the second death is labelled "undetermined", and "a third case . . . is not possible and is a case of homicide"[28]. It has been pointed out that this approach represents a denial of natural justice, with child carers being presumed guilty until proven innocent. Certainly, serious consideration of the possibility of inflicted lethal injury has to be entertained when multiple deaths occur in the same family, as does the possibility of familial cardiac or metabolic conditions. The aphorism of 'think dirty' when confronted by infant deaths[29] is to be avoided lest errors such as those that occurred in the Sally Clark case in the United Kingdom are to be repeated. Sally Clark's conviction for the murder of her two sons was quashed in 2004 due to inadequacy in the pathological evaluation, documentation and interpretation[30]. Perhaps better advice would be to "think laterally, investigate meticulously and proceed cautiously". The penalties for error are significant.

A question that is often asked is "How many deaths that are currently being attributed to SIDS are due to occult homicides?" This is an impossible question to answer, given that there is no way to quantify numbers of cases that are not being identified. One way to approach this issue is to turn the clock back to the late 1980's when it was being proposed at meetings internationally and in discussions among certain physicians that between 10 and 80% of cases that were being called SIDS, were instead due to occult homicidal suffocations. As noted, there is simply no way to disprove this allegation based on the autopsy findings in individual cases. However, if one accepts for a moment this high figure for lethal injury and takes an epidemiological approach and examines the dramatic fall in SIDS deaths following the "reduce the risks" campaigns, it would have to be asserted that sleeping infants on their backs and avoiding cigarette smoke significantly reduces rates of homicide. If this were the case then perhaps sleeping the entire population on their backs would cut homicide rates at all ages. Although perhaps a desirable outcome, this is obviously nonsensical. An 18-year study in California including this time period has shown no increase in the absolute numbers of infant homicides[31].

Most pathologists and pediatricians who deal with families who have suffered a SIDS death will agree that occult homicides do occur, but only rarely, and that

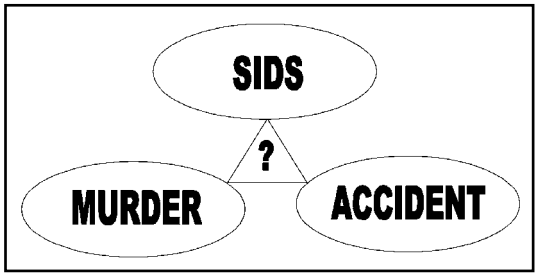

Figure 1: The "triple problem" model for SIDS, murder and accidents indicating that a small percentage of cases will remain "unclassified" (?) due to the non-specificity of findings. The size of this group will vary inversely with the amount and quality of investigations.

these probably constitute less than 5% of cases. This of course may vary depending on the population being studied and may be greater in areas with severe socioeconomic hardships and high levels of domestic violence. While this opinion is certainly anecdotal and not evidence-based, some weight must be given to the value of clinical assessment of families by experienced physicians who are used to dealing with grieving patients.

MODEL

Once it was realised that SIDS was not a single disease with a single cause, it became clear that death in certain infants resulted from the summation and interaction of a series of influences involving environmental risk factors, vulnerable age and individual susceptibility. This has been encapsulated as the "fatal triangle" or "triple risk" model where infants succumb when they have a sufficient number of overlapping and interacting negative influences[32,33] Given the difficulties that may arise in distinguishing accidental from homicidal suffocation, and both of these from SIDS cases at autopsy, and the non-specificity of pathological findings in other types of deaths, perhaps a way to view this issue could be as a "triple problem" model (*Figure 1*). This recognises that while the manner of death can be determined in most cases, there exists a gray zone where there will always exist doubt as to the precise classification of the death. Certainty regarding the cause, mechanism and manner of death of these unclassified cases is not possible given the limitations of our current technology and systems, although maximising our investigations should keep the numbers in this group to a minimum.

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Rib fractures and cardiopulmonary resuscitation in small children

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ABSTRACT Background: Cardiopulmonary resuscitation (CPR) is sometimes claimed to have caused rib or sternal fractures in child abuse cases. It is both medically and legally important to establish whether rib fractures are secondary to abuse or a result of CPR. Such fractures are significant when identified, and in small children considered pathognomonic for child abuse. It was therefore decided to go through our archives to investigate rib fractures in small children. Method: A large forensic material from Western Norway was investigated retrospectively. All fractures were registered in autopsied small children below 5 years of age. All information of cardiopulmonary resuscitation in these small children was also registered. Results: Among 9632 forensic post mortem examinations performed from 1985 through 2004, 261 examinations were performed on children below 5 years of age. Among these 261, CPR was performed in 142. Only six had rib fractures, three homicides and three accidents. All fractures were either posterior or lateral, with the exception of one child with osteogenesis imperfecta who was involved in a car accident and had two anterior rib fractures. All the children had an injury pattern and an injury history that could explain both the rib fractures and their death. Most fractures were discovered by x-ray examination before autopsy and some during the autopsy procedure. Conclusion: Radiology performed before autopsy should be a routine part of every infant autopsy to reveal both recent and old fractures, both in ribs and in other parts of the skeleton. Some recent fractures will only be found at autopsy, while some old fractures may be overlooked at autopsy if the pleural membrane is not reflected. The findings support previous studies in that CPR is not a common cause of rib fractures, and that it does not lead to posterior fractures.

Key words **Rib fracture, cardiopulmonary resuscitation (CPR), child abuse**

INTRODUCTION

Although rib fractures themselves are not necessarily life threatening, they are significant when identified, and in small children considered pathognomonic for child abuse. Most rib fractures in infants are caused by child abuse and make up between 5% and 27% of all skeletal injuries in abused children (1,2). Rib fractures may not be evident on radiographs in the acute stage, as little displacement occurs. Several studies have shown that rib fractures seldom are accompanied by external evidence of trauma (2,3,4). They are often not identified until in the healing stage, as a result of developed callus, and are often found coincidentally if there are not other injuries.

Cardiopulmonary resuscitation (CPR) is sometimes claimed to have caused rib or sternal fractures in child abuse cases. It is both medically and legally important to establish whether rib fractures are secondary to abuse or a result of CPR. It is also important to rule out the possibility that a fracture might have rare causes such as bone dysplasia or prematurity.

The objective of this study was to identify rib fractures in infants and small children in a large forensic material, with particular focus on rib fractures caused by cardiopulmonary resuscitation.

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MATERIAL AND METHODS

The study is retrospective. The material was collected from medico-legal reports, based upon forensic examinations performed at the forensic unit in a 20-year period from 1985 throughout 2004. There were performed 9632 forensic post mortem examinations during this period. From the police reports in each case, medical and other data were available. All post mortem examined infants and small children aged from 0 throughout 4 years were reviewed, and a number of demographic factors registered. Children dying on the same day as they were born, were registered with an age of 0 days. In all cases where child abuse was suspected, whole body x-ray examinations were performed. A number of projections were performed to give the best result in every case. These radiographs were all examined in the Department of Paediatric Radiology and reviewed by one or two experienced paediatric radiologists prior to autopsy. In a few cases, specimen radiography was performed in the autopsy room, using a radiation-shielded cabinet (Faxitron X-ray systems, model 43804N, Hewlett Packard), in combination with ready-made film in envelopes (Kodak X-Omat MA, Ready Pack), giving an excellent quality. In some cases with very small children, this equipment was used in whole body radiography. These radiographs were reviewed by the forensic pathologists before or during the autopsy. In about half of the cases originally suspected to be SIDS cases, or undetermined manner of death, x-ray examinations were performed, but not systematically. These cases were examined using a stationary x-ray instrument in the autopsy room, where only one frontal projection was made. The radiographs were reviewed by the forensic pathologist before the autopsy and by a radiologist later. These radiographs were of lesser quality than the x-rays taken in the Department of Radiology. None of the x-rays were reviewed during the study, just the reports. Inspection and manual examination of the chest wall during the autopsy procedure were performed in all cases. All injuries, including fractures were registered. Data extracted from the individual patient charts included: age, sex, number and location of rib fractures and associated injuries. If CPR was performed, it was registered who had performed the resuscitation attempt.

The Regional Committee for Medical Research Ethics in Western Norway has approved the study.

RESULTS

Among the 9632 medicolegal examinations in the 20-year period, there were 261 (2.7%) medico-legal examinations of children below 5 years of age where a full autopsy was performed. Of these 261 cases, 158 (60.5%) were boys and

103 (39.5%) girls. The age distribution range was from 0 years to 4 years and 11 months (mean 297.4 days, median 144.5 days). There were 31 (11.9%) victims of accidents, 12 (4.6%) homicide victims, 43 (16,5%) cases of natural death, and 175 (67.0%) children with an unknown manner of death, all certified as cases of SIDS (Table 1). Of the 261 cases, CPR was performed in 142 cases. Health care workers performed CPR in 119 cases, parents or other unskilled personnel in 23 cases. In 68 cases, no information indicated whether CPR had been performed or not, and in 51 cases no CPR had been performed. It was not possible to find reliable information of the length of the individual resuscitation period.

Rib fractures were discovered in 6 of the 261 cases (Table 1). In 3 of these cases, health care workers had performed CPR. In the other 3, CPR was not performed (Table 2). Sternal fractures were not found. The rib fractures were found in 3 victims of high-energy traumatic accidents and 3 victims of homicides. Five of the six children had posterior rib fractures. The sixth had two right anterior rib fractures discovered during the post mortem examination, but not seen on x-ray examination. No CPR was performed on this sixth child suffering from osteogenesis imperfecta (OI). The child was involved in a car accident. The original four-point safety belt had been replaced with a weaker, non-original, type. The belt snapped on the right side, and the child was thrown around in the car. The sites of the fractures were consistent with the pressure from the right safety-belt.

DISCUSSION

Children are less vulnerable to rib fractures than adults because of the plasticity of the rib cage. The anterior parts of the ribs consist of cartilage. Ossification first begins toward the end of the second month of foetal life, and is a process, which develops gradually. Rib fractures are much more common in older people than in young adults.

Rib fractures-mechanism

Rib fractures occur by anterior-posterior compression or a direct trauma (1,5,6,7). Anterior-posterior compression will stress the lateral aspects of the ribs and can result in lateral rib fractures.

In addition to compression, direct trauma of sufficient force to the thorax can result in rib fractures at the site of impact. Both of these fracture mechanisms require substantial force (8).

In infants with unexplained fractures, causes of bone fragility such as osteogenesis imperfecta (OI), rickets/ vit-D deficiency and osteopenia/ prematurity (in very low birth weight infants) must be considered. OI, the most common genetic cause of bone fragility, is a heterogeneous disorder caused by a molecular defect of collagen (9,10). A case has been reported where chest compressions were performed in an infant with OI type 2, without any new rib fractures (11). This supports previous reports that have concluded that rib fractures rarely, if ever result from CPR in children, even in children with a lethal bone disease. Rib fractures which occur secondary to birth trauma are often located posteriorly near the costovertebral junction. In rare cases, severe coughing has been reported as a cause of rib fractures (12). Rib fractures have also been seen after chest physiotherapy in infants. These have been found to be lateral and posterior fractures (12).

In a animal study it has been shown by simultaneous CT imaging, that squeezing the chest with the fingers, leads to levering of the ribs over the transverse processes of the spine, leading to rib fractures, all posterior (5). If a small, unsupported baby is resuscitated with the hands encircling the chest, there is accordingly a risk of posterior rib fractures (6). This so called two-thumb CPR chest compression method resembles the abusive compression or shaking of an infant (13). Many of the cited studies in the literature were published before the International Consensus on Science's revised guidelines in 2000 (14). It is thus important to detail the resuscitation techniques used. In the animal study, when CPR was performed on a firm surface, this movement could not occur, and posterior rib fractures were not found (5). It is therefore argumented that posterior fractures in a child who has been resuscitated on a firm surface would be inconsistent with the biomechanics of resuscitation (5,15). Establishing the mechanisms of trauma from the injuries has recently been reviewed (6).

CPR and rib fractures

In many cases of the present study, it was difficult to get information of whether CPR was performed or not. In a substantial number of cases there were no information about CPR, a well-known procedure in Norway already in the eighties. Information was regularly missing in cases from the period 1985-90, which was the peak period of the SIDS "epidemic" in Norway, when a high number of SIDS cases were examined annually. CPR was performed on many of these, but documentation is lacking. Therefore the group "No CPR information" in Table 2, probably could be substantially reduced, theoretically making the incidence of fractures even lower.

There was no difference as to who had performed the CPR in the present study. It is sometimes believed that parents or non-medical personnel can cause injuries

Table 1. Rib fractures

Fractures	Natural death		Accident		Homicide		Unknown		Total	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Present	0	0	2	1	1	2	0	0	3	3
Not present	27	16	14	14	6	3	108	67	155	100
Total	27	16	16	15	7	5	108	67	158	103
	43		31		12		175		261	

Table 1. The number of victims with rib fractures according to the manner of death is shown.

Table 2. CPR

CPR	Fractures present		Fractures not present		Total	
	Male	Female	Male	Female	Male	Female
CPR - Medical	1	2	75	41	76	43
CPR - Other	0	0	14	9	14	9
No CPR performed	1	1	29	20	30	21
No CPR information	1	0	37	30	38	30
Total	3	3	155	100	158	103
	6		255		261	

Table 2. CPR and the number of victims with and without rib fractures is shown. In a number of cases no CPR was performed, and in a large number of cases, no information was present.

by performing CPR in a wrong manner. It is, however, established in studies of CPR performed by adults, that non medical personnel is more afraid of using force than professionals are, and rarely cause injuries. In one review where CPR performance of non-medical and medical personnel was compared, no difference in the frequency of rib fractures as adverse effects was found (16). This review included only adults, but probably also applies to children. Unfortunately, we had no systematic information of how long and how intense the CPR procedures were. It is, however, discussed whether this is of importance or not (17).

Rib fracture identification

Sometimes rib fractures can be overlooked by radiography. This was the case in one of the accident cases, where x-rays were performed as a part of the routine in the emergency room. In the suspected abuse cases where a paediatric radiologist had performed and reviewed the x-rays, all rib fractures were found and confirmed by autopsy. In the present study, inspection and a gentle manual examination of the chest wall were performed. The parietal pleura was, however, not routinely removed. The authors feel, however, convinced that no recent fractures were overlooked. Old fractures, however, may have been overlooked if the callus only was of modest size. In several studies, post-mortem skeletal surveys were included (18,19,20,21,22). In some studies, the ribs were dissected and the pleural membrane reflected back in infants and very young children, to find rib fractures (15,22). This method is probably the method of choice and will lead to finding of all fractures, both recent and old. None of the studies above referred to the use of specimen radiography, which has been proposed as the optimal method of detecting subtle fractures at postmortem examination (23). In our study, specimen radiography was performed in many cases, in a Faxitron x-ray cabinet, with excellent quality of the radiographs. This was, however, not done routinely.

Rib fracture causes

Among the 31 victims of accidents (mean age 2.8 years) in our material only three had rib fractures. All information from the accidents, together with medical information indicated that these rib fractures were caused by high-energy traumas (Table 3). Among the 28 remaining children, 8 were also involved in accidents classified as high-energy traumas, without any signs of rib fractures, indicating that substantial force is necessary for a fracture to occur. Among the 12 homicide victims, three had posterior rib fractures. Two of these were abuse cases while one was a homicide on a newborn, by a young girl having secretely giving birth to the child. In the abuse cases, available information revealed that both shaking and squeezing had taken place, indicating that this caused the fractures, and not CPR.

Although most previous reviews have shown that most rib fractures in infants are caused by child abuse, some studies have revealed that fractures of ventral parts of the thorax can occur during resuscitation. In a recent systematic review of studies addressing rib fractures and CPR in children, 6 studies were included where 923 children underwent CPR (24). Three children had rib fractures attributed to CPR. Reports on conventional CPR in adults suggest an incidence of rib fractures ranging from 13% to 97%, and of sternal fractures from 1 to 43% (17). Rib fractures after cardiopulmonary resuscitation in children are rare. When they do occur, they are either mid-clavicular or at the sternochondral junction (24). The locations of these fractures are in contrast to the posterior rib fractures, which are more commonly found as a result of abuse in infants and young children (1,3,18,25,26). Fractures resulting from abuse can also occur anteriorly (3,25).

Posterior rib fractures have not been described after CPR, except in a recent case where one posterior fracture was found and claimed to be caused by CPR (27).

SUMMARY

The findings in this study support previous studies in that CPR is not a common cause of rib fractures, and that it does not lead to posterior rib fractures. Rib fractures in children are significant when identified, and in small children considered pathognomonic for child abuse. Whole body radiology taken prior to autopsy should be a routine part of every infant autopsy, and reflection of the pleural membrane should be performed during the autopsy, as some rib fractures otherwise can be overlooked.

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The *San Diego* definition of SIDS – is it practicable?

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ABSTRACT The San Diego definition of SIDS was first introduced in 2004. This general definition adds an additional element to the NICHD definition, namely, that death should occur during sleep. This factor is widely accepted, and this element of the definition is applied in some countries in daily casework.
The stratified definition connects the findings and the extent of investigations for a sub-classification of SIDS cases. This procedure is more difficult because 30 different items of information are required to render a SIDS diagnosis at the highest level of severity (SIDS IA). If any one of the set of additional investigations is not performed, this level cannot be reached. The stratified part of the new definition is felt to be too complicated and excessively complex. The San Diego definition can be used retrospectively to redefine cases but to do so requires a lot of time. Prospectively it should be easier to use. In practice, this stratified definition is currently only used in the San Diego County, and is not accepted by researchers.
An important advantage of the new definition is that it introduces unclassified sudden infant deaths (USID). This new category makes it absolutely clear that a sudden and unexpected infant death cannot be classified as SIDS unless an autopsy has been performed. This category of deaths should be included in the *International Classification of Diseases* with its own code number.

***Key Words*: SIDS - San Diego definition – Applicability - Unclassified Sudden Infant Death (USID)**

INTRODUCTION

Beckwith [1] first introduced the term SIDS and proposed its well-known definition in 1969, since when it has been the subject of much controversy [2]. Moreover, the definition has been subjected to wide interpretation. In 1989, the definition was extended to increase its precision, and additional requirements were introduced: an examination of the death scene, a complete autopsy and a review of the clinical history (NICHD definition)[3]. During the nineties, various authors proposed and used different subclassifications of SIDS cases [4,5,6,7]. As a consequence, the results of studies from different countries are more difficult to compare. To redefine the term SIDS and to categorise as precisely as possible the various SIDS cases [5], a panel of experts proposed a new definition in January 2004 (the San Diego definition - SDD)[2]. In addition to constituting a more general definition, which can be used for drawing up essential statistics and implementing general epidemiological studies, a sub-classification based on specific pathological features and the amount of information available from other sources was agreed upon (*Table 1*). Four years later, it is now time to evaluate the applicability of this new definition to practical work.

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MATERIALS and METHODS

Three different approaches were used to evaluate the applicability of the SDD of SIDS:

1. The citation frequency of the original paper was determined. To do this, we looked at the electronic version of the paper on January 3rd, 2008 (http://pediatrics.aappublications.org/cgi/content/full/114/1/234) and used the service offered by *Pediatrics* to search for citations ("citing articles").
2. Some of the authors of the paper were asked whether or not they used the new definition in their daily work,
3. The SDD was compared to the definition used for the German SIDS study (GeSID) [7] and 100 cases of this study were reclassified using the SDD [8].

RESULTS

Looking at the citation index of the paper published by Krous et al. in 2004 [2], we found that it had been cited by other papers with a high frequency (*Tab. 2)*. About 50% of these citations are self-citations by the authors of the original paper. The authors (first authors) who cite the Krous paper come from the US (n=35), Australia (n=13), Norway (n=7), Italy (n=7), Germany (n=5), Canada (n=3), the UK (n=3), The Netherlands (n=2), and Mexico (n=2). Others were from Argentina, Belgium, Brazil, China, Czech Rep., Israel, Japan, Switzerland, South Africa, Spain, Turkey, and Uruguay.

We then asked some of the authors whether they applied the SDD in their work and if so, how they applied it (*Tab. 3*). Their answers were that they don't use it because independently of the fact that the use of the stratified part of the SDD in daily case work is not possible as the ICD-10 does not really allow it by its coding system, the authors of the paper use the general part of definition inconsistently but not the stratified part.

Finally, the practicability of the SDD was tested by reclassifying 100 cases of the GeSID study using the new criteria. Although 30 different items of information have to be considered in the general and stratified parts of the SDD, it is still deemed as practicable, in particular as an international standard for performing scientific studies. The comparison of the SDD and the classification used for GeSID [7] shows similarities in the methodology but differences in the criteria used. Nevertheless, the numbers of cases classified as SIDS and borderline SIDS are similar (San Diego – SIDS IA, IB, and II: n=69, GeSID – SIDS 1 to 3, n=74). The SIDS IA criteria of the SDD could not be fulfilled in any of the cases, because metabolic screening and vitreous chemistry were not included in the GeSID investigation scheme (*Tab. 4)*.

DISCUSSION

The analysis of the literature shows that the SDD of SIDS is well known in the scientific community. The paper published by Krous et al. [2] has been cited in nearly 100 different papers from

Table 1: Criteria used in the San Diego definition [2]. USID - Unclassified Sudden Infant Death (Tab. according to [8]).

	Clinical History (CH)	Circumstances of death	Autopsy
SIDS general definition	- sudden und unexpected death - under 1 year of age - lethal episode during sleep - death unexplained by CH	- unexplained after review of the circumstances	- unexplained after complete autopsy
Specific definition			
Category IA SIDS	1. older than 21 days, under 9 months 2. normal CH 3. full term pregnancy (>37 weeks) 4. normal growth and development 5. no similar deaths in siblings/relatives	- scene investigation performed and gave no explanation - safe sleep environment - no evidence for an accident	1. no lethal pathological findings 2. no unexplained trauma, abuse, neglect or unintentional injury 3. no substantial thymic stress 4. toxicology, microbiology, radiology, vitreous chemistry and metabolic screening negative
Category IB SIDS	1.-5. (criteria for category IA SIDS)	- scene investigation was not	1.-4. and 5. one or more of the following analyses were not performed: toxicology, microbiology, radiology, vitreous chemistry and metabolic
Category II SIDS	differences to category I criteria: 6. age range (0 to 21 days, 270 to 365 days) 7. neonatal/perinatal conditions that have resolved by the time of death 8. similar deaths in siblings, near relatives	- mechanical asphyxia or suffocation by overlaying not determined with certainty	1-5. and 6. abnormal growth and development not thought to have contributed to death 7. more marked inflammatory changes or abnormalities not sufficient to cause the death
USID	- criteria for cat. I or II SIDS are not fulfilled	- alternative diagnoses of natural or unnatural death are equivocal	- autopsy has not been performed

Table 2: Citation frequency of the paper "*Sudden infant death syndrome (SIDS) and unclassified sudden infant deaths (USID): a definitional and diagnostic approach*." by Krous et al. [2]. On January 3rd 2008.

Citation System	Citation Frequency (N)
ISI Web of Science	58
Google Scholar	96
Cross Ref	25
High Wire	19

Table 3: Use of the SDD in practical work. Those asked were R. Byard (Australia), H. Krous (U.S.A), E. Mitchell (New Zealand), T. Rognum (Norway), and T. Bajanowski (Germany).

Country	General Definition	Stratified Part of Definition
Australia	Yes	For some reason, no
Germany	Inconsistently	For research only (TOKEN study)
New Zealand	No	No
Norway	Yes	We try to use it, but it is too detailed
USA	Inconsistently	Inconsistently

more than 20 countries. But, it has to be considered that a considerable number of SIDS researchers view the new definition critically. Most of them accept the general part of the definition, but not the stratified part. The general San Diego definition includes one new element compared to the NICHD definition: the onset of the fatal episode should occur during sleep. In the majority of cases in which an infant is found dead, the parents had thought that the infant was asleep. But since it is extremely rare that anybody actually witnesses such a death, it is presumed that most cases occur during sleep. For example, out of the 100 GeSID cases, which were reclassified,

Table 4: Comparison of the two classifications used (according to [8]). GeSID 1: SIDS without any pathological findings; GeSID 2: SIDS showing minor pathological findings; GeSID 3: SIDS with more severe changes, not sufficient to explain the death; GeSID 4: explained natural death.

	GeSID					
San Diego	1 (SIDS)	2 (SIDS+)	3 (SIDS++)	4 (explained)	SUDI	All
SIDS I A	-	-	-	-	-	0
SIDS I B	3	18	4	-	-	25
SIDS II	-	19	25	-	-	44
USID	-	-	5	-	10	15
Explained	-	-	-	16	-	16
All	3	37	34	16	10	100

only one case had to be reclassified retrospectively [8] as non-SIDS, because the fatal episode happened while the infant was awake. Other arguments against the SDD were expressed during the 8th SIDS International Conference held in Edmonton, Canada, such as the high financial costs of performing autopsies in accordance with the standards of the requirements of category IA SIDS, and abandoning the definition by exclusion, introducing positive criteria for SIDS [9].

In the stratified part, the authors combine qualitative and quantitative parameters to make clear that the diagnostic severity depends on the diagnostic procedure and its extent. The stratified part includes 30 different items of information stemming from the findings of specific investigations: autopsy findings, results of additional investigations, death scene investigation, and clinical history. If one or more of the important diagnostic steps are missing, the diagnostic severity is influenced leading to a depreciation of the case to a low-priority sub-group. A retrospective classification using the SDD is very difficult, as shown in a previous analysis [8], and most of the other authors criticise the stratified definition as too detailed and too complex. But, in planning new prospective studies, it should still be generally possible to use the San Diego criteria.

Moreover, the definition of category IA SIDS includes very narrow criteria, which can be fulfilled only in a very small number of cases. For example, none of the GeSID cases met all of these criteria, because no metabolic screening or vitreous chemistry had been carried out. An analysis of some other large SIDS studies shows that none of the protocols used in the past included all the investigations which must be carried out in SIDS IA cases (Nordic study, International Standardised Autopsy Protocol, GeSID study, CESDI study [10], Australasian SIDS autopsy protocol [11]). Therefore, the question to be discussed is whether it would be more practical to combine the subgroups IA and IB into one SIDS group. The main advantage of this approach is that it would create a larger group of cases, in particular with regard to detailed epidemiological analyses.

The responses given by the authors of the *San Diego paper*, when asked about their use of the definition underline the difficulties in the use of the stratified part in daily case work. Only in San Diego County is the stratified definition routinely used in all cases (personal communication, H. Krous). This shows that this part of the definition has not yet been fully accepted in the *SIDS community*.

One major issue remains unresolved, even with the new definition: It is still possible to classify an infanticide as SIDS. For example, in cases of lethal poisoning, it is common that characteristic changes cannot be found during autopsy. Nevertheless, the diagnosis can be SIDS IB because a toxicological analysis is not mandatory.

An important advantage of the SDD is the introduction of the USID group (unclassified sudden infant death). This new category makes absolutely clear that a sudden and unexpected infant death cannot be classified as SIDS unless an autopsy has been performed. In Germany 55.2% of all officially notified SIDS cases of the years 1985-1989 have been autopsied [12. This means, if the SDD would be used, the remaining 45% of cases could not be classified as SIDS anymore.

Another advantage of the new definition as stated by Krous et al. – its flexibility – still needs to be demonstrated.

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Microbial genotyping as a tool in forensic case work

"The banana case"

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INTRODUCTION

Microbiologic examinations are a routine part of forensic autopsies, especially in the examination of sudden unexpected death, both in children and in adults. In these cases, blood, urine, cerebrospinal fluid or tissue samples are routinely examined for the presence of micro organisms that could have caused or influenced the process that led to the death of the victim. In the examination of sexually abused victims, samples are taken for microbiological examination to search for micro organisms transferred during the alleged sexual assault. Under these circumstances, in addition to the identification of the micro organisms from different sources, microbiologists, when requested, use various phenotypic and genotypic techniques to find out whether the isolated organisms that belong to the same species or subspecies are clonally identical or closely related. Such information would either corroborate or contradict the alleged abuse. Molecular microbiological methods are especially useful for determining clonal relationship within bacterial species/subspecies, and are generally more discriminative than the phenotypic methods. Of the different molecular biological methods, Pulsed Field Gel Electrophoresis (PFGE) is a widely accepted genotypic method, applicable to many different bacteria, and gives accurate, reliable and reproducible results (1). In clinical microbiology, PFGE has been mostly used to identify clonal outbreaks and to trace the spread of bacteria, from source to patient, or from an index patient to other patients. This method could also be of use in forensic settings, as reported for N.gonorrhoeae (2), We report a case of sexual abuse where PFGE was used to determine the clonal relationship of E.coli isolated from the patient and the item used to abuse the victim.

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CASE REPORT

A 31year old man was admitted to the local university clinic, after he allegedly escaped from a flat where he had been hold prisoner against his will. He claimed to have been beaten for hours until he finally managed to escape, naked, with only a duvet around himself. He walked to the local hospital where he told that he had also been sexually humiliated, and that a banana was forced into his anus. The incident happened between 6 pm on May 2nd and 5.00 am on May 3rd. In the hospital he was treated for rib fractures, small wounds and bruises. After two days he left the hospital. The police searched the scene at 7.40 pm on May 8th, 5-6 days after the incident. The flat was covered with powder from a fire extinguisher. Small droplets of possible blood were seen several places in the flat. Among other findings in the flat, a banana was found. The banana, which also was covered with powder from a fire extinguisher, was handled with gloves, and transported in a sealed, clean bag to the crime lab. The banana was brushed gently, to remove the powder, before sampling. No faecal material or blood was visible on the surface of the banana, which was decomposed, soft and partly black (Fig. 1a and 1b). After a primary sampling, the banana was brought to the forensic section at the university hospital for further analyses that could possibly link the banana to the alleged assault.

MATERIAL AND METHODS

The banana, which was heavily decomposed and covered with powder from the fire extinguisher, was swabbed with cotton swabs which were sent to the university hospital's microbiological unit, where the sample was registered 8-9 days after the assault (May 11th, 2006, sample ID: 1073926). In the forensic section, some of the swabs were transferred to slides, stained with haematoxylin-eosin and examined under a light microscope by one of the authors. A histological section of the banana skin was also made, but no conclusions could be made from direct microscopic examination except that erythrocytes were present. Testing a small sample with tetrabasebariumperoxide gave a positive reaction, indicating the presence of blood.

DNA analysis of biological material: The surface of the banana was gently swept with two sterile cotton swabs, which where dried and forwarded to the DNA lab for analysis of possible biological material from the perpetrators. Human DNA was found in the samples, which were further analysed with DNA/SGM+.

Microbiological methods: The culture of these swabs from the banana surface (sample ID: 1073926-1, -2 and -3) for bacteria revealed different bacterial strains, but after conferring with the pathologist, attention was focussed on bacteria usually found in the anal canal and rectum. Gram negative bacteria were found in all three samples from the surface of the banana, including *E.coli* and *Klebsiella*. It was decided to ask the victim for a faecal sample, to make comparisons between the bacteria isolated from the banana and the bacterial colonists in the lower intestine of the victim. A faecal sample from the victim was received 17 days after the incident (May 19th, 2006) and was sent to the microbiology unit where strains of E.coli were isolated (sample ID: 1078033-1). As definite conclusions could not be made with phenotypic characteristics of the *E.coli* isolates, it was decided to compare the samples genotypically, by PFGE.

The different isolates of *E.coli* from the banana and the victim (sample ID: 1073926-1, -2 and -3 and 1078033-1) were subjected to PFGE technique as described by Pulse Net USA (3). DNA was digested using the XbaI enzyme (New England BioLabs, Beverley, MA, USA) and Multi core buffer (Promega, Madison, WI, U.S.A). Electrophoresis was performed using a CHEF-DR III

Figure 1a. The banana found covered with powder from a fire extinguisher, in the flat where the assault took place.

Figure 1b. The banana, after brushing off most of the powder from the fire extinguisher.

system (Bio-Rad, Hercules, CA, USA), using the following parameters; Initial A time: 2,2 s, Final A time: 54,2 s, Start ratio: 1,0, Volt: 200 V, Run time: 20-22 hours. After electrophoresis the gel was stained with ethidium bromide and photographed under UV-light. Genotypic relatedness, based on the band patterns obtained, was determined visually.

RESULTS

Identical PFGE patterns were found between the *E.coli* isolates from the banana sample 1073926-1 and the victim's sample 1078033-1-M1, as shown in figure 2. It was therefore concluded that these *E.coli* isolates were clonally identical or very closely related, in support of his complaint of sexual harassment.

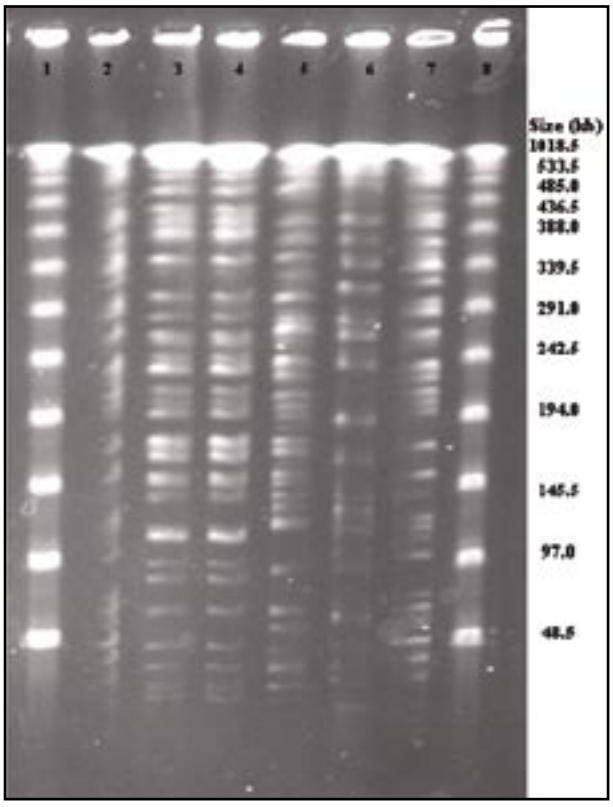

Figure 2 PFGE results. Molecular weight sizes in kilobase pairs on the right side. Lanes 1 and 8 are Lambda Ladder PFG Marker (New England BioLabs, Beverley, MA, USA), size range: 50 -1,000 kb. Lane 2 and 7 are control strain E.coli NCTC 25922. Lane 3 is the isolate 1073926-1 (banana) and lane 4 is the isolate 1078033-1-M1 (victim), which are identical. Lane 5 is another isolate of E.coli from the victim, and lane 6 is another isolate of E.coli from the banana, which show unique patterns, indicating different and unrelated strains.

The results from the examination of human DNA from the material on one of the cotton swabs from the banana and the reference sample from the victim revealed identical results in all ten markers, in addition to a male sex marker. The other swab gave identical results in six out of ten markers. DNA from other persons was not found in the samples from the banana.

DISCUSSION

Forensic microbiological investigation is not a new field. However, a new subfield of forensics, microbial forensics, is recognised in the investigation of bioterrorism and biocrime, which is focused on identification and characterisation of causative organisms from a bioterrorism act, biocrime, hoax, or an inadvertent release of biothreat micro organisms (4).

In the present case, identification of the same strain of a bacterium, namely *E.coli*, as determined by PFGE, was used to establish a link between an item used to assault the victim and the part of victim's anatomy that was exposed to the item in the alleged assault.

PFGE is a technique that checks for identity or similarity of the total genome of bacteria, in order to determine the clonal relationship between different bacterial isolates. Restriction endonucleases that recognise specific nucleotide sequences are used to cut the bacterial DNA in such restriction analyses. Since the restriction occurs at specific sites, bacteria that have identical genomes would result in an identical set DNA fragments. The fragments between 500 kb to about 40 kb could be separated according to their lengths on an agarose gel, using an electric current in short pulses, that flows in alternate directions towards the positive electrode. With each reorientation of the electric field, the DNA fragments migrate towards the positive pole, manoeuvring through the gel, the smaller sized DNA fragments moving more quickly than the larger fragments. Thus, such pulsed-field electrophoresis allows the large DNA fragments to be separated according to their lengths, and appear as distinct bands when stained with ethidium bromide and viewed under ultraviolet light. The quantity of DNA in each band is reflected by the intensity of fluorescence under UV light. Thus, qualitative and quantitative assessment could be made of the resulting restricted fragments. Bacterial DNA that are not identical would give rise to fragments that are different in size, and may also give rise to differences in the intensity of bands due to varying numbers of fragments with the same size.

We used *XbaI*, which had a recognition sequence T⬇CTAGA that resulted in fragments in the size range mentioned above. The discriminatory power of this

enzyme on *E.coli*, to identify subtypes within the same serotype has been documented. For example, 19 different PFGE types were found among *E. coli* isolates within serotype O157 (5). In another study, PFGE revealed 13, 27 and 6 different patterns among *E.coli* belonging to serotypes O26, O103 and O145 isolates, respectively (6). The stability of PFGE patterns obtained from the same strain has also been documented, where repeated subculturing of an *E. coli* O157 strain, 110 times, resulted in no variation from the original PFGE pattern (5). This study also reported the use of PFGE to trace the source of *E. coli* O157, obtained from a patient with hemolytic-uremic syndrome, to cattle. In another study from cattle, 79 unique patterns (XbaI-PFGE subtypes) were found in 235 typeable isolates confirmed to be *E.coli* O157 (7). Thus, practically, given the diversity of PFGE patterns within the same serotypes in *E.coli*, and the stability of the *E.coli* DNA, one could conclude that the victim's story was highly probable. The chance of coincidental finding of the same subtype of *E.coli* on a banana and in a sample from the victim is extremely low.

In the present case, the banana was found covered with powder from a fire extinguisher. Nevertheless, traces of blood could be found on the surface. A DNA match between this material and from the victim also was established, as identical markers were found both in the sample from the banana and in the reference sample from the victim. It could be argued that the victim's DNA material could have been deposited there by handling of the banana by the victim at an earlier stage, or that blood from the victim's wounds could have been deposited on the banana. The same could also be the case with the E.coli bacteria. There was no visible faecal material in the flat where the incident happened. There is, however, no information that the victim had planted both blood and faeces on the banana, but investigation of such possibilities lies in the hands of police and judgement is passed in courts. This case has not yet come to court.

The method has been of limited use in forensic casework in the past, but is emerging as a useful tool. Recently, it was reported in a case of forensic evaluation of a three-year-old girl with gonorrhoea (2). Application of similar genotypic microbiological examinations can be of help in future forensic microbiology, especially in cases of sexual abuse, like the present and other settings, for instance in cases with bite marks (9).

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Status of routine post-mortem computerized tomography in Odense, Denmark

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ABSTRACT In February 2006, a dual slice CT scanner was installed at the Institute of Forensic Medicine in Odense, Denmark. Since that time a CT-scanning has been performed on all bodies prior to autopsy. This article provides an overview of the experience gained. We found that computerized tomography rarely is a substitute for autopsy, but may contribute with important new information in many cases such as identifications (including massdisasters), battered child, gunshot wounds, traffic accidents and air embolism. Computerized tomography provides documentation in digital form – easily stored – permits review by others and provides pictures that may be more suitable for presentation in court than autopsy photos.

Key words: **Autopsy, computerized tomography, CT-scanning, forensic science, imaging, post-mortem imagining.**

INTRODUCTION

X-rays were first observed and documented in 1895 by the German scientist Wilhelm Conrad Roentgen. It seemed like magic – science had achieved a mean to visualize the internal structures of the body. Radiographic examination was soon introduced in forensic medicine. It was a giant leap forward, but the conventional X-ray technique has several shortcomings. One of the fundamental limitations is an inability to distinguish between the small density differences in soft tissues. Another limitation is that structures in three-dimensional space overlap in a conventional, two-dimensional, X-ray photograph. Professor Torgny Greitz expressed it this way in his presentation of Allan Cormack and Godfrey Hounsfield, who won the Nobel Prize for the invention of the CT-scanner: "What we see is a shadow play – a play with far too many actors on the stage. It becomes difficult to discern the villain".

These problems have been eliminated by computerized tomography (CT). In a CT-scanner, a X-ray tube transmits a fan shaped X-ray beam through the object to be investigated. Signals are picked up by an array of detectors on the opposite side, measuring the proportion of energy that passes through the object – the attenuation of the X-rays. These measurements are repeated many times while the X-ray tube and detectors rotate around the object under investigation. The attenuation profiles thus obtained are digitalized and sent to the computer for processing. The computer uses special mathematical techniques to obtain attenuation values for a matrix of small volume units called voxels, and these are then transformed to the pixels in the CT-images.

In a modern spiral or helical CT-scanner, the object under investigation is sent through the gantry opening at a constant speed, thus obtaining a whole volume of attenuation measurements. This digital information is then used for creating sectional CT-images in the transversal plane (figure 1). The volume of digital information may also be used for creating sectional CT-images in other planes and for 3-dimensional reconstructions (figure 2). CT is now gaining access in forensic medicine after the pioneer works of Thali and Dirnhofer (1),(2).

This paper is an overview of the post-mortem CT service at the Institute of Forensic Medicine at the University of Southern Denmark with a discussion of integration of CT into established autopsy practice and its legal implication.

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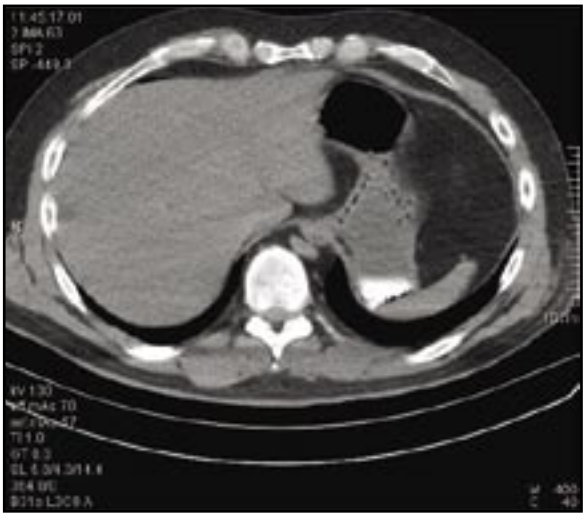
POST-MORTEM COMPUTERIZED TOMOGRAPHY AT ODENSE

In February 2006, a CT-scanner was installed at the Insti-



Figur 1. Transversal view of the abdomen. This is an example of suicide by tablet-ingestion. Tablet residues can be seen in the ventricle (white).

Figure 2: Severe blunt force injury to the cranium (car crash)

tute of Forensic Medicine in Odense at the University of Southern Denmark, and is now used as routine procedure at all forensic autopsies. Conventional X-ray is still used for some purposes including dental identification, child abuse and age determination. This conventional X-ray service is provided by the Department of Radiology at the University Hospital in Odense.

Our institute is the smallest of the three institutes of forensic medicine in Denmark. We provide forensic medical service for the population of 730.780 (as of January 2006) individuals who live on the island of Fyn and in the southernmost county of the Jutland peninsula at the Danish-German border. We perform 230 medico legal autopsies each year, and 250 clinical forensic examinations of victims of violence and perpetrators, and employ three specialists in forensic medicine, and three younger doctors (Ph.D. students and trainees for forensic pathology). In addition, we teach medical students at the University of Southern Denmark and perform research.

The CT-scanner is a dual slice Somatom Spirit spiral-scanner from Siemens (figure 3). Dual slice means that it has two parallel detector-rows. The X-ray tube is air-cooled and needs a short pause for cooling between each scan. This is not a problem because of the relatively small number of autopsies, but for larger numbers an oil-cooled X-ray tube must be recommended. The scanner is situated in a specially equipped room in the cellar (figure 4). All biological material is scanned: whole bodies, body parts and bones. 4 separate scans are performed as a routine: the head, the neck, the thorax and the abdomen. Further scans may be needed, for example of the lower extremities in victims of traffic accidents. This requires that the body is turned around on the table, so the legs can move into the gantry opening. The routine scans take about 10 minutes. The scan operator is one of the specialists in forensic medicine. He is also responsible for the evaluation of the images and writing the CT-report. The scan operator has access to the images within minutes after the scan. It is our opinion that is easier to teach a pathologist to evaluate the scanning-pictures, than to teach a radiologist to evaluate post-mortem CT findings, especially when the autopsy-results can be reviewed shortly after the scanning. Radiologists used to clinical radiology have a tendency to overinterpreting the findings. This is caused by the dramatic alterations of the body after death. CT findings that would be considered highly abnormal in life are seen as normal post-mortem findings. This includes air collection in organs and body cavities, visceral lividity and changes in organ anatomy.

Figure 3: The CT-scanner (Siemens Somatom Spirit)

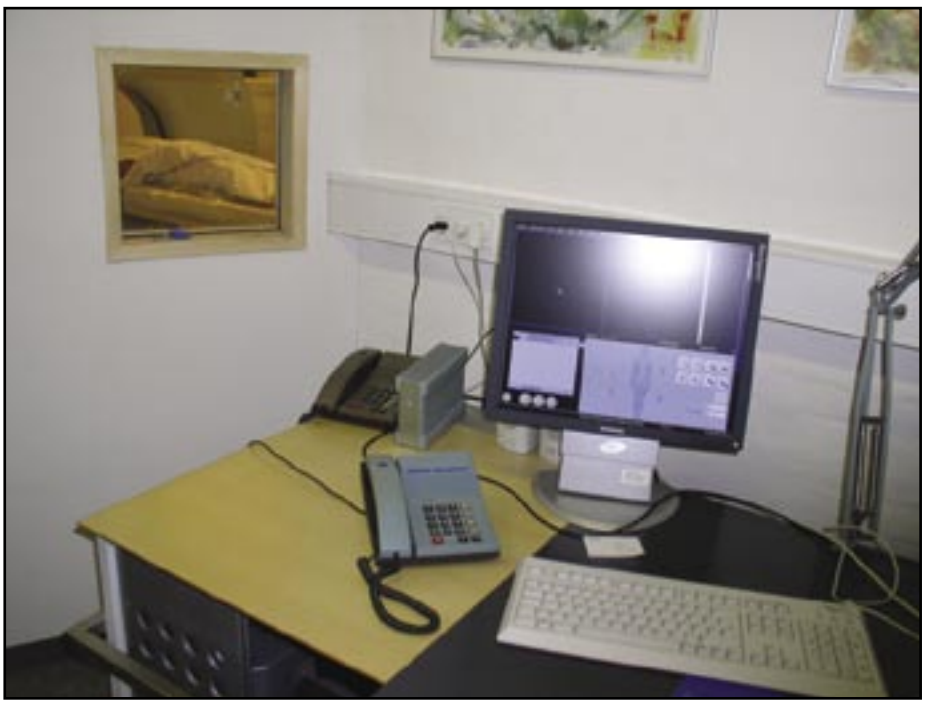


Figure 4: The operation room. The scanner can be seen through the window

The images are sent to the work station in an office at the ground floor. The CT-findings and the autopsy-findings are registered in a computer database (SPSS for windows) for further analysis and future research. The CT images are archieved on CDs and on an external harddisc.

The forensic pathologist who performs the autopsy has no prior knowledge of the scan results, but the CT-findings are discussed before the organs are returned to the body, and the results from the CT-scanning are included in the final forensic report.

OUR PRELIMINARY EXPERIENCES: CT VERSUS AUTOPSY

Until now we have scanned approximately 300 bodies. The results of the CT scanning of the first 100 cases have been presented elsewhere (3). We found that the autopsy presented several important

Figure 5: Gunshot injury to the head (suicide with a pistol).

advantages compared to CT, and that CT must be considered a supplement and not a substitute to the autopsy. The cause of death can be established by CT in approximately a quarter of all cases, and is especially useful in cases of traumatic death. Many important diagnoses cannot be established by post-mortem CT, including coronary thrombosis and many infections such as meningitis and peritonitis. One important advantage of the autopsy is the possibility to perform microscopy and microbiology on tissue samples. Post-mortem CT-scanning suffers under the severe limitation that contrast cannot be used. CT may on the other hand contribute with important new information which could not be obtained by an autopsy and allows investigation of anatomic regions that are not easily available by autopsy. CT allows 3-dimensional reconstructions of bone fractures and inner organs as they appear "in situ" before they are disturbed by an autopsy (figure 3). CT is also very useful in cases involving gunshot injuries. The projectile can easily be found, the bullet tract can often be visualized and the shot-angles measured (4),(5) (figure 5). In identification cases CT gives a quick overview of the body revealing old fractures and transplants. CT is according to other authors useful in identification of victims of massdisasters (6), (7) and is helpful in cases of terror bombings by allowing a quick evaluation of the distribution and type of shell fragments. CT is also useful in cases of child abuse revealing old and new fractures and intracranial bleedings, but must be combined with conventional X-ray pictures. We believe this to be a job for a specialist in radiology. CT is superior to autopsy in visualizing air embolism (8), but artefact may occur due to putrefaction. Finally it should be mentioned that computerized tomography provides documentation in digital form - easily stored - permits review by others and provides pictures that may be more suitable for presentation in court than autopsy photos.

An often raised question is: how often can an autopsy be substituted by CT? This question has become relevant because of the decreasing autopsy frequency. In Denmark, this reduction has been from more than 65% of all deceased autopsied in the 1970es to less than 15% today (the number of medico legal autopsies has remained constant). The forensic autopsy is a procedure designed to determine not only the cause of death, but also to satisfy the requirements of many different parties – the juridical system, the relatives and the public health system. The evaluation of this question is therefore not an easy task. We made a subjective judgement of whether the purpose of the autopsy was fulfilled by CT or not at two separate occasions: first before and then again after the autopsy (including microscopy, microbiology and toxicology) (3). We estimated that the autopsy could be omitted in approximately a third of the cases, and only in one case did we reach another conclusion after having seen the results of the autopsy (in this case a ring fracture in the cranial base was overlooked at the CT).

If expert evidence is to be presented in court, a body of scientific data must be available to support that evidence. Such a body of evidence is not always available for post-mortem CT. We need more experience with CT combined with autopsy before we can decide if CT can be used instead of autopsy in some cases.

CONCLUSION

Computerized tomography is now an integral part of the post mortem examination process at the Institute of Forensic Medicine at the University of Southern Denmark. Our preliminary experience has lead to the following statements:

1. CT can only in a minority of cases be seen as a substitute for an autopsy.
2. CT are however helpful in many cases such as identifications, battered child, gunshot wounds, trafficaccidents, air embolism, etc.
3. CT allows investigation of anatomic regions that are not easily available by autopsy, and allows fractures and inner organs to be seen "in situ".
4. CT provides documentation in digital form – easily stored – permits review by others and provides pictures that may be more suitable for presentation in court than autopsy photos.
5. CT opens new fields of research.

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Benefits from CT scan in a fatal drag race accident

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ABSTRACT A case report of a 45-year-old motorcyclist who died during a drag race is presented, showing a considerable difference between external and internal injury.

Comparison of autopsy findings and computerized tomography (CT) scan is made. CT scan renders a qualified tool in diagnosing skeletal fractures whereas findings of parenchymal damage, however, are compromised by post mortem artefacts and remains a challenge to be solved.

***Keywords*: Computed tomography, autopsy, motorcycle accident.**

INTRODUCTION

While accident injuries often are multiple and serious due to various and complex forces occurring at the moment of impact, there is sometimes a considerable difference between external and internal injuries of the injured (1). The complex mechanisms of exposure and high velocity make motorcyclists extremely exposed to injury and mortality (2). Pelvic fractures are indicators of high severity and multiplicity of injury (14). This report presents an autopsy case with fatal rupture of the femoral artery and vein, pelvic rupture, and luxation of the femur resulting from braking and crashing on a drag race motorcycle (*table 1)*. Autopsy and CT scan were made to provide information of the mechanism of injury.

CASE REPORT

A 45-year old male professional drag race motorcyclist died in a drag race. The deceased was driving at 220 kilometres per hour. He lost control of the motorcycle while he was braking and most likely turned somersaults in the air and landed on the ground. Paramedics arrived within 30 seconds and found the deceased lifeless without respiration or pulse. An attempt of resuscitation was made resulting in heart rhythm changing from bradycardia to sinus rhythm, in spite of this the deceased remained pulse less. Further attempts of resuscitation rendered no changes. The autopsy and CT scan were performed 4 days after the accident.

Autopsy findings

The deceased was 182 cm in length and weighed 105 kg. External examination revealed only slight injuries. Sand was found in the eyes and mouth. Fresh bruises were found on the scalp, the neck and the left shoulder. 3 old bruises were noted on the right side of thorax and abdomen. There was swelling and discoloration of the right inguinal region, and anterior luxation of the femur was suspected. Furthermore there was gaseous air in the abdominal wall and scrotum with greenish discoloration indicating putrefaction.

The internal examination showed fracture of the 8th thoracic vertebral body and slight haemorrhage surrounding the spinal cord. There was rupture of the pubic symphysis and right anterior sacro-iliac joint, and the anterior luxation of the right femur was confirmed. In the pelvic and right inguinal region there was blood haemorrhaging and clotting of approximately 1.5-2 litres, and rupture of the right femoral artery and vein. Slight haemorrhaging was noted around the descending part of the aorta shortly after the aortic arch.

There were findings of slight arteriosclerosis in the aorta, carotid, and coronary arteries.

Histological examination revealed haemorrhage surrounding the spinal cord, rupture of the right femoral vein, haemorrhage from the right femoral artery, and signs of cerebral contusion.

Alcohol testing was negative. Drug testing revealed propranolole: 0.27 mg/kg.

The cause of death was concluded to be exsanguination due to rupture of the pelvis and the femoral artery and vein resulting in fatal impairment of heart action and blood circulation.

Table 1

Drag race is a competition between two cars, motorcycles, or speedboats at high velocity. It started in California, USA, in the 1920ies and the drag-strip is ¼ mile (app. 402 metres), which is the distance between traffic lights in most American cities (3).

The velocity of the motorcycle in this case was 220 kilometres per hour prior to the accident and shortly before the driver was braking his motorcycle.

CT scan findings

Skeletal Fractures

The transversal fracture of the 8th thoracic vertebral body was shown (*fig. 1)* and there was rupture of the right anterior sacro-iliac joint, and rupture of the pubic symphysis with proximal displacement of the left part of the pelvis, compatible with moment of vertical shear. The right femoral head had luxated anteriorly with fracture of the acetabular rim (*fig. 2*).

A possible fissure in the bony part of the left temporal bone was noted, with fluid in the left sphenoid sinus.

Pelvic region, abdomen and lungs

There was massive bleeding in the right pelvic region and in front of the right femur with subcutaneous emphysema and gaseous air in the vessels. There was retroperitoneal and intraperitoneal fluid consistent with bleeding around the spleen and in the pelvis.

There was a minor right side pneumothorax and pleural fluid was localised bilaterally.

Post-mortem changes

CT scan detected gaseous air surrounding the brain, brain stem, in the ventricular system, in the vessels of the neck, in the heart and central vessels, retroperitoneally, imbibed in the liver, surrounding the kidneys, in the vessels of the lower extremities, and in the scrotum.

Furthermore images revealed subcutaneous emphysema from the neck to the temporal and parietal regions of the skull, located dorsally, retroperitoneally, and surrounding both femural regions.

In addition there were signs of lung condensation distally on both sides.

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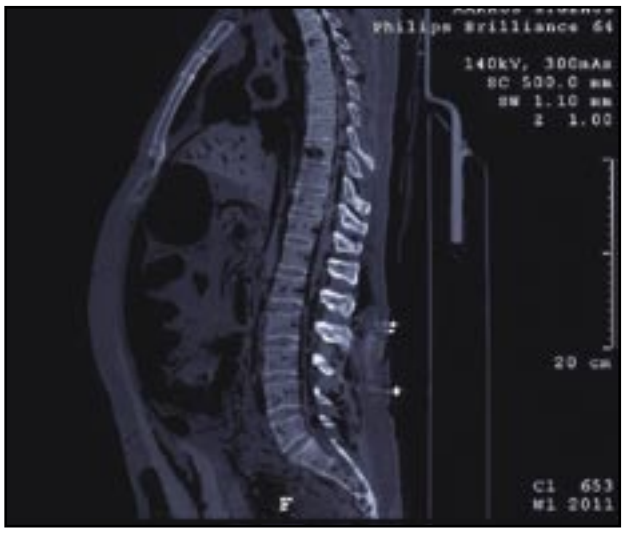

Figur 1. CT scan showing transversal fracture of the 8th thoracic vertebral body.

DISCUSSION

In this case there was a considerable difference between external and internal injuries, and compared to the exposure and high velocity, few external injuries.

Prior medical history could not be obtained but the drug propranolole could be used to treat a medical condition as arterial hypertension or be used to diminish the "racing anxiety" of the driver.

Several groups have in recent years evaluated and validated post-mortem CT and MRI (magnetic resonance imaging) examinations (4-13).

Post-mortem CT scan did demonstrate the relevant autopsy findings; fracture of the 8th thoracic vertebral body, rupture of the pubic symphysis and the right anterior sacro-iliac joint, anterior luxation of the right femur, intra- and retroperitoneal bleeding, and bleeding in the right inguinal region. Papadopoulos et al. (14) found that pelvic fractures indicate high severity and multiplicity of injury but only counts for a relatively small proportion of deaths.

The gaseous air found by autopsy and post-mortem CT scan was most likely due to putrefaction.

Figur 2. CT scan showing the pelvic region with fracture and luxation.

The deceased was wearing a leather suit that kept him warm post-mortem and the autopsy and post-mortem CT scan were not performed until 4 days after death. Several studies (4-5,15-16) found that elapsed time after death before autopsy, complicates the investigation of a corpse.

This indicates the importance of performing the post-mortem investigation as soon as possible after death.

The CT scan found possible fissure in the bony part of the left temporal bone and fluid in the left sphenoid sinus, in contrast; the autopsy didn't identify these changes. Cattaneo et al (17) performed an animal study of battered piglets comparing traditional radiology, CT scan, and autopsy with osteological control. They found that CT scan may inaccurately overestimate the number of fractures as well as traditional radiology and autopsy may be inadequate for exposing fractures during post-mortem examination.

The CT scan found pleural fluid bilaterally, a minor right side pneumothorax and bleeding around the spleen. This was not confirmed by autopsy. Poulsen and Simonsen (18) found that CT scan is not suitable for examination of the lungs in dead bodies and difficult to use in the abdominal region because of post-mortem development of putrefactive gaseous air. Dirnhofer et al (4) state that CT scan can be used in gross tissue injury; however, MRI demonstrates soft tissue injury better.

Leth (19) found that CT scan is most useful in cases of traumatic death. The cause of death could be established by CT scan and external examination in 27 %, by CT scan, external examination and forensic chemistry in 32 % and by autopsy in 95 %. Several groups (4-13) support the use of modern cross-sectional imaging techniques as a supplement to traditional autopsy that will lead to qualitative improvement in forensic traumatology- and injury mechanisms. This fatal case of a drag race motorcyclist supports the combination of autopsy and CT scan as the most accurate tool in finding skeletal fractures post-mortem.

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Dansk Selskab for Retsmedicin

20080313/dr

Indkaldelse til generalforsamling i Dansk Selskab for Retsmedicin

Onsdag d. 23. april 2008 kl. 18.30

Auditorium A, Frederik V's vej 11, 2100 København Ø

Dagsorden:

1. Valg af dirigent og referent.
2. Formandsberetning.
3. Beretning fra udvalg.
3a Beretning fra selskabets repræsentation i DANAK og DMS.
4. Aflæggelse af det reviderede regnskab fra 2007.
5. Fastsættelse af kontingent.
6. Forslag fra bestyrelsen og medlemmerne:
   a. Speciallægeuddannelsen
   b. Forretningsorden for uddannelsesudvalg
   c. Vedtægtsændring
7. Valg: Dorte Rollmann er på valg (villig til at genopstille) revisorer og revisorsuppleanter

Evt. *(Eventuelle forslag skal indgives til bestyrelsen ledsaget af en kort motivering senest 2 uger før generalforsamlingen)*

Bilag er tilgængelige på selskabets hjemmeside/for medlemmer: www.forensic.dk, glemt medlemsnummer kan indhentes ved henvendelse til formanden (jb@retsmedicin.au.dk).

Videnskabeligt forårsmøde forud for den ordinære generalforsamling i Dansk Selskab for Retsmedicin

Onsdag den 23. april 2008 kl. 16.00 – 18.00

Auditorium A, Frederik V's vej 11, 2100 København Ø

Emne: **Aldersbestemmelse**

Mødeleder: Overlæge, Steen Holger Hansen Retsmedicinsk Institut, København

Program:

1. Mads Warnecke, læge Retsmedicinsk institut, København: En opgørelse over undersøgelse fra Retsmedicinsk Institut, Københavns universitet.
2. Steen Holger Hansen, overlæge, Retsmedicinsk Institut, København: Retslægerådets procedurer i sager med henblik på familiesammenføring.
3. Niels Lynnerup, lektor, Retsantropologisk laboratorium Retsmedicinsk Institut, København: En retrospektiv opgørelse af aldersbestemmelse ved håndrøntgen.
4. Niels Lynnerup, lektor, Retsantropologisk laboratorium Retsmedicinsk Institut, København Kulstof 14 analyse af øjenlinser

Kl. ca. 18.00: Pause med let anretning, øl og vand

BOOK REVIEW

TORLEIV OLE ROGNUM WAS HONOURED BY THE KING OF NORWAY WITH THE ORDER OF ST OLAV ON NOVEMBER 30, 2007. THE KING'S REPRESENTATIVE GOVERNOR OF SOUTH NORWAY ANN-KRISTIN OLSEN PERFORMED THE SEREMONY.

Rognum was honoured for his contribution to SIDS research and forensic medical work. The council of the order has in its evaluation especially emphasized his untiring contribution to research and passing on knowledge about research and work in forensic medicine.

The book is based on a set of lectures and comments given at the symposium Kvalitetsheving av rettsmedisinsk sakkyndig-virksomhet – hvordan?(How to improve the quality of medicolegal expertise) arranged by The University of Oslo in September 2006. The editors have a strong commitment to what they think is a wrongful judgment of the medical and technical evidence in a fifty years old, Norwegian murder case. Even if the book has to be considered as a plea in this case, it is in my opinion worth reading for scientists and other specialists appointed to expert witnessing in court. The authors point out the importance of careful examination by approved methods and scientific evaluation of the evidence.

RETTSMEDISINSK SAKKYNDIGHET I FORTID, NÅTID OG FREMTID.

Mot et paradigmeskifte ved vurdering av rettsmedisinsk sakkyndighet.

Per Brandtzæg og Ståle Eskeland (red.)

Cappelen Akademisk Forlag, 2007. 124 sider.

Denne lille boken bygger på en samling foredrag og debattinnlegg som ble gitt under samme tema ved et dagsseminar ved Universitetet i Oslo i september 2006, arrangert av det Juridiske og det Medisinske Fakultet. Initiativtakerne til seminaret, professorene Per Brandtzæg og Ståle Eskeland, har blant annet gjennom dagspressen gitt uttrykk for sitt sterke engasjement i kravet fra drapsdømte Fredrik Fasting Torgersen om gjenopptagelse av straffesaken fra 1958 - hvor han ble funnet skyldig i seksualdrap. Deres overbevisning er at de tekniske bevisene i saken ikke var korrekt tolket av de rettsoppnevnte sakkyndige og at eksperttuttalelsene manglet et grunnleggende vitenskapelig fundament for å knytte siktede til offer og åsted.

Redaktørenes sterke engasjement i denne saken preger selvsagt boken, som delvis må leses som et partsinnlegg i Torgersensaken. I sin gjennomgang av bevisene og de sakkyndiges uttalelser mener de at denne saken har vært gjenstand for de samme feil som en rekke saker i USA, der det såkalte Innocent Project viser at en rekke justismord er begått blant annet støttet av feilaktige vitneutsagn fra sakkyndige eksperter. (DNA-analyser av oppbevart bevismateriale gir i ettertid grunnlag for en annen tolkning av bevisene enn det som opprinnelig førte til domfellelse). 200 tidligere dømte personer er blitt frikjent og psykologen Michael Saks har analysert 86 av disse rettssakene og viser i en artikkel i Science i 2005 hvilke feil som er begått og som kan ha ført til en gal beslutning.

Møtedeltagernes bidrag til de ulike kapitlene i boken gir et visst innblikk i hva sakkyndige eksperter bør bestrebe seg på og ikke minst unngå. Boken kan være verdt å lese for dem som blir oppnevnt som sakkyndige i en rettssak, ikke minst om det er første gang og deres daglige virke ikke er innrettet mot rettssystemet.

Hovedbudskapet er at det i vurderingen av et teknisk bevis ofte ligger et element av likhetsbetraktninger og, dersom likhet stadfestes, hvorvidt det er grunnlag for å hevde at likheten ikke er tilfeldig, dvs stammer fra siktede og ikke en annen person. Førstnevnte krever gode, kvalitetssikrede og anerkjente metoder, sistnevnte en systematisk analyse med de samme metoder av et tilstrekkelig stort normalmateriale. Det vil si forskning. Bare da foreligger et vitenskapelig grunnlag for å kunne foreta en avveining mellom de to forklaringer beviset representerer; gjerningspersonen har tilknytning til beviset eller beviset representerer et tilfeldig sammentreff mellom den mistenkte og gjerningspersonen.

Jeg tenker at boken kan fungere som lesestoff i forbindelse med DRK's kurs for sakkyndige; deler av stoffet bør kunne systematiseres og bidra ved utarbeidelse av gode retningslinjer for sakkyndigrollen.

Professor Aina Schiøtz' beskrivelse av Hetle-saken fra tidlig 1900-tall var for undertegnede interessant lesning og minner om viktige faktorer i arbeidet som sakkyndig er å ha distanse til saken, partsuavhengighet og å unngå følelsesmessig engasjement.

Margurethe Steneren

NRF

Norsk Rettsmedisinsk Forening

ÅRSRAPPORT FOR 2007:

Styret i Norsk Rettsmedisinsk Forening har i 2007 bestått av Torleiv O. Rognum (leder),

Kjærsti Helland (kasserer) og Per Holck (sekretær). Styrets sammensetning har vært den samme som året før, gjenvalgt av generalforsamlingen.

Valgkomiteen (Lars Uhlin-Hansen og Lisbeth Wille Sveum) stilte ikke til gjenvalg, men innstilte Ivar Sjåk Nordrum og Audun Skogseth som nye komitemedlemmer. Også deler av rådet ble skiftet ut, idet man innstilte Andreas Hamnes (for Stein Ikdahl), Anne Christine Johannessen (for Sigrid Kvaal) og Tarjei Rygnestad (for Jørg Mørland) – for derved å skape større geografisk spredning. Gjenvalgt ble Christian Lycke Ellingsen som har revidert regnskapet.

Styret har i denne perioden hatt 3 ordinære møter, ved et par av dem var kasserer fraværende grunnet utenlandsreise. Det er utgitt ett nummer av journalen Scandinavian Journal of Forensic Science.

Følgende faglige medlemsmøter/kurs har vært avholdt i 2007:

- Den 19. og 20. april holdt foreningen sitt årsmøte i form av et faglig kurs i Rødt auditorium på Rikshospitalet, med 36 påmeldte deltagere. Kursets to temaer var "Den sakkyndiges rolle i straffesaker – erfaringer og utfordringer", samt "Sakkyndighet 50 år etter Torgersen-saken". Møtet ble avsluttet med generalforsamling.
- I samarbeid med Radiologiforeningen og Den norske Patologforening arrangerte NRF møte i Kvinneklinikkens gamle lokaler, den 17. oktober. Møtets tema var "Virtopsy – the future auto-psy?", hvor professor Michael Thali fra Bern og overlege Anders Persson fra Linköping redegjorde for det nyeste på dette området.
- I samarbeid med Barnedødsårsaksgruppen ved Rettsmedisinsk institutt og Norsk barnelegeforening arran-gerte NRF møte om barnemishandling på Soria Moria, den 28. november. Møtet var meget godt besøkt, med hele 80 deltagere.

NRF

Norsk Rettsmedisinsk Forening

Norsk Rettsmedisinsk Forening arrangerer faglig møte og generalforsamling i oktober 2008

Tema for det faglige møtet blir

REKONSTRUKSJON – BRUK AV MODERNE TEKNIKKER

19/1 sendte foreningen en søknad om fagmedisinsk godkjenning til Den norske Lægeforening. Siden dette ikke førte frem, vil nye fremstøt forsøkes.

Siden generalforsamlingen påpekte svikt i rutinene for innkreving av medlemskontingent, er dette nå skjerpet.

Oslo 13/1-08

Torleiv O. Rognum,
leder (sign.)

Kjærsti Helland,
kasserer (sign.)

Per Holck,
sekretær (sign.)