
Sudden death whilst swimming – Is it safe to go into the water?

Dr Anthony Handley¹ and **Dr Patrick Morgan**^{2,3}

Royal Life Saving Society – UK¹, Surf Life Saving Great Britain² and Royal National Lifeboat Institute³

In the developed world, the risk of death whilst swimming has reduced steadily over the years. As it is now relatively rare for a drowning to take place during supervised swimming, such a death, particularly in a young swimmer, attracts considerable media attention.

This presentation will discuss the cause of sudden, unexpected, and often 'silent' drowning in these circumstances, in particular, the role of pre-submersion hyperventilation, and inherited heart conditions.

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Sudden Death Whilst Swimming

Is it safe to go into the water?



Dr Anthony J Handley

Chief Medical Adviser, RLSS UK
Chairman Medical Committee, ILS

Dr Patrick Morgan

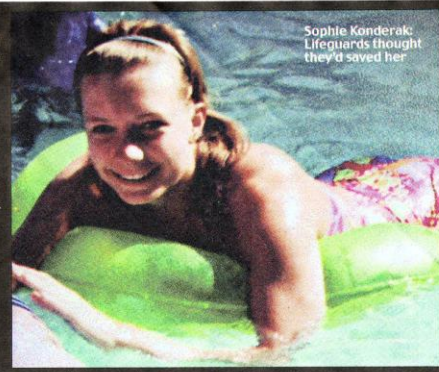
Medical Adviser SLSGB
Medical Committee, ILS



Daily Mail, Friday, February 26, 2010

Page 27

Girl died at the poolside after young lifeguard stopped trying to revive her



A CORONER demanded an overhaul of resuscitation training after hearing how a teenage swimmer was revived at a poolside, only to die when a lifeguard stopped giving her mouth-to-mouth too soon.

Sophie Konderak had a cardiac arrest moments after starting a training session at a leisure centre.

The 16-year-old was dragged from the water unconscious and young lifeguard Katy Butler began cardiopulmonary resuscitation – mouth-to-mouth breathing and chest compressions.

Miss Butler, 23, who had never tried to revive a swimmer before, believed she had saved Sophie

By **Andy Dolan**

when she started breathing again. However, she did not take the crucial step of checking for a pulse – to determine whether the heart had restarted – and unwittingly left Sophie dying on the wet floor. Paramedics arrived four minutes later and resumed CPR, only to be asked by one of the lifeguards: 'Why are you doing CPR? She's alive.' The hearing was told.

As a paramedic gave evidence to the inquest, the teenager's distraught mother, Lesley, 46, broke down in tears and cried out: 'It's my child's life, why didn't anybody do anything?'

'How could you just leave her lying there? She would have survived.' The ambulance crew tried to revive Sophie, a talented

swimmer who dreamed of winning an Olympic gold, with a defibrillator at the leisure centre in Braunstone, Leicester, on September 15 last year.

However, she was pronounced dead shortly afterwards at the city's Royal Infirmary. The inquest

'She would have survived'

heard Sophie's initial cardiac arrest was caused by an

heart condition. Heart expert Dr Chris said Sophie would have survived if she had received a defibrillator until 4.5pm – 14 minutes after she was pulled out of

there's breathing and a pulse.' The inquest on Wednesday heard that Miss Butler, who was employed by Leicester City Council and was performing CPR for the first time, spent four minutes trying to revive Sophie and believed she had succeeded when the teenager began breathing.

She said: 'If a person is breathing we're told to stop CPR and put them in the recovery position.'

Sophie's heart was not restarted by defibrillator until 4.5pm – 14 minutes after she was pulled out of

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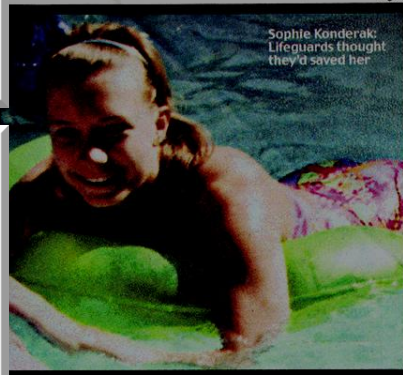
Mrs Mason, coroner for Leicester and South Leicestershire, said: 'The crucial point of this is that the CPR was stopped.'

'The guidelines should be changed so that from when CPR commences it is conducted until a medically qualified person arrives or the patient regains consciousness.'

After the inquest, Mrs Konderak

Case 1

- Swim training
- Cardiac arrest
- Rescued by Lifeguard
- Resuscitation commenced
- Unsuccessful - Died



Sophie Konderak: Lifeguards thought they'd saved her

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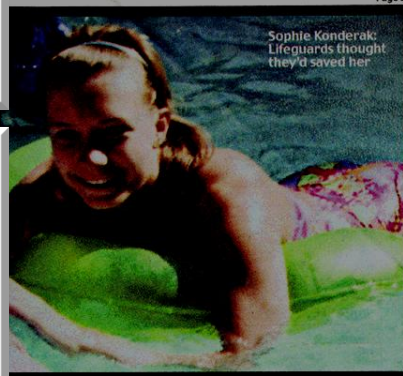
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Autopsy

“Arrhythmogenic
Right Ventricular
Cardiomyopathy
(ARVC)”



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Boy, 11, drowns in swimming class
 An 11-year-old boy has drowned during a school swimming lesson at a leisure centre in Oxfordshire.

Nathan Matthews was pulled from the swimming pool at Thame Leisure Centre by a lifeguard, after he appeared motionless in the water.

Attempts to resuscitate the year six pupil, from Stokenchurch Primary School, High Wycombe, Bucks, failed.

He was taken to Oxford's John Radcliffe Hospital where he was pronounced dead at 1230 BST.

His parents were taken to the hospital after being contacted immediately by the school.

Nathan was one of 88 pupils having a Monday morning swimming lesson when the incident took place.

Headteacher Andrew White said: "This is a tragedy, and our deepest sympathies are with the boy's family and friends at this time."

“ It is too early to tell how or why this happened. We can only hope that swift investigation will shed more light ”
 Andrew White, head teacher

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Case 2

Last Updated: Monday, 12 July, 2004, 18:27 GMT 19:27 UK

- Moderate swimmer
- Supervised lesson
- Relay race
- Dive to pick up a "sinker"
- Motionless on pool floor

swimming lesson when the incident took place.

Headteacher Andrew White said: "This is a tragedy, and our deepest sympathies are with the boy's family and friends at this time."

robbery


- Elderly woman tricked by burglar
- Seventeen arrested in drugs raids

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Case 2

- Swimming instructor rescued
- Lifeguards attempted resuscitation
- Ventricular Fibrillation with paramedics
- Unsuccessful - Died



swimming lesson when the incident took place.

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Autopsy

"The findings in the lung fully consistent with drowning

The underlying reason as to why he ran into difficulties is not apparent from the post mortem"



swimming lesson when the incident took place.

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“After considering the expert medical evidence, and on the balance of probability, we were unable to identify the primary event that led to Nathan Scott Matthew’s drowning”



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...s Valley Police
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FORDSHIRE STORIES
...abbed during street robbery

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Relevance?

Table. Demographics of Sudden Death in Young Athletes

Sport	No. (%)	Age, y	Male, n (%)	Female, n (%)	Race, n			Survivors, n (%)	Trauma Injury	Cause of Death, n (%)		
					White	Black	Other*			Coronary	CV (Diseases)	Overexert
Football	565 (20)	17-4	564 (99.8)	1 (0.2)	280	205	80	13 (2)	140 (25)	12 (2)	281 (50)	
Basketball	405 (22)	17-4	364 (90)	41 (10)	142	243	20	30 (7)	4 (1.0)	0	349 (86)	
Soccer	115 (6)	16-4	93 (81)	22 (19)	81	14	20	7 (6)	11 (10)	4 (4)	80 (70)	
Baseball	111 (6)	16-4	111 (100)	0	95	5	11	14 (13)	16 (14)	30 (27)	54 (49)	
Motor vehicle racing†	104 (6)	28-8	103 (99)	1 (1)	102	0	2	0	97 (93)	0	5 (5)	
Track and field	96 (5)	17-4	74 (77)	22 (23)	62	22	12	3 (3)	25 (26)	0	61 (64)	
Wrestling	69 (4)	22-8	69 (100)	0	56	4	9	2 (3)	7 (10)	1 (1.4)	37 (54)	
Boxing	56 (3)	25-6	55 (98)	1 (2)	21	19	16	0	42 (75)	0	11 (19)	
Swimming‡	46 (2)	17-4	30 (65)	16 (35)	43	1	2	1 (2)	0	0	35 (76)	
Cross country	38 (2)	17-4	29 (76)	9 (24)	30	6	2	2 (5)	0	0	29 (76)	
Hockey	29 (1.5)	18-5	29 (100)	0	28	1	0	3 (10)	4 (14)	7 (24)	11 (38)	
Horse riding§	27 (1.4)	27-8	17 (63)	10 (37)	21	1	5	0	24 (89)	0	2 (7)	
Softball	22 (1.2)	19-6	6 (27)	16 (73)	19	0	3	2 (9)	3 (14)	1 (5)	12 (55)	
Marathon	20 (1.1)	28-7	15 (75)	5 (25)	16	0	4	3 (15)	0	0	13 (65)	
Lacrosse	19 (1.0)	18-2	19 (100)	0	18	1	0	2 (11)	1 (5)	8 (42)	9 (47)	
Skating¶	19 (1.0)	25-8	14 (74)	5 (26)	19	0	0	0	15 (79)	0	1 (5)	
Triathlon	17 (0.9)	32-5	15 (88)	2 (12)	16	0	1	0	3 (18)	0	8 (47)	
Rugby	16 (0.9)	21-3	16 (100)	0	13	2	1	0	3 (19)	0	7 (44)	
Martial arts	15 (0.8)	23-7	14 (93)	1 (7)	12	3	0	0	5 (33)	2 (13)	2 (13)	
Others‡‡	14 (0.8)	26-9	12 (86)	2 (14)	14	0	0	2 (14)	3 (21)	0	5 (36)	
Rowing	11 (0.6)	22-6	8 (73)	3 (27)	10	0	1	0	0	0	9 (82)	
Cycling	10 (0.5)	29-8	8 (80)	2 (20)	7	2	1	0	7 (70)	0	3 (30)	
Tennis	10 (0.5)	19-4	8 (80)	2 (20)	6	0	2	0	0	0	8 (80)	
Volleyball	10 (0.5)	18-5	1 (10)	9 (90)	5	3	2	1 (10)	0	0	10 (100)	
Gymnastics	9 (0.5)	15-3	5 (56)	4 (44)	6	0	3	0	4 (44)	0	3 (33)	
Surfing	9 (0.5)	23-8	9 (100)	0	7	0	2	0	2 (22)	0	1 (11)	
Figure skating	2 (0.1)	24-6	2 (100)	0	2	0	0	0	0	0	1 (50)	
Golf	2 (0.1)	18-0.7	2 (100)	0	2	0	0	0	0	0	2 (100)	
Totals	1866	19-6	1692	174	1135	532	199	85	416	65	1049	

Maron Circulation 2009; 119: 1085-1092

Relevance?

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1866 deaths in 27 years
Swimming 2% of all cases
Majority cardiac related
2% survived

Maron Circulation 2009; 119: 1085-1092

Causes of Sudden Death

Causes of Sudden Death



Diagnosed at Autopsy

Causes of Sudden Death

Diagnosed at Autopsy

No Abnormality at Autopsy

Causes of Sudden Death

Diagnosed at Autopsy

No Abnormality at Autopsy

- Myocardial Infarction
- Trauma
- Sudden Cardiac Death

Causes of Sudden Death

Diagnosed at Autopsy

- Myocardial Infarction
- Trauma
- Sudden Cardiac Death

No Abnormality at Autopsy

- Seizures
- Shallow Water Blackout
- Cold Water responses
- Sudden Cardiac Death




NAVAL SAFETY CENTER

Work, Play, Live...Safely!

ALSAFE Message 30/98 Shallow Water Blackout

TRAINEES REQUIRED TO PARTICIPATE IN BREATH HOLDING EXERCISES MUST BE CLOSELY SUPERVISED AND REMAIN IN DIRECT LINE OF SIGHT WITH AN OBSERVER. HYPERVENTILATION SHALL NOT BE PRACTICED.

ILSF.org ILS Europe WCDP 2011 Rescue 2012



International Life Saving Federation

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Shallow Water Blackout

- Actively discourage hyperventilation prior to “breath hold” diving.
- Lifeguard Education
 - Low threshold for immediate rescue and recovery.
- Special observation of “breath-holding” dives

<http://ilsf.org/index.php?q=en/medical/statements>

Sudden Cardiac Death (SCD)

“..death due to cardiac causes.. within one hour of onset of acute symptoms..”

Myerburg & Castellanos A. In Braunwald *Heart Disease* 1997: 742–79

Sudden Cardiac Death (SCD)

- Two thirds of sudden (non-traumatic) death cases are of cardiac origin

– Thomas et al BMJ 1988; 297: 1453-1456

Sudden Cardiac Death (SCD)

- General Population 1:1000 pa

– Priori et al. Eur Heart J, 2001; 22: 1374-1450

- Young people (<35yrs) 0.3-3.6(1):100,000 pa

– Borjesson & Pelliccia. Br J Sports Med 2009; 43: 644-648

Sudden Cardiac Death (SCD)

- Non-athletes (<35yrs) 0.7:100,000 pa
- Athletes (<35yrs) 2.1:100,000 pa

3 x the risk

Corrado et al. J Am Coll Cardiol 2003; 42: 1959-1963

Sudden Cardiac Death (SCD)

- Structural

OR

- Electrical



Myerburg & Castellanos A. In Braunwald *Heart Disease* 1997: 742-79

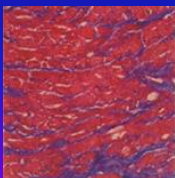
Hypertrophic cardiomyopathy	36%
Congenital coronary artery anomalies	17%
Myocarditis	6%
Arrhythmogenic right ventricular cardiomyopathy	4%

Maron et al. Circulation 2009; 119: 1085-1092

Hypertrophic Cardiomyopathy (HCM)



Normal



HCM

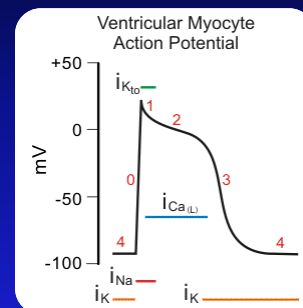
Ion channelopathies

4%

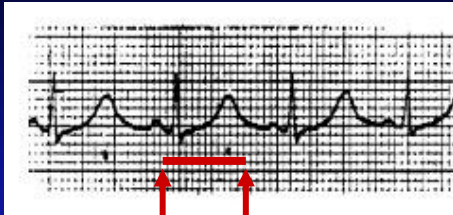
Maron et al. Circulation 2009; 119: 1085-1092

Ion Channelopathies

- Ion channel is the route ions (Sodium, Potassium, Calcium) move in and out of the cardiac muscle cell
- The Action potential is the electrical signal for the muscle to contract



Long QT Syndrome (LQTS)



Normal



LQTS

Long QT Syndrome (LQTS)

Type of LQTS	Chromosomal Locus	Mutated Gene	Ion Current Affected
LQT1	11p15.5	<i>KVLQT1</i> , or <i>KCNQ1</i> (heterozygotes)	Potassium (I_{Ks})
LQT2	7q35-36	<i>HERG</i> , <i>KCNH2</i>	Potassium (I_{Kr})
LQT3	3p21-24	<i>SCN5A</i>	Sodium (I_{Na})
LQT4	4q25-27	<i>ANK2</i> , <i>ANKB</i>	Sodium, potassium and calcium
LQT5	21q22.1-22.2	<i>KCNE1</i> (heterozygotes)	Potassium (I_{Ks})
LQT6	21q22.1-22.2	<i>MIRP1</i> , <i>KNCE2</i>	Potassium (I_{Kr})
LQT7 (Anderson syndrome)	17q23.1-q24.2	<i>KCNJ2</i>	Potassium (I_{Kr})
LQT8 (Timothy syndrome)	12q13.3	<i>CACNA1C</i>	Calcium ($I_{Ca-L\alpha}$)
LQT9	3p25.3	<i>CAV3</i>	Sodium (I_{Na})
LQT10	11q23.3	<i>SCN4B</i>	Sodium (I_{Na})
LQT11	7q21-q22	<i>AKAP9</i>	Potassium (I_{Ks})
LQT12		<i>SNTA1</i>	Sodium (I_{Na})
JLN1	11p15.5	<i>KVLQT1</i> , or <i>KCNQ1</i> (homozygotes)	Potassium (I_{Ks})
JLN2	21q22.1-22.2	<i>KCNE1</i> (homozygotes)	Potassium (I_{Ks})

Sovari. eMedicine Cardiology 18 June 2009

Long QT Syndrome (LQTS)

Swimming appears to be a gene-specific (KVLQT1)
... trigger for LQTS ... an unexplained drowning ...
may have a genetic basis

Ackerman et al. Mayo Clin Proc 1999; 74: 1088-1094

Is it relevant to me?

BEST (Bristol English Channel Swim Team)
On September 4th 2010 – 6 children from Bristol became the youngest team ever to swim the English Channel



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BEST LINDA
BEST HANNAH
BEST DANIEL
BEST DANIEL
BEST ELEANOR
BEST CLARE

Pre-participation screening

Young Competitive Athletes

Corrado et al. Eur Heart J 2005; 26: 516-524

Pre-participation screening

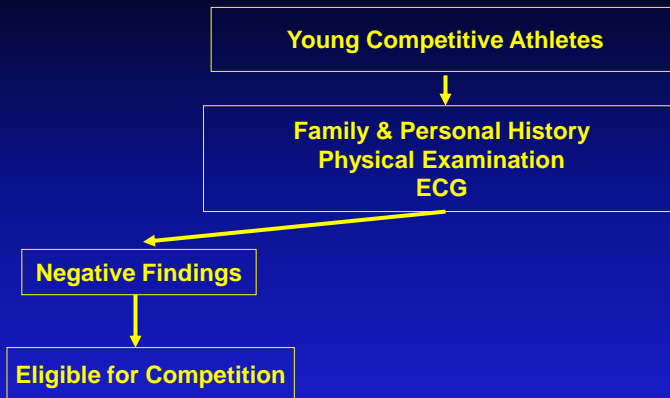
Young Competitive Athletes



Family & Personal History
Physical Examination
ECG

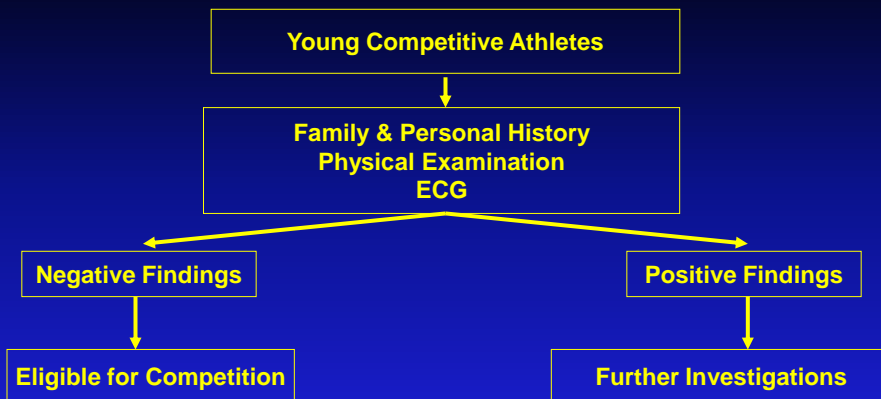
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Pre-participation screening



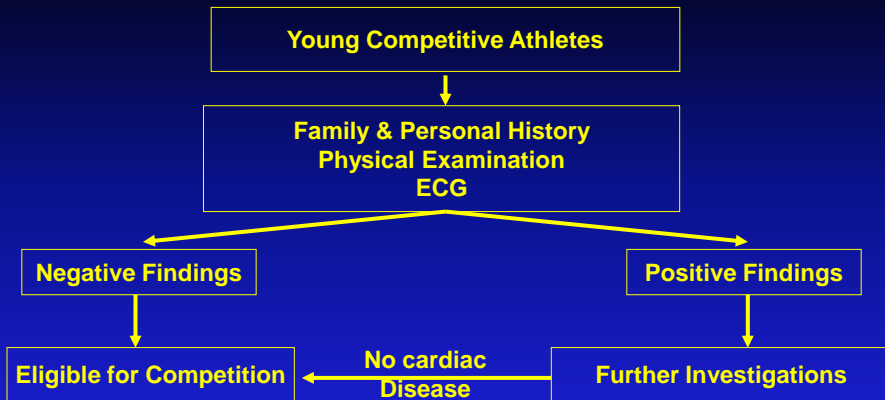
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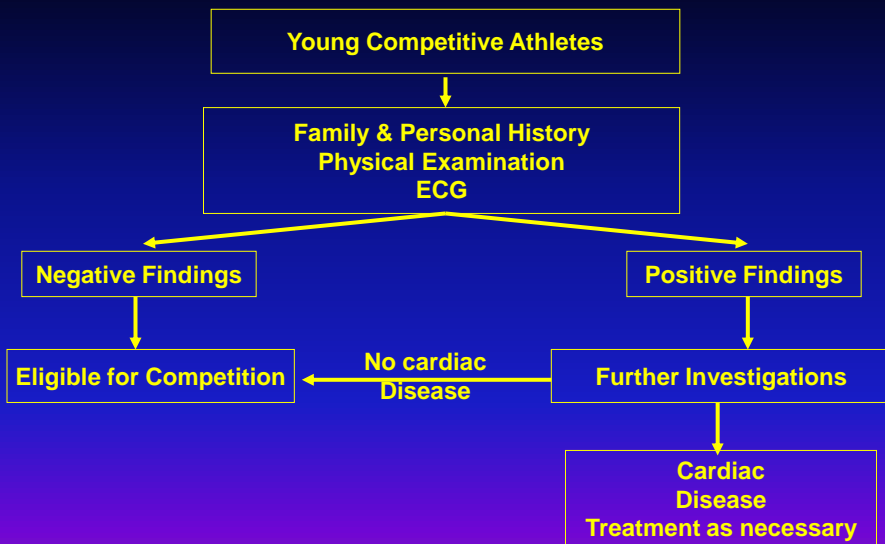
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