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Original article

RETROSPECTIVE STUDY ON THE COMPARISON OF OUT-OF-HOSPITAL AND IN -HOSPITAL SUDDEN CARDIOVASCULAR DEATH: AN ITALIAN EXPERIENCE.

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Summary

A retrospective study of forensic autopsies was carried out in the time interval January 2007 to December 2012 at the Forensic Pathology Service, Catania, south Italy, with a reference population of 3 000 000 inhabitants. During the study period, 1346 forensic autopsies were performed, including 223 (16.57%) sudden/unexpected deaths. Among the latter, 116 fulfilled the criteria of out-of-hospital (Group A) and 107 were in-hospital (Group B) sudden/unexpected deaths with suspected medical malpractice and/or a professional liability claim.

In Group A, coronary artery disease was the most common cause of death (N=67; 57.65 %), followed by cardiomyopathies (N=19, 16.38%) and myocarditis (N= 6; 17%). In Group B, coronary artery disease (N=32, 29.91%), post-procedural or post-surgical complications (N=30, 28.04%), pulmonary thromboembolism (N= 17; 15.89%) and aortic dissection (N=7, 6.54%) were the main causes of death.

Introduction

In the last decades, the number of claims for suspected medical malpractice has been dramatically rising worldwide, leading to increased legal controversies and financial costs for individuals and communities [1]. This trend may be partially related to improved medical care, which has also heightened the expectations of the general population and of the media. Furthermore, the health insurance system might play a role in sustaining a litigious climate. Thus far, only a few recent studies have focused on the epidemiology and/or causes of this phenomenon [2-3].

According to the current legal framework in Italy, in cases of sudden or unexplained deaths, or in suspected medical errors causing patient death, it is the responsibility of the Public Prosecutor to conduct a preliminary investigation. In such cases, the autopsy is usually performed by a forensic medicine specialist, who is often supported by

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clinical experts. The histopathologic analyses are often performed by a forensic pathologist and by a clinical pathologist, the latter one representing a consultant of the public prosecutor or an associated specialist of the forensic pathologist. Subsequently, in a unified final report, the Prosecutor's consultants present their opinions on the cause(s) of death and on the likelihood of medical malpractice.

Most epidemiological studies on adverse events focus on hospitalized patients for methodical reasons. Our own retrospective analysis also covers out-of-hospital sudden (SDs)/unexpected deaths (Group A).

Sudden death (SD) represents 12% to 13% of overall natural mortality when the temporal definition is restricted to death occurring <2 hours after the onset of symptoms [4-7], with approximately 50% of deaths in patients with cardiovascular disease [8-10]. Sudden cardiac death (SCD) represents about 80% to 90% of all SDs [5, 6]. Therefore, SCD constitutes one of the most important challenges in modern cardiology.

The present study was designed to investigate in parallel the two different groups of SCD (out-of-hospital and in-hospital) with their different epidemiological and histopathological characteristics in an Italian population.

Material and methods

According to Italian Legislation, all cases of violent or suspicious (sudden unexpected) death must undergo a medico-legal investigation with the aim of establishing the cause and the manner of death. We carried out a study of all forensic autopsies performed by the Forensic Pathology Service (Catania, Italy). The Forensic Pathology Service covers the town of Catania and province and Eastern Sicily, located in the south of Italy, (a region with a population of 3 million inhabitants). The study was carried out from 1 January 2007 to 31 December 2012. Sudden/unexpected deaths which occurred out-of-hospital and fatal cases of suspected medical malpractice and/or a professional liability were included in the present study.

The autopsies were performed, with a post-mortem delay of less than 18h, according to the Recommendations on the Harmonization of Medico-Legal Autopsy Rules produced by the Committee of Ministers of the Council of Europe [11] and the guidelines for the autopsy investigation of cardiac SD from the Association for European Cardiovascular Pathology [12]. Two hundred and twenty-three out of 1,346 consecutive forensic autopsies (16.57%) were included in the present study. Femoral blood and vesical or pelvic kidney urine samples were obtained by puncture. The coronary arteries and myocardium were studied specifically.

The exclusion criteria were traumatic or suicidal events, deaths involving the use of illicit or street drugs (e.g., heroin, cocaine), in-hospital deaths with overt non-cardiovascular causes, foetal and perinatal deaths. The following groups were categorised according to the circumstances of death (Figure 1):

Out-of-hospital sudden (SDs)/ unexpected deaths, including the following 3 sub-groups:

A1) SDs, unexpected deaths and unwitnessed deaths in subjects documented to be alive within the previous 24 hours for assessing or not a natural cause of death;

A2) deaths occurring during or shortly after sport activity, the expert board examined the possible anatomical substrates, sport activity relations and doping matter;

A3) SDs occurring shortly (<1 hour) after a trigger event (an emotional or stressful event or a low-voltage electrocution insufficient to cause death);

In-hospital adverse events (AE) occurring in the following 3 sub-groups and involving a malpractice liability claim (MPL):

B1) cardiovascular medicine or surgery units following coronary revascularisation, valve replacement, or aortic surgery;

B2) emergency room (ER) or within 24 -48 hours from ER discharge;

B3) other hospital units, particularly

general and orthopaedic surgery, neurosurgery or internal medicine.
Sudden death criteria were defined according to the World Heart Organization specifications [13]. According to the Harmonization for Medico-Legal Autopsy Rules produced by the European Ministers Council Committee, all autopsy specimens were sequentially examined [11]. In particular, heart or en bloc heart -lungs underwent gross examination and dissection, routine histology and, whenever appropriate, ancillary immunohistochemical investigations (e.g., for the characterisation of inflammatory infiltrates, of interstitial or myocyte changes). Histological studies of all organs were performed at the Forensic Pathology Service in Catania, Italy.

Results

Out-of-hospital deaths (Group A)

For SD and found dead (A1 sub-group, Table 1) patients' group, coronary artery disease (CAD) was the most common cause of death, followed by structural heart diseases (i.e., cardiomyopathies or cardiac defects), myocarditis (Table 1, Figure 2) and valvular diseases. Cardiomyopathies and non-atherosclerotic arterial diseases constituted the most frequent pathologies in sport-related deaths (A2 sub-group, Table 2); all cases of this subgroup (few of them previously reported [14-15]) had previously undergone the routinely requested medical screening.
Regarding SDs occurring after a stressful emotional event (A3 sub-group, Table 3), cardiac pathology investigations disclosed: a) a severe and calcific bicuspid aortic valve stenosis in a 64-year-old woman who had witnessed a violent car accident shortly before expiring; b) an obstructive coronary atherosclerosis associated with myocyte contraction band necrosis in a 60-year-old man who expired following a verbal altercation; c) both sub-obstructive coronary atherosclerosis and sub-aortic hypertensive hypertrophy in a 46-year-old man who experienced low-voltage electrocution.
In only 3 cases (2 cases of A2 group and 1 case of A1 group) no anatomical or morphological substrate was found, in one of them (A1 sub-group, Table 1) clinical and genetic screenings for arrhythmogenic diseases were proposed to the relatives because of a familial history of SD.

In-hospital adverse events (Group B)

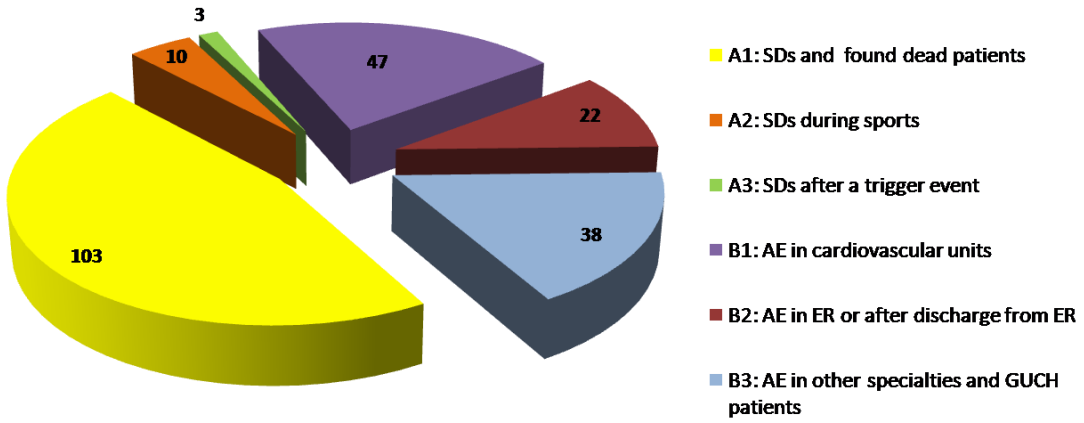

Figure 1: Pie chart showing the causes of 223 deaths studied at our institution; SDs: Sudden Deaths; AE: Adverse Events; ER: Emergency Room; GUCH: Grown-up congenital heart disease

Acute Myocardial Infarction (AMI) or vasculitis complications were found in patients of the acute cardiology care units, post-procedural or post-surgical compli-

Cause of death	N° of cases	Age	Gender	Clinical and pathological findings/circumstances of death
ATS coronary disease	64 (55.17%)	24-79 (53.9)	52 M, 12 F	Ischemic heart disease (51); post-MI bi-ventricular failure (2); cardiac rupture (4); coronary thrombosis (2); electrocution death (3); other coronary diseases (5)
Cardiomyopathy	15 (12.93%)	17-68 (50.3)	11 M, 4 F	Hypertrophic cardiomyopathy (4); inflammatory cardiomyopathy (1); ARVC (3); DCM (3); other cardiomyopathy (4)
Myocarditis	6 (5.17%)	24-72 (49.3)	4 M, 2 F	Diffuse or multifocal CD3-positive lymphocytic infiltrate, with or without myocytolysis
No ATS coronary disease	5 (4.31%)	23-46 (37.4)	2 M, 3 F	Anomalous origin of main left coronary from right coronary sinus, intramural course of LAD (interventricular septum) and myocardial post-ischemic scars (1); altered microcirculation in sickle-cell trait (1); Congenital coronary anomalies (1); Takayasu's arteritis (2)
Valve disease	2 (1.73%)	63,74	2 M	Aortic stenosis (2)
GUCH	3 (2.59%)	26-53 (34.6)	3 M	Long term surgical corrections of interatrial septal defect (2); Tetralogy of Fallot (1): fibrous retraction of the atrioventricular region
Aortic dissection	4 (3.45%)	46-71 (55.5)	3 M, 1 F	Acute dissection without organisation of false lumen; tunica media or adventitial inflammation (3); early organisation of false lumen (1)
Pulmonary thromboembolism	3 (2.59%)	41-79 (62.3)	2 M, 1 F	Massive thromboembolic obstruction of main pulmonary trunk or branches
No anatomical changes	1 (0.86%)	45	F	Multifocal contraction bands foci, without coronary disease

Table 1: Subgroup A1 (*ATS: Atherosclerosis; ARVC: Arrhythmogenic right ventricular cardiomyopathy; DCM: Dilated cardiomyopathy; GUCH: Grown-up congenital heart disease)

cations in invasive cardiology or surgical unit patients, respectively (Subgroup B1, Table 4; Figure 3). In the coronary angioplasty subgroup, we observed 5 ruptured AMIs. Three of them with coronary athero-embolism secondary to the revas-

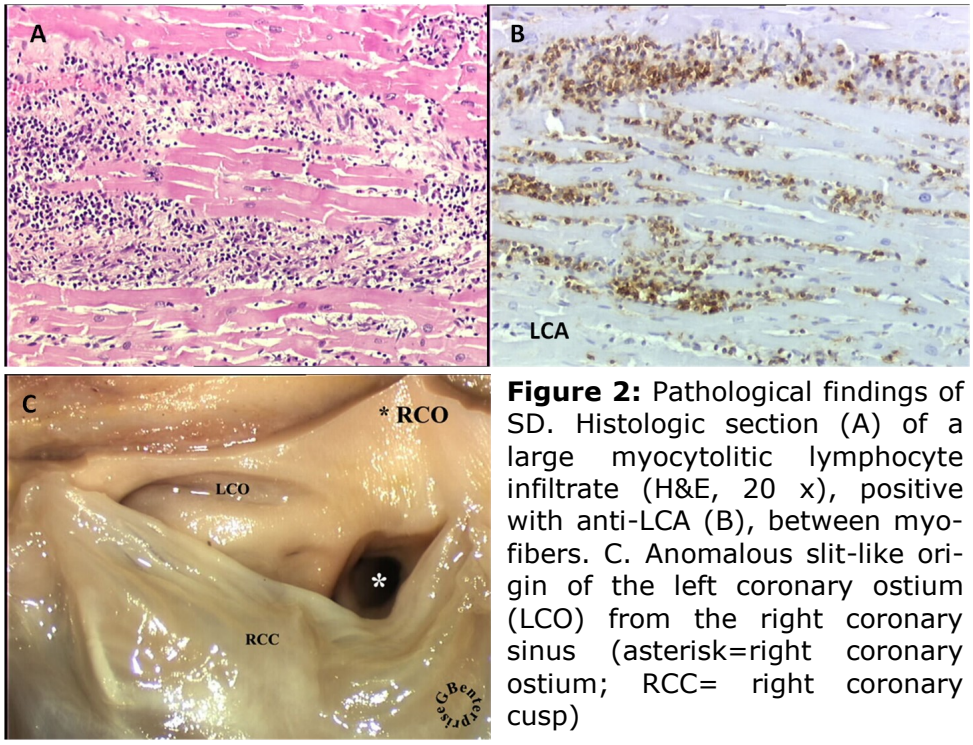

Figure 2: Pathological findings of SD. Histologic section (A) of a large myocytolitic lymphocyte infiltrate (H&E, 20 x), positive with anti-LCA (B), between myofibers. C. Anomalous slit-like origin of the left coronary ostium (LCO) from the right coronary sinus (asterisk=right coronary ostium; RCC= right coronary cusp)

Cause of death	Number of cases	Age	Gender	Clinical and pathological findings/ circumstances of death	
Cardiomyopathy	4 (3.44%)	14-50 (26.2)	3 M, 1 F	Swimming (2)	Hypertrophic cardiomyopathy
					Inflammatory cardiomyopathy
				Gymnastics (2)	Hypertrophic cardiomyopathy
					Inflammatory cardiomyopathy
No ATS coronary disease	4 (3.44%)	12-34 (22.2)	3 M, 1 F	Soccer (2)	Anomalous origin of left main from right coronary sinus and myocardial post-ischemic scars (1) Multiple coronary artery–left ventricular fistulas and myocardial post-ischemic scars (1)
				Cycling (1)	Hypertrophy/Healing foci of myocardial necrosis; contraction bands
				Volleyball (1)	Coronary aneurysms/ coronary arteritis; recent myocardial infarction
No anatomical changes	2 (1.73%)	18, 61	2 M	Running (1); Soccer (1)	

Table 2: Subgroup A2 († ATS: Atherosclerosis)

cularisation procedure.
In the ER (B2 subgroup, Table 5), severe coronary atherosclerosis, which was usually associated with AMI, aortic dissec-

Cause of death	N° of cases	Age	Gender	Clinical and pathological findings/circumstances of death
ATS coronary disease	2 (1.72%)	42-73 (57.5)	2 M	Coronary atherosclerosis and subaortic hypertensive hypertrophy (1); obstructive coronary atherosclerosis and myocyte contraction band necrosis (1)
Idiopathic calcific aortic stenosis	1 (0.86%)	54	1 M	severe and calcific bicuspid aortic valve stenosis (1)

Table 3: Subgroup A3 ([+]ATS: Atherosclerosis)

Treatment	N° of cases (%)	Age	Gender	Causes of death and pathological findings
Acute cardiology unit care	11 (10.19)	28-80 (63.9)	3 F, 8 M	Acute thrombosis of main coronary arteries (4); ruptured acute myocardial infarction (2), myopericarditis and vasculitis in collagenopathy (1); acute decompensation in chronic congestive heart failure (4)
Coronary angioplasty	15 (13.89)	45-78 (60.8)	6 F, 9 M	Haemorrhagic infarct, contraction bands (1); trivascular ATS, extensive scars (1); acute and chronic myocardial damage (5); VFWR (5); LAD dissection or perforation (2); septic endocarditis (1)
Vascular catheterisation	5 (4.63)	24-62 (44.2)	5 M	Vessel rupture: aorta (1); left internal iliac artery (1); right internal jugular vein (1); superior vena cava (1); cardiac arrest after catheter ablation for ventricular tachycardia (1)
Valve replacement (VR); CABG	10 (9.26)	50-74 (58.4)	3 F, 7 M	Aortic-mitral VR (1); infection of aortic VR (5); mechanical aortic valve prostheses (1); postoperative sepsis: CABG (2); LV dysfunction after CABG (extensive stunned myocardium and healing infarct (1)
Aortic surgery	6 (5.56)	45-60 (52.8)	1 F, 5 M	Penetrating atherosclerotic ulcer: abdominal aorta (1); aortic redissection after Dacron aortic prosthesis implant (2); Dacron aortic prosthesis rupture: in the tracheobronchial tree (1); into the oesophagus (1); into the mediastinum (1)

Table 4: Subgroup B1 ([§]ATS: atherosclerosis; VFWR: ventricular free wall rupture; VR: valve replacement; CABG: coronary artery bypass grafting)

tion, prosthetic valve dysfunction, or non-atherosclerotic coronary disease were found (Figure 4).

In subgroup B3 (i.e., adverse events in non-cardiovascular units), the main cause of death was pulmonary thromboembolism, followed by critical coronary atherosclerosis, systemic microcirculation disorders, sepsis and other miscellaneous causes (Table 6).

Discussion

The present study shows how a multidisciplinary approach to selected cases of forensic autopsy might provide diagnosis and/or diagnostic clues. Moreover, such an approach may contribute to preventive medicine [16].

During the last decade, increasingly more physicians have been diagnosing and treating AMI, performing coronary artery bypass graft surgery, percutaneous coronary interventions, valvular and other surgical procedures and using tissue plasminogen activators, particularly in a large elderly population. Consequently, cardiac surgery and cardiology nowadays represent the 2nd and 16th specialties most commonly involved in litigation [17].

Nevertheless, the autopsy data are of special relevance for the identification, evaluation and prevention of errors, moreover, autopsies are a valuable source of information for improvement in patient safety [2]. This has recently been underlined by the Council of Europe which, in its recent recommendation on management of patient safety and prevention of adverse events in health care, suggested a review of the role of other existing data sources, such as patient complaints and compensation systems, clinical data bases and monitoring systems as a complimentary source of information on patient safety [18]. Lethal cases are surely the most dramatic events that can occur during medical care.

The results of the present study have provided epidemiologic and, in particular, anatomopathologic information on SD in Southern Italy.

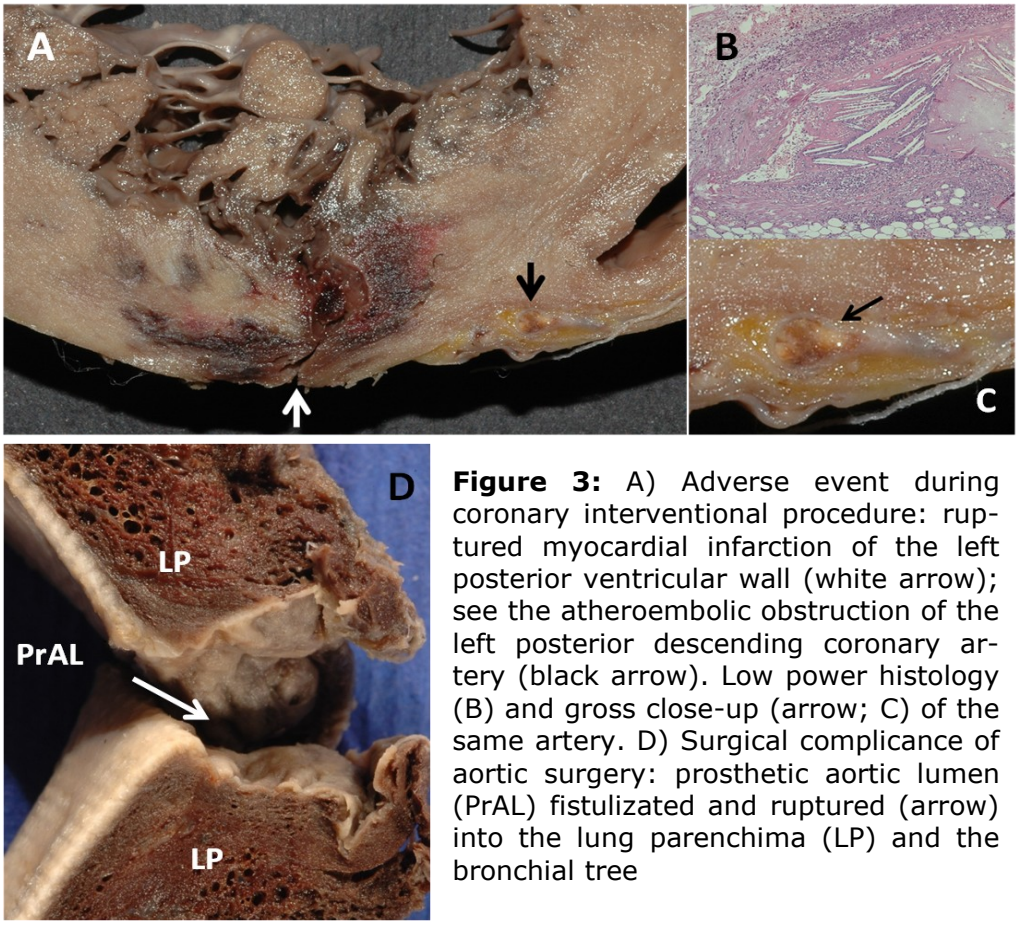

Figure 3: A) Adverse event during coronary interventional procedure: ruptured myocardial infarction of the left posterior ventricular wall (white arrow); see the atheroembolic obstruction of the left posterior descending coronary artery (black arrow). Low power histology (B) and gross close-up (arrow; C) of the same artery. D) Surgical complicance of aortic surgery: prosthetic aortic lumen (PrAL) fistulizated and ruptured (arrow) into the lung parenchima (LP) and the bronchial tree

Concerning to the present series, in SDs (**Group A**) the final diagnoses showed coronary atherosclerosis, structural heart diseases, and myocarditis as the main causes of death (A1 sub-group, Table 1). In SDs occurring during non-competitive (recreational) sports activities (A2 sub-group, Table 2), the forensic investigations proved to be quite helpful, lacking the mandatory medical screening for competitive sports (e.g., the stress ECG) [19-21].

The exclusion of doping, by performing toxicological analysis, and the identification of cardiac diseases are not only crucial for diagnosis and for preventive medicine in relatives, but also for the acceptance of the tragic event by families and public.

The A3 sub-group included SDs occurring shortly after a trigger event, in such cases the cause of death was determined by toxicological analysis and autopsy findings, in order to investigate whether an anatomical substrate contributed to death. In literature, numerous cases of emotional stress facilitating the occurrence of cardiac arrhythmias including sudden cardiac death are reported [22-24]. In our three cases, the autopsy re-

Cause of death	**N° of cases (%)**	**Age Sex**	**Pathology**		
			ATS coronary disease	Aortic dissection	Other pathologies
Out-of-hospital deaths (early deaths after discharge from ER)	12 (11.11)	52-73 (56.2) 9 M, 3 F	Chronic occlusive ATS, recent and late ischemic lesions without granulocytes (3); LAD thrombosis; recent ischemic lesions with granulocytes (2); LAD thrombosis, CBs (2)	Organised FL (1); organised FL and BAV (1) Organised FL and aortic coarctation (1)	No ATS coronary disease: LAD occlusive thrombosis in sickle cell disease (1); Left coronary ostium occlusion in Takayasu disease (1)
ER deaths	10 (9.26)	47-75 (61) 6 M, 4 F	RCA thrombosis, acute ruptured myocardial infarction (1); Recent ischemic lesions with granulocytes: with RCA thrombosis (1); with LAD thrombosis (1) Multi-vessel coronary thrombosis; recent ischemic lesions with granulocytes (1);	Acute FL (2); Organised FL, BAV (2)	Valve disease: Acute thrombosis of prosthetic mitral valve (1); Stenotic prosthetic aortic valve (1)

Table 5: Subgroup B2 (" ER: emergency room; LAD: left arterial descending coronary artery; RCA: right coronary artery; FL: false lumen; CBs: contraction bands; BAV: bicuspid aortic valve)

vealed: coronary atherosclerosis and sub-aortic hypertensive hypertrophy; severe and calcific bicuspid aortic valve stenosis; and obstructive coronary atherosclerosis associated with myocyte contraction band necrosis.

In Group A the low percentage (3%) of negative autopsy cases, compared to previously reported results [25], may be explained by the fact that we studied a particular cohort of SDs reported to the office of public enquiry, and therefore lacking a significant proportion of natural SDs.

As for adverse events in interventional cardiology units (**B1 sub-group,** Table 4), a thorough examination of the coronary tree (with serial section) is highly recommended in order to evaluate whether the post-procedural adverse events have to be considered intrinsic procedural risks [26-27]. Atheroembolism was probably a procedure complication. In this subgroup, abdominal aortic rupture during catheterisation, fatal arrhythmia after thermoablation procedures, septic endocarditis, and multiple microscopic septic infarcts after coronary angiography were also detected. In deaths after cardiac surgery, infection was the most common post-mortem diagnosis and it was often associated with early hospital discharge that is frequently adopted to reduce hospitalisation costs. Re-dissection or aorto-esophageal fistulisation complicating aortic surgery were

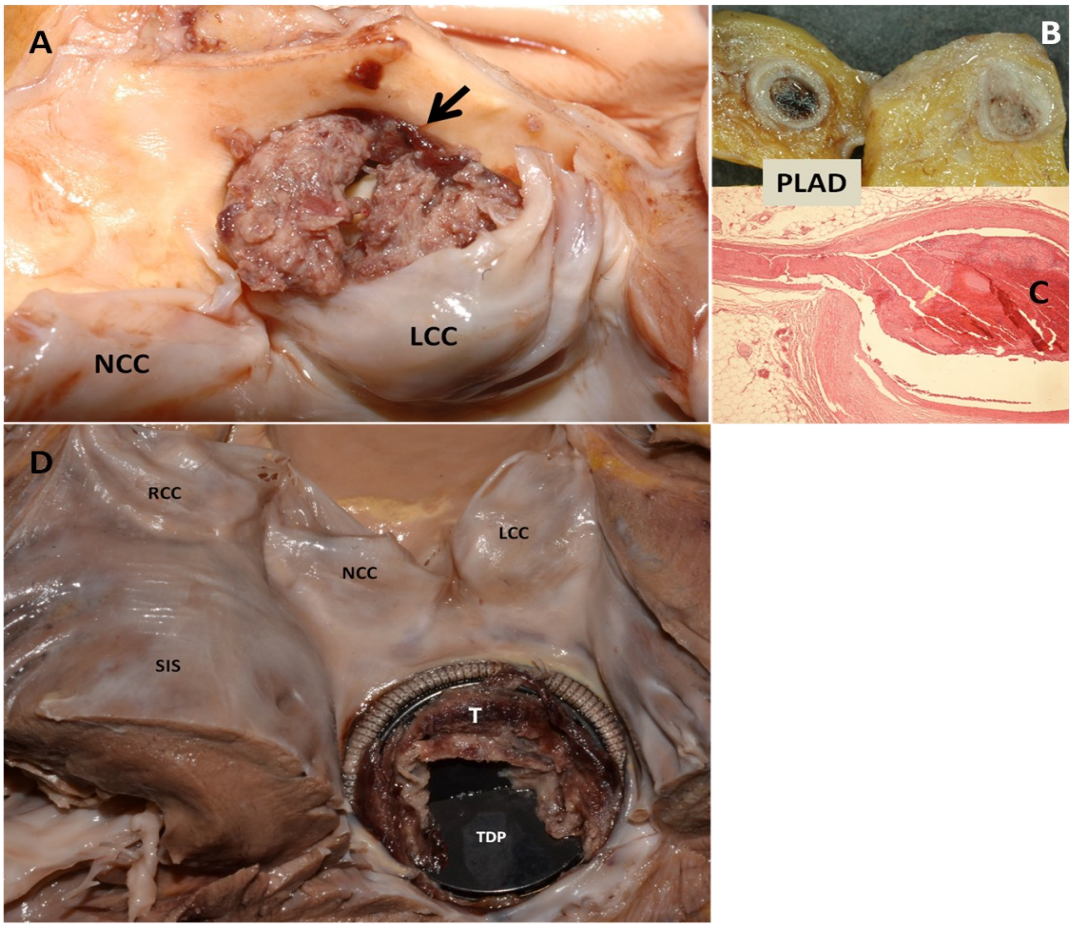

Figure 4: A) Massive thrombotic obstruction of the left coronary sinus (arrow; NCC and LCC = non coronary and left coronary cusps respectively) in a case of sickle cell disease (ER adverse event). Gross (B) and histologic (C) findings of the thrombosed proximal left anterior descending coronary artery (PLAD). D) Thrombotic occlusion of a mechanical mitral tilting disk prostheses (ventricular view; RCC, LCC, NCC=right, left and posterior coronary cusps; SIS= subaorticinterventricular septum; T= thrombus; TDP= tilting disk prostheses)

Specialty	N. (%)	Age (%) Gender	Pathology	
General surgery	15 (13.9)	57-78 (67.2) 8 M, 6 F	**ATS/ MI**	LAD thrombosis (1); MI after cholecystectomy, late survivor after Ross procedure (1)
			PTE	Main pulmonary artery trunk (9); pulmonary artery branches (3)
			Systemic microcirculation disorders	Sepsis and intramyocardial micro-abscesses (1)
Nephrology	4 (3.7)	65-70 (68,2) 3 M, 1 F	**Systemic microcirculation disorders**	Renal echinococcosis and sepsis (1)
			Others	Renal insufficiency and amyloidosis (2); Uremic cardiomyopathy (1)
Internal medicine	7 (6.5)	45-80 (66.7) 4 M, 2 F	**ATS/ MI**	Chronic congestive heart failure (jail infirmary,(1) post-pneumonitis (1))
			Systemic microcirculation disorders; vasculitis	Moskowitz syndrome (2); haemolytic anaemia (1); polyarteritis nodosa (1)
			Others	Malabsorption syndrome (1)
Orthopaedic surgery	7 (6.5)	50-74 (62,6) 4 M, 3 F	**ATS/ MI**	LAD thrombosis (2), Chronic congestive heart failure, healing infarction (2)
			PTE	Main pulmonary artery trunk (2), pulmonary artery branches (1)
Neurosurgery	1 (0.9)	75 M	**Others**	Evaluation of a bidirectional Glenn procedure (1) (treatment and death for cerebral trauma)
Oncology	4 (4.6)	45-82 (62,7) 1 M, 3 F	**PTE**	Pulmonary thrombotic microangiopathy; GC (1), Pulmonary and intramyocardial embolism; GC (1)
			Vasculitis	Vasculitis, MI; LC (1)
			Others	Pericardial rupture and cardiac tamponade after sternal marrow biopsy; NHL (1)

Table 6: Subgroup B3 (¶ ATS: Atherosclerosis; LAD: left anterior descending artery; MI: myocardial infarction; PTE: pulmonary thromboembolism; GC: gastric carcinoma; LC: leukaemia cutis; NHL: non-Hodgkin lymphoma.)

also reported; the latter being a rare complication [28].

In grown-up congenital heart disease (GUCH) patients (**B1 sub-group**), the pathologist expertise was crucial in determining whether death was related to and/or a consequence of the disease severity or whether the death could have been prevented. Nowadays the progressive evolution of palliative and corrective surgery in GUCH has dramatically improved the life expectancy and/or quality of life in these patients. A good knowledge of the surgical procedures for congenital heart diseases is required by the pathologist, who must also consider the native pathology, the post-surgical cardiovascular remodelling, the potentially associated pulmonary changes and/or the coronary vascular tree alterations. All these conditions or situations, whether singularly or in various combinations, may predispose such patients to a wide range of complications, including arrhythmias, ischemic and hypertrophic myocardial changes [29]. Fibrotic changes (related or not to the previous surgical procedure/s) may constitute an arrhythmogenic substrate; negative ventricular remodelling may lead to heart decompensation and failure.

Deaths following brief hospitalisation in ER (**B2 sub-group,** Table 5) represented another complex forensic matter [30], the timing of ischemic lesions becoming a crucial issue in MPL claims as the myocardial histology had to be compared with the patient's symptoms and with the laboratory tests [31]. As regards aortic dissection, this represented an important cause of missed diagnosis. Aortic dissection may be misdiagnosed as gastritis or sciatic neuralgia after excluding myocardial ischemia on the basis of negative electrocardiographic and biochemical (cardiac enzymes) findings; it may be missed by computed tomography without contrast [32]. In particular, a progressively organised acquired false lumen (as in 4 out of 6 aortic rupture cases of this series) with delayed aortic rupture may be the cause of a missed diagnosis resulting in cardiac tamponade finding at autopsy.

Regarding adverse events occurring in non-cardiovascular medicine or surgery units (**B3 sub-group,** Table 6), pulmonary thromboembolism was found in a significant number of cases after orthopaedic surgery. This observation may have several causes, including comorbidities, difficulties in making a differential diagnosis, the effectiveness and accuracy of anti-thrombotic and/or anticoagulant treatments, or difficulty managing anti-thrombotic and/or anticoagulant treatments in elderly and/or critically ill patients or in genetic thrombophilia [33]. Non-atherosclerotic coronary artery disease, including vasculitis, coronary embolism, or congenital anomaly, represented another relatively frequent autopsy finding, followed by acute cardiac toxicity (related to vinblastine over dosage), acute pulmonary hypertension, and biventricular heart failure with metastatic pulmonary vasculopathy (from gastric carcinoma).

Coronary atherosclerosis represents the main cause of sudden cardiac death in adults [34]. In the present series, no histological evidence or early ischemic changes (i.e., contraction bands with or without myocardial scarring) were found in subgroup A1, whereas the in-hospital deaths (**group B**) revealed ischemic changes that were characterised by coagulative necrosis and early granulocytic reaction. Such features are related to a different time interval between the ischemic event and death. The missed diagnosis of AMI in the ER or following ER discharge was related to the failure to perform a troponin assay, or the absence of serial troponin testing, which led to a misdiagnosis of gastritis [35].

Without autopsies these cases cannot be properly clarified. To use medical malpractice claims in lethal cases and their objective clarification by autopsies as additional sources for the evaluation and prevention of errors naturally requires case sampling, not only on a local but also on a national or better international level. The special value of objective data we have in forensic pathology and toxicology also becomes evident from previous studies [36-37], which show how clinicians are ''walking in the fog'' without having access to autopsy data and drug

analysis data [37].

Conclusions

The Anglo-Saxon coroner acts as an independent judicial officer, he must establish the 'who, when, where and how' of unexplained deaths. In Italy such role is undertaken by a forensic medicine specialist designated by the Public Prosecutor in order to investigate sudden/ unexplained and hospital deaths. In selected complex cases a pathologist may also be called upon directly by the Public Prosecutor, as full expert witness. In such a context the prosecutor's consultants determine or exclude medical errors, producing a unified final report.

In conclusion, evolution and progress in the medical and surgical sciences often requires qualified and multidisciplinary expertise for the correct management of forensic autopsies and of MPL claims.

Autopsies are the necessary basis for determining the cause of death, medical negligence and causality of negligence for cause of death. Without autopsy lethal cases cannot be judged in an appropriate way. Autopsies are, however, not only the essential basis for expert evidence in a particular case but also for preventing similar cases [2]. Rare but serious events detected at autopsy should be reported and evaluated, risk factors could be identified for the implementation of preventive measures [38].

Some peculiarities characterize the present paper: in our study several rare pathological data were found (i.e. grown-up congenital heart disease deaths; fatal aortic–esophageal fistula; rare non atherosclerotic coronary diseases;); furthermore, our series gives insights into an unresolved clinical matter [30] : early death after emergency department (ED) discharge and hospital discharge.

Finally, our experience supports the crucial role of a good cardiovascular pathology background in the investigation board [39], in a field frequently lacking clinical expert witness available for the Public Prosecutor [40-41].

We believe our findings can provide important epidemiological and anatomopathological information and offer the possibility of establishing comparative data with the data from others countries.

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