The appropriate assessment of apparently innocent symptoms could be the way to find out a dangerous disease. Clinical case

Gavino Cossu[1]
Rosario Garofalo[1]
Laura Voccia[2]
Laura Musella[3]

[1] Emergency Department, Tarquinia Hospital, Tarquinia (VT), Italy
[2] Radiology Department, Tarquinia Hospital, Tarquinia (VT), Italy
[3] Emergency Department, ASL Roma 6, Pomezia (RM), Italy

Corresponding Author:
Gavino Cossu
Emergency Department
Tarquinia Hospital
Viale Igea 1
01016 Tarquinia (VT), Italy
E-mail: gcossu@inwind.it

Abstract

All symptoms are important; it would be a serious mistake to underestimate those that appear slight or more commonly associated to a pathology with a favorable outcome. An accurate clinical examination and an appropriate laboratory and instrumental assessment can show an important and potentially dangerous pathology that otherwise would not be recognized or diagnosed late. In this article the Authors demonstrate how an "innocent" symptom, such as the lumbar pain, adequately investigated with a radiological test, allowed them to detect an infrarenal abdominal aortic aneurysm, a disease with fatal outcome if not treated appropriately.

KEY WORDS: assessment, aortic aneurysm, CT scan.

Introduction

Any symptom detected during the medical investigation has its own importance to express a correct diagnosis; it would be a serious mistake to underestimate those symptoms that appear mild or more commonly associated with favorable outcome pathologies. In this article the Authors demonstrate how a generally "innocent" symptom such as a lower back pain, adequately investigated radiologically, allowed them to diagnose an infrarenal abdominal aortic aneurysm, an often only lately symptomatic disease with a fatal outcome if not treated properly.

The infrarenal Abdominal Aortic Aneurysm (AAA) is a relatively common condition and it is associated with a mortality rate that's only slightly lower than that related to the prostate cancer in men and the breast cancer in women (1). However its diagnosis is often omitted because most of the time the disease begins in asymptomatic form, the physical examination is poorly sensitive to reveal its presence (2), and, unfortunately, its systematic research is frequently neglected. The risk of rupture for the small aneurysms is very low, but the natural history shows a progressive expansion of the aneurysmatic sac (3), that becomes of surgical interest when it reaches a size >55 mm (4).

The incidence and mortality from a ruptured infrarenal AAA are increasing. Therefore it is important to identify the high-risk subjects. The cigarette smoking, the hypertension, a family history of AAA, and the male sex are risk factors for the development of an aneurysm (5, 6). The chronic inflammation and the enzymatic degradation of the elastin and the collagen are the predominant pathogenic mechanism of the infrarenal AAA (7, 8).

The infrarenal AAA is generally asymptomatic; it becomes symptomatic when it reaches dimensions able to cause the compression of the adjacent structures. Lumbar or hypogastric pain and intermittent claudication may be the symptoms related to its presence. The symptomatic aneurysms require emergency surgery; the rupture of an AAA implies a complete loss of the aortic wall integrity, and it is a surgical emergency requiring an immediate correction.

The frequency of the controls depends on the diameter of the aneurysm (9, 10); the recommendations provided by the Society for Vascular Surgery and by the Society for Vascular Medicine show:

- The critical point for the rupture of an AAA is represented by a 55 mm diameter;
- The surveillance of the aneurysm must be cadenced and that is:
  - an aortic diameter between 30 mm and 40 mm: an ultrasonographic examination every 12 months;
  - an aortic diameter between 40 mm and 50 mm: an ultrasound examination every 6 months;
  - an aortic diameter >50 mm: a surgical consultancy after a CT angiography (CTA).

The treatment of an infrarenal AAA is surgical with the endoprosthesis implantation when it is technically possible. This endovascular technique has shown a lower short and long term mortality than the conventional surgery (11-13).

Clinical case

C. E., 76-year-old male, got to our Emergency Room for a back pain started ten days before, worsened by motions and resistant to therapy. The patient, in hypertension therapy, reported allergy to ASA. The medical examination didn't indicate anything significant except a mild achiness of the lumbar spine. The peripheral pulses were symmetrical and normosfigmici. An intravenous therapy with corticosteroids and NSAID with marked improvement in symptomatology was practiced.

In the aim to indentify the cause of the lumbar pain, a Rx exam of the lumbosacral column and an ultrasound exam of the abdominal vessels were required. The Rx exam demonstrated: "modest front cuneation of the L1 soma, that should be further examinated with CT scan.". The CT scan was performed with the following report: "The exam performed without intravenous contrast medium to integrate the Rx exam, indicates depression of the upper somatic limiting with mild anterior wedging of L1 for the presence of Schmorl hernia. There are no endocanal fragments. As collateral finding, an infrarenal AAA with TRD of 52 mm is worthy of further evaluation with CTA " (Figures 1, 2).

An Abdominal CTA was then performed with the following report: "Exam performed before and after intravenous contrast medium administration targeted at the study of the aorta: it is present a saccular aneurysm of the infrarenal abdominal aorta with TRD of 51 mm and APD of 57 mm with predominantly anterolateral right eccentric parietal thrombosis with true lumen about 20 mm. The upper aneurysmatic collar is at 5 cm from the renal arteries and the longitudinal extension is to the iliac carrefour. The iliac arteries have a regular caliber. There are no periaortic or peritoneal free fluid" (Figures 3, 4).

The patient was then sent for consultation at the Unit of Vascular Surgery, Belcolle Hospital in Viterbo, where the Specialist inserted him in the pre-hospitalization list for the surgical treatment of competence.

The patient, returned to our Emergency Room, was resigned with medical therapy and behavioral recommendations.

Figure 1 - CT scan, L1 soma study.

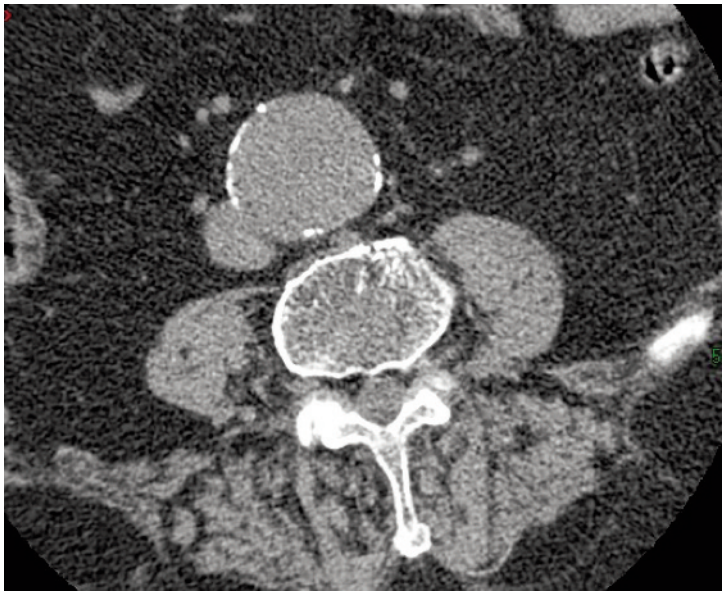

Figure 2 - CT scan, infrarenal AAA.

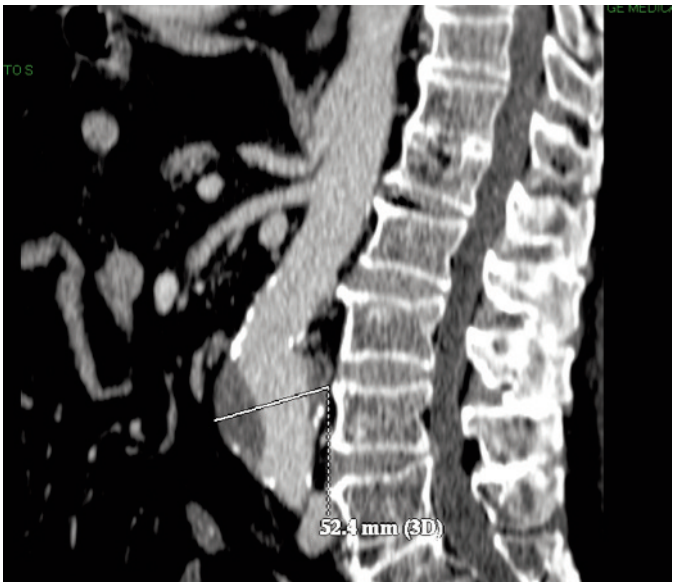

Figure 3 - CTA, sagittal reconstruction of the AAA.

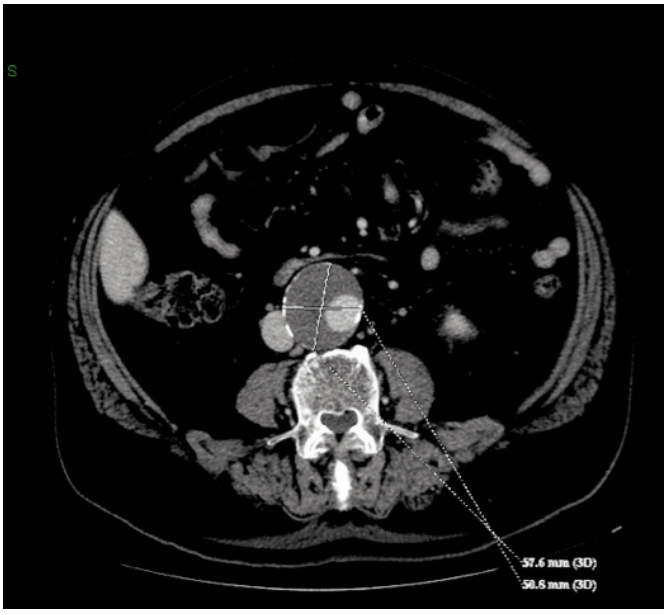

Figure 4 - CTA, axial reconstruction of the AAA.

Conclusions

All the detected symptoms have equal clinical dignity, even those that appear innocent; a thorough clinical examination and an appropriate diagnostic assessment can highlight an important and potentially dangerous disease that would not be recognized or diagnosed late. In the reported case, the Authors have demonstrated that the instrumental assessment in this patient with back pain has allowed them to identify an infrarenal abdominal aortic aneurysm with a diameter >55 mm; this disease of the patient otherwise would have remained unrecognized, or discovered later with a larger diameter and an increased risk of breakage.

References

1. National Center for Health Statistics. Deaths, percent of total deaths and death rates for the 15 leading causes of death in the 5-year age group, by race and sex: United States. 2000. Available from: https://www.cdc.gov/nchs/data/dvs/lcwk1_2000.pdf
2. Lederle FA, Simel DL. The rational clinical examination. Does this patient have abdominal aortic aneurysm? JAMA. 1999;281:77-82.
3. Vardulaki KA, Prevost TC, Walker NM, et al. Growth rates and risk of rupture of abdominal aortic aneurysms. Br J Surg. 1998;85:1674-1680.
4. Powell JT, Greenhalgh RM. Clinical practice. Small abdominal aortic aneurysms. N Engl J Med. 2003;348:1895-1901.

5. Lederle FA, Johnson GR, Wilson SE, et al. Prevalence and associations of abdominal aortic aneurysm detected through screening. Aneurysm Detection and Management (ADAM) Veterans Affairs Cooperative Study Group. Ann Intern Med. 1997;126:441-449.
6. Strachan DP. Predictors of death from aortic aneurysm among middle-aged men: the Whitehall study. Br J Surg. 1991;78:401-404.
7. Freestone T, Turner RJ, Coady A, et al. Inflammation and matrix metalloproteinases in the enlarging abdominal aortic aneurysm. Arterioscler Thromb Vasc Biol. 1995;15: 1145-1151.
8. Longo GM, Xiong W, Greiner TC, et al. Matrix metalloproteinases 2 and 9 work in concert to produce aortic aneurysms. J Clin Invest. 2002;110:625-632.
9. Kent KC, Zwolak RM, Jaff MR, et al. Screening for abdominal aortic aneurysm: a consensus statement. J Vasc Surg. 2004;39:267-269.
10. Powell JT, Greenhalgh RM, Ruckley CV, Fowkes FG. Prologue to a surgical trial. Lancet. 1993;342:1473-1474.
11. Lee WA, Carter JW, Upchurch G, et al. Perioperative outcomes after open and endovascular repair of intact abdominal aortic aneurysms in the United States during 2001. J Vasc Surg. 2004;39:491-496.
12. Anderson PL, Arons RR, Moskowitz AJ, et al. A statewide experience with endovascular abdominal aortic aneurysm repair: rapid diffusion with excellent early results. J Vasc Surg. 2004;39:10-19.
13. Iannelli G, Monaco M, Di Tommaso L, et al. Endovascular vs open surgery of abdominal aortic aneurysm in high-risk patients: a single center experience. Thorac Cardiovasc Surg. 2005;53:291-294.

Work-related death due to a carotid artery injury: a case report

Silvia Perotti
Chiara Rossetti

Medical Legal Institute, University of Brescia, Brescia, Italy

Corresponding Author:
Silvia Perotti
Medical Legal Institute,
University of Brescia
Piazzale Spedali Civili 1
25123 Brescia, Italy
E-mail: silvia.perotti@unibs.it

Abstract

Work-related deaths represent an important social problem which interests workers from over the world. This paper presents an unusual occupational death occurred in Brescia (Northern-Italy) involving a young man who was working with a press machine.
The man arrived unconscious at the Emergency Room presenting a severe bleeding from the nose and the oral cavity and a small wound to the neck. An autopsy was performed in order to verify the cause of death.
The autopsy revealed an extensive haemorrhages of neck's soft tissues and muscles, the laceration of the trachea and the presence of a metal fragment in soft tissues close to the right carotid, which resulted lacerated. The worker death was caused by a haemorrhagic shock and the recovered metal fragment.

KEY WORDS: autopsy, occupational fatalities, workplace, work-related fatal injuries.

Introduction

Nowadays, work-related deaths represent an important public health problem which interests workers from all over the world. This paper presents a fatal occupational case occurred in Brescia, one of the most important industrial district in Northern Italy with an occupational rate significantly elevated. A recent analysis of Eurostat, the statistical office of the European Union, regarding work-relating deaths in Europe, showed that the number of occupational accidents in Italy is much higher than the European average. In contrast with other Italian Counties, Brescia showed a great number of victims by work-related fatal injuries even if the trend has been registering a continuous decrease in the last years, as reported by the National Institute for the Insurance against Accidents at Work (INAIL), in 2012.
An unusual case of occupational death involving a young man who was working with an automatic press-machine has been reported in this paper.
The knowledge of the cause of death, resulting from the autopsy, let assume the dynamics and the details of fatal incidents. The complete reconstruction of the event allows to distinguish between the lack of machinery safety and worker's liability. Moreover, the determination of occupational death's cause and dynamics reveals the necessity to improve safeguards for machinery and protecting workers against the risk of future accidental injuries and fatalities.

Case report

A 35-year-old man was working in a metal working factory in Brescia; his job consisted of controlling an automatic machine capable of cutting, bending, piercing and punching steel sheets.
The machine was punching a steel plate, the worker suddenly started screaming and shouting for help, holding his hand around his neck. He was seen by his co-workers staggering and bleeding severely from his nose and mouth, a few seconds before collapsing.
The emergency team arrived promptly by air ambulance and tried to resuscitate him but the worker died during the transfer to the E.R. The medical report stated severe blood loss from nose and oral cavity (estimate about 900 ml of blood) and a small wound to the neck. As decided by the Prosecutor, an autopsy was performed in order to clarify the cause of death.

Autopsy findings

The external examination revealed a 4 x 1 cm rectangular, bruised area in the mediastinum region, due to defibrillation and a 8 x 3 mm oval shaped hole surrounded by a 3 mm eccentric bruised abrasion ring located at the base of the neck, slightly left sided, about 1 cm above the jugular notch. The characteristics of the neck wound closely resembled a gunshot lesion (Figure 1).
After the removal of the cutaneous planes and the rib shield, an extensive haemorrhage of the muscles and

Figure 1 - External examination: penetrating injury at the base of the neck.

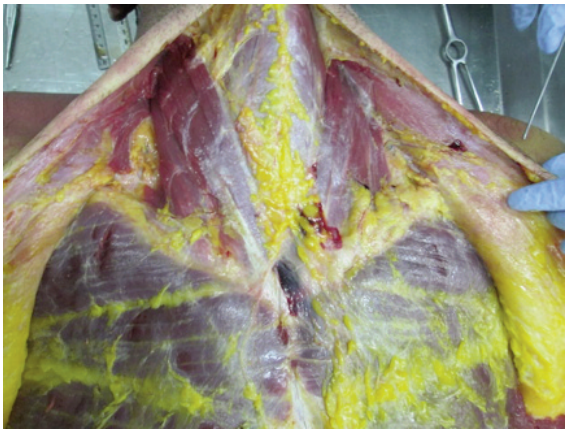

Figure 2 - Removal of the cutaneous planes: a small lesion was observed through the muscles of the neck with haemorrhages of the soft tissues.

the soft tissues was seen at the base of the neck (Figures 2, 3).
The wound track passed through the left peri-tracheal muscles to the other side, lacerated the anterior and lateral right surface of trachea, approximately 11 cm from the lower opening of the larynx and ended at the soft tissues close to the right common carotid artery, which resulted lacerated. The carotid laceration, sited about 5 cm above the aortic arch, interested half of the circumference of the vessel. In this laceration, a 15 x 5 mm slightly curved, cylindrical metal fragment was found (Figures 4-6).
The section also revealed blood into the lumen of the larynx, trachea and bronchi.

Discussion

The autopsy findings allowed to know the cause of death and to provide the reconstruction of the fatal event's dynamics. The worker dead because of a hemorrhagic shock due to the penetration of a foreign

Figure 3 - Removal of the sternum plate: haemorrhagic shedding of the muscles and the soft tissues at the base of the neck.

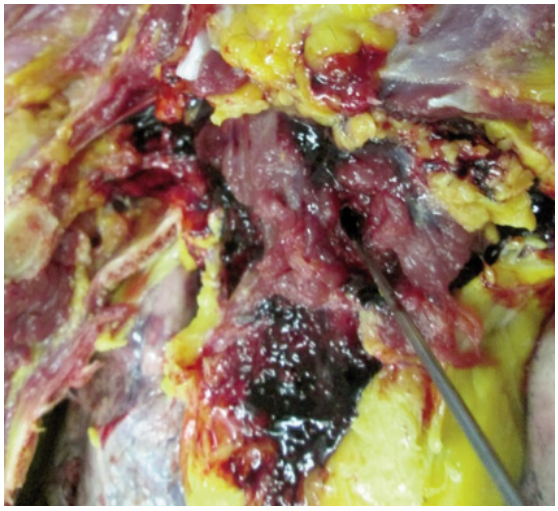

Figure 4 - The metal stylet locates the wound track through the paratracheal muscles of the neck.

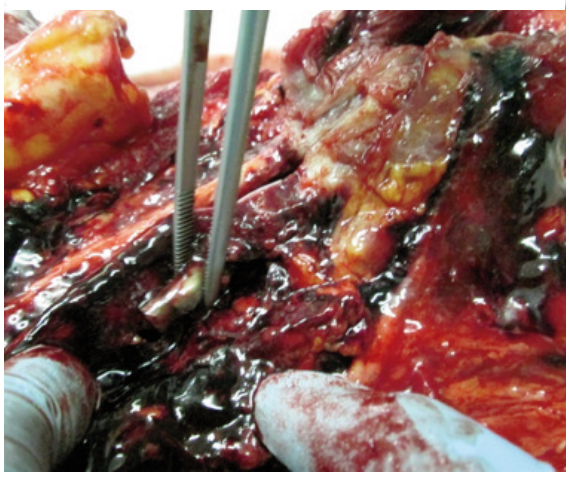

Figure 5 - Laceration of the internal structure of the neck by the metal fragment.

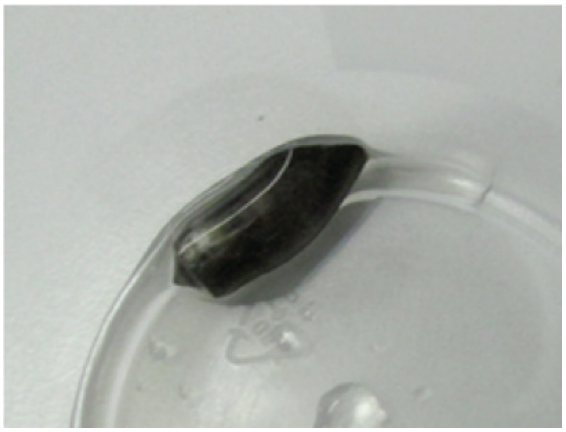

Figure 6 - Punch tip found into the neck missing from the machine controlled by the victim.

metallic body into the neck leading to the laceration of the carotid artery. This explains the rapid loose of consciousness and the severe bleeding from mouth and nose registered by the emergency team that was due to the intra-tracheal hemorrhage.

The metal fragment was confirmed to be the punch tip missing from the machine controlled by the victim. Regarding the reconstruction of the fatal event, the most plausible hypothesis is that the punch detached itself from the machine after pressure and the break was due to a non-perpendicular position of the steel sheet during punching. However, it was not possible to establish whether the metal sheet has been positioned incorrectly or if it has moved during processing.

Comparing this case with the those in the literature, it can be said that males are the most affected by occupational death (1-9). This data is necessarily connected to the higher men occupational rate comparing to women and is also related to the more dangerous types of work performed by the male sex. Regarding the age other international studies reported a young age among workers with occupational injuries, such as in this case (9-12).

In many studies (1, 2, 13-19), construction has to be considered one of the most dangerous working categories, while mechanical factories represented the second or the third place where occupation deaths occurred. This date has been confirmed in 2014 by an analysis of Eurostat, the statistical office of the European Union, which revealed that the deaths during manufacturing were in third place, after construction and transportation.

From autopsies carried out from 1982 to 2015, occupational deaths occurred in the 19.2% of cases in mechanical factories, hence in a high percentage. This data must necessarily be linked to the fact that Brescia County is one of the most industrialized areas in Northern Italy with an occupational rate significantly elevated. Regarding regions involved in the incident, the head is considered the site of the commonest type of injury among occupational fatalities (1, 2, 20, 21): this suggests the importance to wear a helmet and safety belts as a kind of protection in order to prevent similar working accidents. In Italy, these security rules are obligatory from the 90's.

In literature, only one very similar case, published in 1986 involving the punching machine, has been published: that worker was setting up a drill press while a piece of the punch broke off and hit the machinist in the chest (22). This case report testifies that even if about 30 years have been passed from the accident published by Katanick et al. and the press-machine have been technologically ameliorated, there is still a permanent risk and the operators should always keep a safety high level.

Moreover, punching machines' workers have the obligation to wear a helmet, as well as keeping headphones for noise. However, any kind of protections for the cervical region or the chest are not yet used. The neck, especially in worked works where glass or metal fragments can start, is exposed and is a vulnerable area, because of the absence of skeletal protecting structures and the presence of vascular structures, whose lesions may necessarily lead to instantaneous death.

In conclusion, it's very important to understand the cause of occupational death in order to detect the workplace risks, find out if there are some responsibilities of the job giver, improve protection devices and, in particular, to ameliorate the occupational surveillance system; an adequate surveillance and a health employees' formation are also essential to improve safety and to obtain a global improvement in working conditions.

References

1. Pianosi G. Fatal occupational accidents in Lombardy. Med Lav. 1995;86(6):534-541.
2. Al-Abdallat EM, Oqailan AM, Al Ali R, et al. Occupational fatalities in Jordan. J Forensic Leg Med. 2015;29:25-29.
3. Lin YH, Chen CY, Luo JL. Gender and age distribution of occupational fatalities in Taiwan. Accid Anal Prev. 2008;40 (4):1604-1610.
4. Villanueva V, Garcia AM. Individual and occupational factors related to fatal occupational injuries: a case-control study. Accid Anal Prev. 2011;43(1):123-127.
5. Jones C, Routley V, Trytell G, et al. A descriptive analysis of work-related fatal injury in older workers in Australia 2000-2009. Int J Inj Contr Saf Promot. 2013;20(1):85-90.
6. Feyer AM, Langley J, Howard M, et al. The work-related fatal injury study: numbers, rates and trends of work-related fatal injuries in New Zealand 1985-1994. N Z Med J. 2001;114(1124):6-10.
7. Koehoorn M, Tamburic L, Xu F, et al. Characteristics of work-related fatal and hospitalised injuries not captured in workers' compensation data. Occup Environ Med. 2015;72 (6):413-420.
8. Jones C, Routley V, Trytell G, et al. A descriptive analysis of work-related fatal injury in older workers in Australia 2000-2009. Int J Inj Contr Saf Promot. 2013;20(1):85-90.
9. Smith TD, DeJoy DM. Occupational injury in America: An analysis of risk factors using data from the General Social Survey (GSS). J Safety Res. 2012;43(1):67-74.
10. Curtis Breslin F, Polzer J, MacEachen E, et al. Workplace injury or "part of the job"?: towards a gendered under-

standing of injuries and complaints among young workers. Soc Sci Med. 2007;64(4):782-793.
11. Salminen S. Have young workers more injuries than older ones? An international literature review. J Safety Res. 2004;35(5):513-521.
12. Rauscher KJ, Myers DJ. Occupational fatalities among young workers in the United States: 2001-2012. Am J Ind Med. 2016;59(6):445-452.
13. Tomei G, Capozzella A, Rosati MV, et al. Stress and work-related injuries. Clin Ter. 2015;166(1):e7-e22.
14. Herbert R, Landrigan PJ. Work-related death: a continuing epidemic. Am J Public Health. 2000;90(4):541-545.
15. Pasqualini O, Libener M, Farina E, Bena A. «All of a sudden...» preventability and priorities of construction fatalities: an experience in Piedmont. Epidemiol Prev. 2011; 35(3-4):207-215.
16. Dong XS, Wang X, Daw C. Fatal falls among older construction workers. Hum Factors. 2012;54(3):303-315.
17. Dong XS, Choi SD, Borchardt JG, et al. Fatal falls from roofs among U.S. construction workers. J Safety Res. 2013;44:17-24.
18. Dong XS, Wang X, Largay JA, et al. Fatal falls in the U.S. residential construction industry. Am J Ind Med. 2014;57 (9):992-1000.
19. Kisner SM, Fosbroke DE. Injury hazards in the construction industry. J Occup Med. 1994;36(2):137-143.
20. Tiesman HM, Konda S, Bell JL. The epidemiology of fatal occupational traumatic brain injury in the U.S. Am J Prev Med. 2011;41(1):61-67.
21. Graves JM, Sears JM, Vavilala MS, Rivara FP. The burden of traumatic brain injury among adolescent and young adult workers in Washington State. J Safety Res. 2013; 45:133-139.
22. Katanick D, Taff ML, Spitz WU. A work-related death due to a penetrating chest injury. Am J Forensic Med Pathol. 1986;7(2):163-164.

Chronic hematoma in the lumbar ligamentum flavum. Case report

Carlo Pizzoni
Enrico Pierangeli
Luigi Antonio Lattanzi

Neurosurgery Unit, P.O. "SS. Annunziata",
Taranto, Italy

Corresponding Author:
Carlo Pizzoni
Neurosurgery Unit,
Presidio Ospedaliero "SS. Annunziata"
Via Bruno Francesco 1
74100 Taranto, Italy
E-mail: c.pizzoni@inwind.it

Abstract

Nerve root compression or myelopathy from ligamentum flavum hematoma are very rare.
A 67-year-old woman who had been suffering from a stiff and painful back, after returning from a trip 2 weeks before admission, presented with 1-day history of sudden progressive paraparesis.
There was no history of significant antecedent trauma, anti-platelet/coagulation therapy, or lumbar puncture; laboratory data excluded any bleeding tendency.
Magnetic resonance imaging on the 8th day after the onset of symptoms, showed hypertrophy of a facet and yellow ligament, and a mass lesion at the L3-L4 levels.
Microsurgical unilateral hemilaminectomy of L3 was performed and a hematoma existing in the ligamentum flavum and cystic mass was removed. Her clinical symptoms completely resolved after surgery.

KEY WORDS: hematoma, laminectomy, ligamentum flavum, lumbar spine, spine.

Introduction

Nerve root compression or myelopathy from ligamentum flavum (yellow ligament) hematoma are very rare.
It generally presents as low back and leg pain, occurring in the fourth decade of life or later.
There is usually a history of minor trauma.
Ligamentum flavum hematoma (LFH) happens less frequently than hypertrophy, calcification, ossification because yellow ligament lack of blood vessels.
Ligamentum flavum serves to bridge the spaces between the laminae of adjacent vertebrae from cervical to the lumbosacral interval.
Therefore, LFH may occur in any places from cervical to sacral vertebral column: most cases of LFH were reported in the lumbar spine (1-22).

Case report

A 67-year-old woman who had been suffering from a stiff and painful back, after returning from a trip 2 weeks before admission, presented with 1-day history of sudden progressive paraparesis.
There was no history of significant antecedent trauma, anti-platelet/coagulation therapy, or lumbar puncture; laboratory data excluded any bleeding tendency.
On neurologic examination, the motor power of both lower limbs was grade II.
Deep tendon reflexes of both lower limbs were markedly decreased.
Magnetic resonance imaging (MRI) on the 8th day after the onset of symptoms, showed hypertrophy of a facet and yellow ligament, and a mass lesion at the L3-L4 levels. The lesion has an area of hyperintense signal in T1-weighted images (w. i.) and isointense in T2- w. i., without contrast enhanced after administration of gadolinium-diethylenetriaminepenta-acetic acid.
The mass lesion exerted a remarkable compression over the dural sac (Figures 1-3).
Because of these neurologic findings, surgical exploration and excision of the intraspinal mass lesion were performed on the 23th day after onset.
Surgical removal was performed through a left microsurgical unilateral approach at L3-L4 levels.
Under general anesthesia, the L3 spinous process was located by plain roentgenography and a left paramedian incision about 3 cm was made halfway between L3 and L4 spinous processes.
The left fascia was dissected, the muscles were displaced laterally and a Caspar retractor was posizionated.
After removal of the left L3 lamina by drilling under optic magnification, a red-brownish solid mass was exposed.
The tip of the lesion was in continuity with the normal yellow ligament and exerted a striking compression over the dural sac.
Piecemeal removal of the superficial lesion exposed the cystic component.

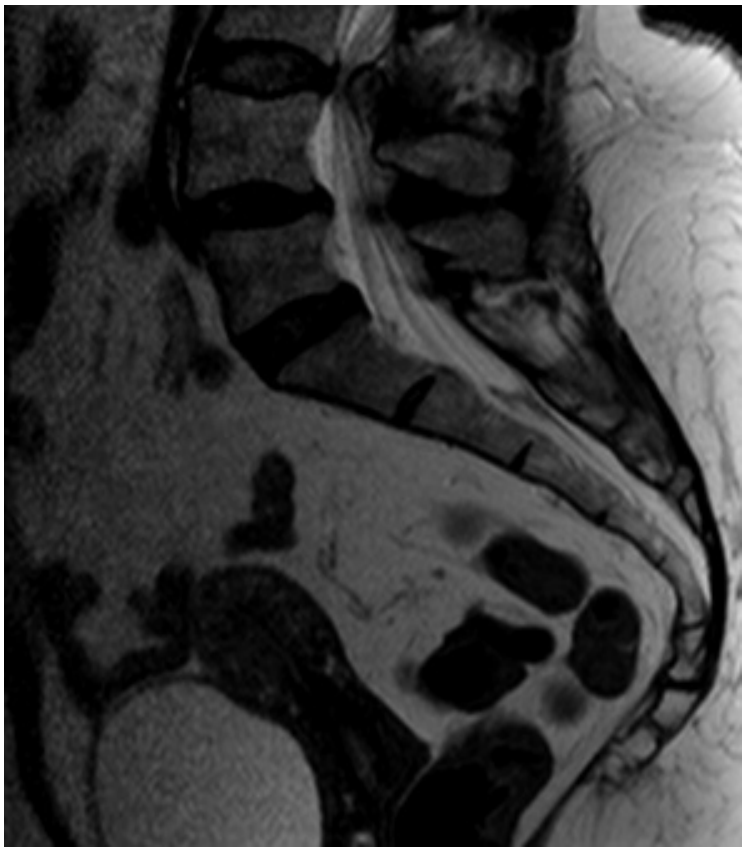

Figure 1 - T2 weighted sagittal MRI evidenced an intraspinal, extradural, semicircular mass lesion, adherent to the posterior surface of the spinal canal in correspondence of the L3-L4 levels, that exerted compression over the dural sac, displaced it anteriorly, resulting in severe spinal canal stenosis. The lesion appears hypointense.

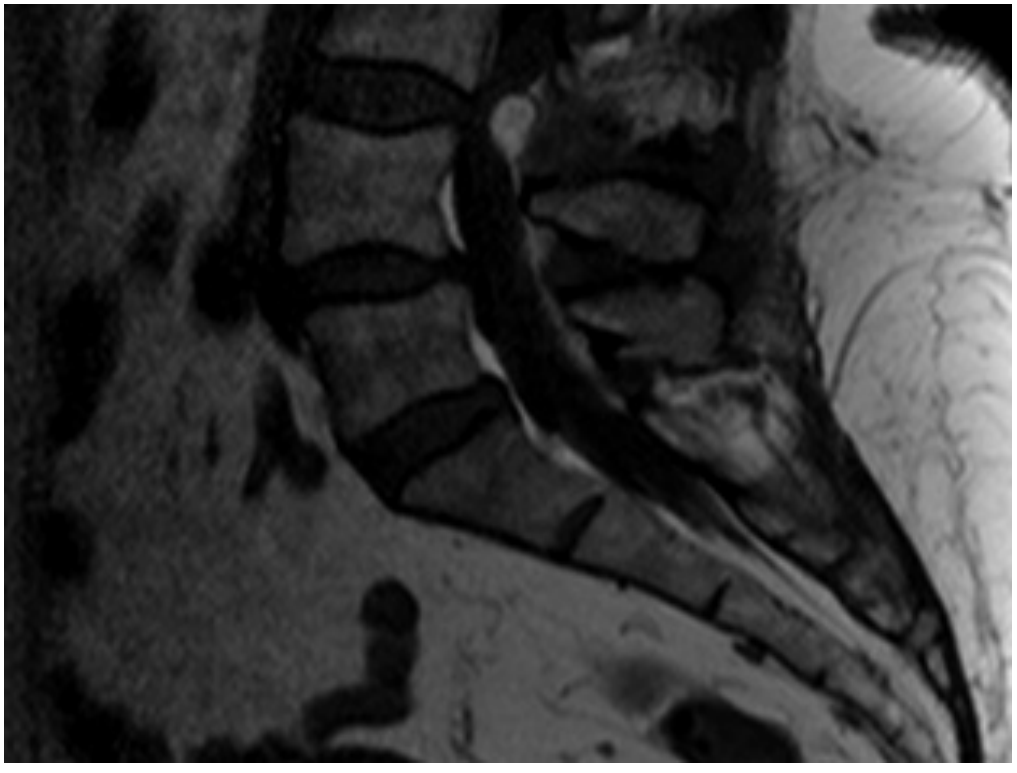

Figure 2 - T1 weighted sagittal MRI. The lesion appears hyperintense.

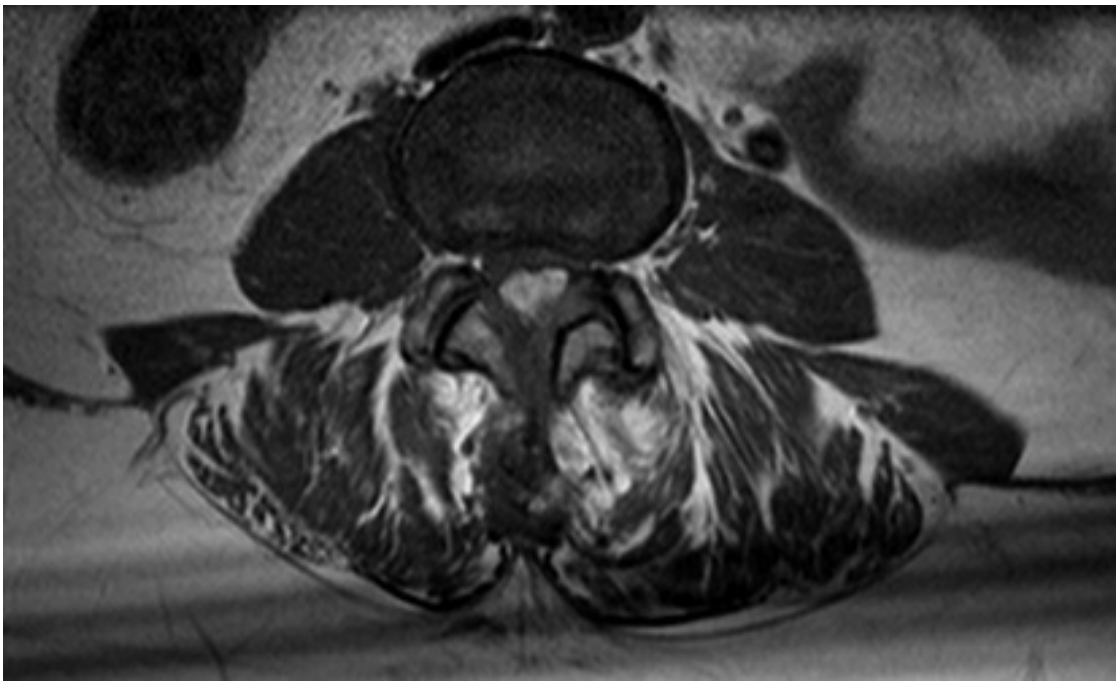

Figure 3 - T1 weighted axial MRI. The mass lesion appeared hyperintense. The axial view better showed the spinal compression.

Puncture of the cyst permitted aspiration of the brownish fluid, suggesting old hematoma.
The bottom of the lesion had tenaciously adhered to the dura mater.
The lesion was dissected and removed completely without causing a dual tear, using microsurgical techniques.
No vascular malformations were found.
Histological examination showed degenerative collagen tissue with a small amount of red blood cells in the elastic fibres. There was no evidence of tumors or infection.
The patient's postoperative was uneventful, the neurological deficits resolved completely within a few days after the operation.
Computed tomography (CT), obtained 6 days after the operation, confirmed total removal of the lesion and the effective decompression of the dural sac (Figures 4-6).

Discussion

Most of the reported cases of LFH were chronic (old) hematomas.
Acute or subacute LFH are extremely rare.
Ligamentum flavum provides to bridge the spaces between the laminae of adjacent vertebrae from cervical to the lumbosacral interval, it consists of elastic fibres (80%) and collagen (20%) and serves as assistance in the maintenance of the erect posture and keeper of the ligament taut during extension.
Because yellow ligament has abundant in motion, any laxity would permit redundancy and infolding toward the ventrally related structures, as occurs in degenerative lumbar spinal stenosis. Because ligamentum flavum is poorly vascularized and only a few small vessels pass through it, LFH is very rare phenomenon (22).
The most frequently involved segment was L4-L5 (10 cases) (1-30).
Fourteen patients experienced minor trivial back injury during daily living lives or sports activities before admission (1-30). These epidemiological factors suggest that LFH is a phenomenon associated to age-related ligamental degeneration rather than hypertrophy which generally seen in spinal degenerative disorders. This fact could be identified from the reported histological examinations.
In fact, in degenerate *ligamentus flavum*, various focal lesions were observed: disappearance of the elastic fibres and scar proliferation of collagen fibres, granulation tissue (consisted of a proliferation of blood capillaries and fibroblasts), calcification, ossification, lymphocyte infiltration, vascularization (consisted of conglomerated proliferation of small vessels) (21).
The histological classification of the regional cyst includes only: 1 true cyst (called synovial cyst, which has a synovial lining membrane) and 2 pseudo cyst. Almost all cysts of the yellow ligament are pseudo cysts. Pseudo cyst is also known as ganglion-like cystic lesion (21, 29).
Ganglion-like cystic lesion definite as cystic structure with granulation tissue in the endocyst wall, was observed most frequently in degenerate ligamentum flavum, like foci with mucinous degeneration. These foci sometimes showed small cystic degeneration and

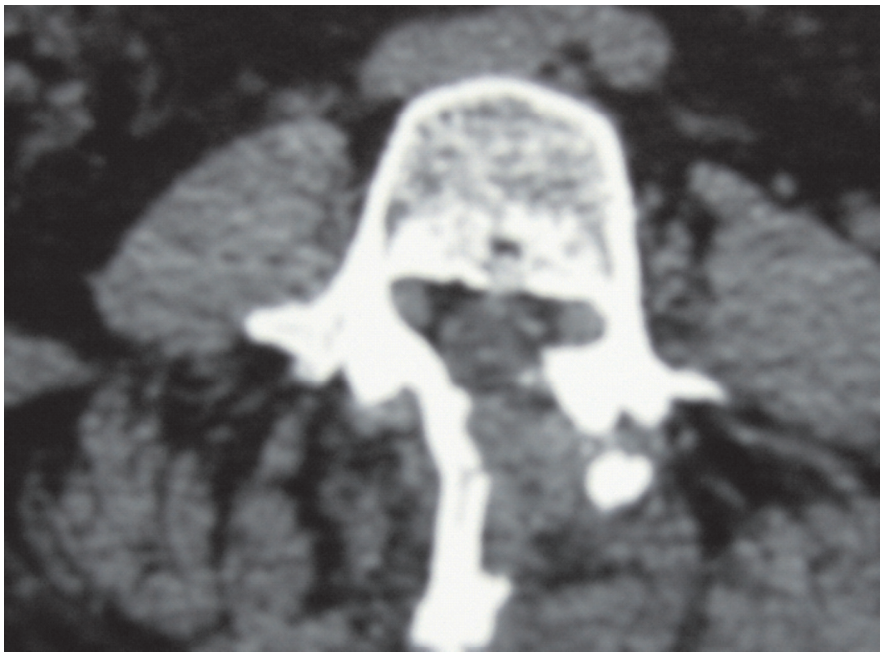

Figure 4 - Postoperative axial CT scan showed complete resection of both the left L3 lamina and the mass lesion.

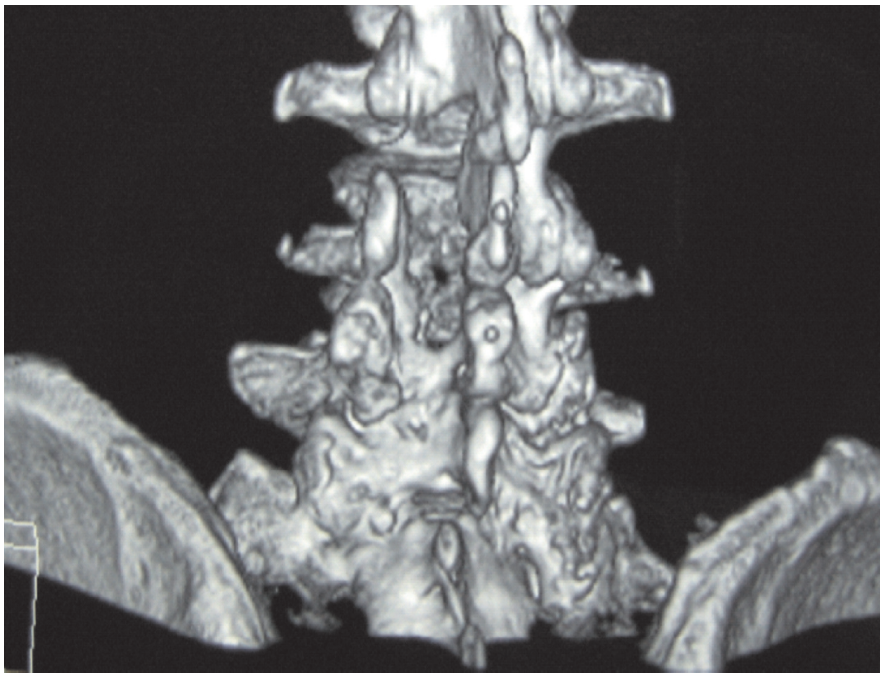

Figure 5 - Postoperative Spiral CT three-dimensional (3D) oblique reconstruction, reivealed complete resection of the left L3 lamina.

a proliferation of fibroblasts surrounding it. Foci with mucinous degeneration were also considered to be a preliminary stage of ganglion-like cystic lesion, in fact these lesions may well largely induce formation of cyst.

Okuda et al. (21) also observed many clefts within the degenerate ligamentum flavum, which seemed to be induced principally by the reduction of elasticity of the ligament. Within these clefts (that can be increase in size), as well as ganglion-like cystic lesion, blood may be gradually accumulate from ruptured capillaries, this can explain the slowly hematoma formation in the legamentum flavum. Spinal epidural veins lack of valves, thus are easily permitting flux in both directions. Consequently, blood from inferior vena cava may be shifted into the vertebral plexus when increased intra-abdominal pressure by physical activity, straining or trauma. In fact more than half of the pa-

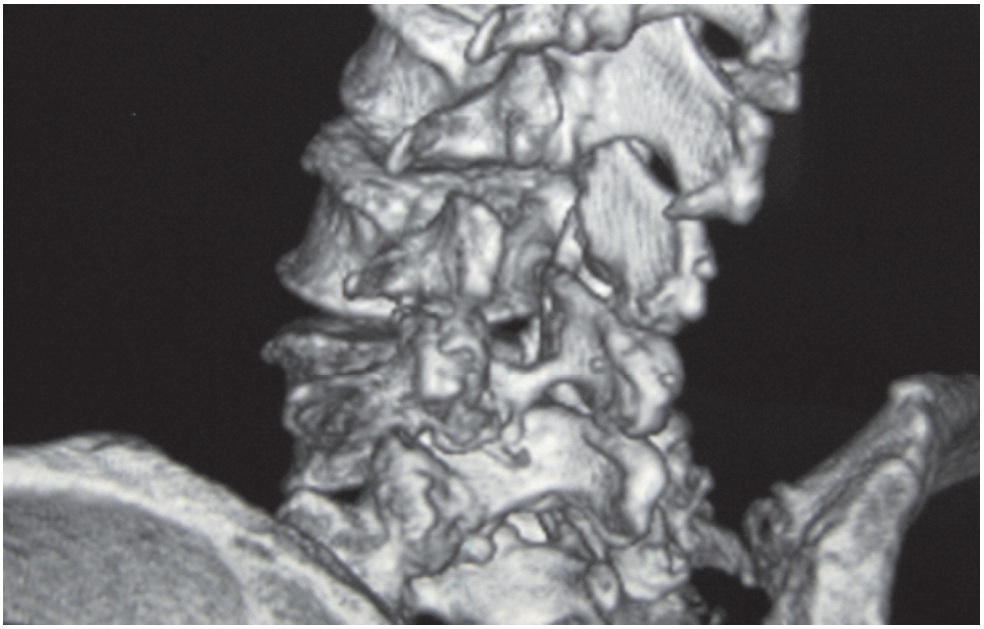

Figure 6 - Postoperative spiral CT 3D reconstruction.

tients had, like precipitating factors, repeated minor abdominal or back trauma which performed during daily living life or sports activities. Increased abdominal pressure transmitted to epidural space resulted in spinal epidural hypertension, which could induce bleeding of degenerated yellow ligament. This bleeding occurs in proliferating small blood vessels which are frequently seen in ligamental degeneration and these vessels are very small, thin-walled and irregularly dispersed in degenerated yellow ligament and are easily broken-down (22).

According to above mentioned mechanisms, the blood can be gradually accumulate in the clefts, and in the ganglion-like cyst: this can result in LFH.

Minimal and repetitive spinal trauma could induce a partial tear in a degenerated ligament and favor intraligamentary hemorrhage. By means of fibrinolytic/hemolytic changes, the hemorrhage would rise significantly in volume inside the yellow ligament, causing neural compression. This can explain the insidious onset and progressive clinical worsening of symptoms in the patients of LFH (22).

The onset of symptom was subtle and clinical course was progressively worsened, like to those of other spinal canal disease, such as lumbar disc herniation, tumour, infection and facet cyst. MRI is an important diagnostic tool because it reveals the connection between the yellow ligament and a posterior epidural mass (22).

The heterogeneous intensity that may be seen on MRI is due to the reflected deoxyhaemoglobin or methaemoglobin contents of the hematoma; in fact, in the acute phase, it appears isointense to the spinal cord on T1-w. i. and hyperintense on T2- w i. After one day, the hematoma usually is hypeintense on T1- w i and isointense to the cerebrospinal fluid in T2- w. i. (15, 22).

Therefore, it is difficult to differentiate an LFH from a synovial cyst.

In recent times, it is an important surgical concept that the posterior supporting tissues should be preserved as far as possible, so unilateral laminectomy (laminotomy) for bilateral decompression is an ideal procedure (20, 30).

Under directed vision by operative microscope, it's possible, after monolateral laminectomy and ligamentectomy in on side, to remove the contralateral ligamentum flavum.

This resection of the contralateral yellow ligament decompressed the dural sac and permitted direct inspection of the contralateral lateral recess (20, 30).

Unlike classic bilateral laminectomy, a unilateral laminectomy conserves the spinous processes, the supraspinous and interspinous ligaments. By conserving these structures, a unilateral laminectomy may reduce the incidence of delayed lumbar instability, which has been reported after laminectomy (20, 30).

For degenerative spinal stenosis, we introduced this technique since 1999 in our Hospital (31).

Adhesion to the dura mater is not rare in chronic LFH, but yellow ligament could be safely detached from it by the microsurgery under optic magnification.

Conclusion

LFH should be included in the differential diagnosis of epidural spinal lesion, especially in the cervical and lumbar regions and in middle age patients. In fact according to above mentioned pathogenetic hypothesis, cervical and lumbar spine prone to receive pressure transmission to epidural space because they have

abundant spinal mobility. Thoracic spine barely receives this pressure transmission because it has scarce spinal mobility. The differential diagnosis of LFH includes synovial cyst, ganglion-like cystic lesion, epidural abscess, necrotic herniated lumbar disc, and some tumour (7, 11, 20).

MRI is the best modality for the diagnosis of LFH.

Surgical therapy permitted a good clinical outcome even if the operation has been performed months after the clinical onset.

References

1. Vernet O, Fankhause H, Schnyder P, Déruaz JP. Cyst of the ligamentum flavum: report of six cases. Neurosurgery. 1991;29:277-283.
2. Sweasey TA, Coester HC, Rawal H, et al. Ligamentum flavum hematoma. Report of two cases. J Neurosurg. 1992;76:534-537.
3. Baker JK, Hanson GW. Cyst of the ligamentum flavum. Spine. 1994;19:1092-1094.
4. Minamide A, Yoshida M, Tamaki T, Natsumi K. Ligamentum flavum hematoma in the lumbar spine. J Orthop Sci. 1999;4:376-379.
5. Mahallati H, Wallace CJ, Hunter KM, et al. MR imaging of a hemorrhagic and granulomatous cyst of the ligamentum flavum with pathologic correlation. AJNR Am J Neuroradiol. 1999;20:1166-1168.
6. Yüceer N, Başkaya MK, Smith P, Willis BK. Hematoma of the ligamentum flavum in the lumbar spine: case report. Surg Neurol. 2000;53:598-600.
7. Hirakawa K, Hanakita J, Suwa H, et al. A post-traumatic ligamentum flavum progressive hematoma: a case report. Spine. 2000;25:1182-1184.
8. Kumazawa S, Sakai H, Watanabe T, et al. A case of lower limb pain caused by ligamentum flavum hematoma. Rinsho Seikei Geka. 2002;37: 879-882.
9. Inoue T, Soshi S, Imuro T, et al. Hematoma in the lumbar ligamentum flavum: a case report. Kanto Seikeisaigaigeka Gakkai Zasshi. 2003;34:101-104.
10. Chi TW, Li KT, Chieng PU. Post-traumatic ligamentum flavum hematoma: a case report. Kaohsiung J Med Sci. 2004;20:41-44.
11. Mizuno J, Nakagawa H, Inoue T, Hashizume Y. Ligamentum flavum hematoma in the lumbar spine. Neurol Med Chir (Tokyo). 2005;45:212-215.
12. Yamaguchi S, Hida K, Akino M, et al. Ligamentum flavum hematoma in the lumbar spine. Neurol Med Chir (Tokyo). 2005;45:272-276.
13. Kim K, Isu T, Miyamoto M, et al. Haemorrhage into the ligamentum flavum of the lumbar spine: case report and review of the literature. Br J Neurosurg. 2005;19:511-512.
14. Spuck S, Stellmacher F, Wiesmann M, Kranz R. Case reports: a rare cause of radicular complaints: ligamentum flavum hematoma. Clin Orthop Relat Res. 2006;443:337-341.
15. Albanese A, Braconi A, Anile C, et L. Spontaneous haematoma of ligamentum flavum. Case report and literature review. J Neurosurg Sci. 2006;50:59-61.
16. Keynan O, Smorgick Y, Schwartz AJ, et al. Spontaneous ligamentum flavum hematoma in the lumbar spine. Skeletal Radiol. 2006;35:687-689.
17. Shimada Y, Kasukawa Y, Miyakoshi N, et al. Chronic subdural hematoma coexisting with ligamentum flavum hematoma in the lumbar spine: a case report. Tohoku J Exp Med. 2006;210:83-89.
18. Kotil K, Bilge T. A ligamentum flavum hematoma presenting as an L5 radiculopathy. J Clin Neurosci. 2007;14:994-997.
19. Takahashi H, Wada A, Yokoyama Y, et al. Ligamentum flavum haematoma: a report of two cases. J Orthop Surg (Hong Kong). 2009;17:212-215.
20. Takeno K, Kobayashi S, Miyazaki T, et al. Microsurgical excision of hematoma of the lumbar ligamentum flavum. Joint Bone Spine. 2010;77:351-354.
21. Okuda T, Baba I, Fujimoto Y, et al. The pathology of ligamentum flavum in degenerative lumbar disease. Spine. 2004;29:1689-1697.
22. Lee HW, Song JH, Chang IB, Choi HC. Spontaneous ligamentum flavum hematoma in the rigid thoracic spine: a case report and review of the literature. J Korean Neurosurg Soc. 2008;44:47-51.
23. Cruz-Conde R, Berjano P, Buitron Z. Ligamentum flavum hematoma presenting as progressive root compression in the lumbar spine. Spine. 1995;20:1506-1509.
24. Gazzeri R, Canova A, Fiore C, et al. Acute hemorrhagic cyst of the ligamentum flavum. J Spinal Disord Tech. 2007;20:536-538.
25. Miyakoshi N, Kasukawa Y, Ando S, Shimada Y. Two-level ligamentum flavum hematoma in the lumbar spine. Case report. Neurol Med Chir (Tokyo). 2008;48:179-182.
26. Kono H, Nakamura H, Seki M, Motoda T. Foot drop of sudden onset caused by acute hematoma in the lumbar ligamentum flavum: a case report and review of the literature. Spine. 2008;33:E573-E575.
27. Takeda M, Takahashi Y, Suzuki H, et al. Ligamentum flavum hematoma of lumbar spine: a case report. Orthop Surg Traumatol. 2005;48:1485-1488.
28. Hashimoto H, Masuda A, Shibata K, et al. Two cases of ligamentum flavum hematoma in the lumbar spine. J East Jpn Orthop Traumatol. 2008;20:223-225.
29. Asamoto S, Jimbo H, Fukui Y, et al. Cyst of the ligamentum flavum. Case report. Neurol Med Chir (Tokyo). 2005;45: 653-656.
30. Poletti CE. Central Lumbar Stenosis Caused by Ligamentum Flavum: Unilateral Laminotomy for Bilateral Ligamentectomy: Preliminary Report of Two Cases. Neurosurgery. 1995;37:343-347.
31. Pierangeli E, Colamaria A, Pizzoni C, Rossano A. Microsurgical technique in lumbar stenosis. Analysis of 70 operated cases. Riv Neurobiologia. 2001;47:83-87.

Benzene and cortisol: relationship in workers exposed to outdoor pollution

Gianfranco Tomei[1]
Maria Valeria Rosati[2]
Francesco Tomei[3]
Savino Baldi[2]
Ottavia Balbi[2]
Alessandra Di Marzio[2]
Teodorico Casale[3]
Stefania Marchione[4]
Nadia Nardone[3]
Giuseppe Buomprisco[2]
Antonino Durante[3]
Pasquale Ricci[4]
Carmina Sacco[3]
Serafino Ricci[4]

[1] Department of Psychiatric and Psycological Science, "Sapienza" University of Rome, Italy
[2] Department of Anatomy, Histology, Legal Medicine and Orthopaedics, O. U. of Occupational Medicine, "Sapienza" University of Rome, Italy
[3] Spin off of "Sapienza", University of Rome, Italy
[4] Department of Anatomy, Histology, Legal Medicine and Orthopaedics, O. U. of Legal Medicine, "Sapienza" University of Rome, Italy

Corresponding Author:
Francesco Tomei
Spin off of "Sapienza",
University of Rome
Viale Regina Elena 336
00161 Rome, Italy
E-mail: francesco.tomei@uniroma1.it

Abstract

***Introduction*: The purpose of our study is to assess whether individual exposure to low-dose benzene in urban air may affect the plasma concentrations of cortisol in a population of outdoor workers in a large Italian city.**
***Materials and methods*: From a population of 1594 workers, 100 outdoor workers were selected. For each worker, a blood sampling was performed to measure benzene and cortisol. Kolmogorov-Smirnov test was used to verify the normality of distribution of the different variables. On the total sample, student T tests were performed for 2 mode variables (sex, smoke and job) and ANOVA test for variables with more than 2 modes (age and seniority). Pearson's correlation index between the variables in the total sample and after division on the basis of sex, smoking habit and manners was evaluated. Were considered significant results with p values below 0.05.**
***Results*: Our study did not show statistically significant correlations between blood benzene levels and cortisol in none of the groups studied.**
***Discussion*: Further studies are needed to confirm the existence of possible significant association between occupational exposure to benzene and cortisol levels alteration.**

KEY WORDS: benzene, biological monitoring, cortisol, environmental pollutants, outdoor workers.

Introduction

Benzene is a volatile, colorless and odorous liquid. It is characterized by a high chemical stability which is the basis of most of the properties of this compound: highly flammable, antiknock, low viscosity, high solubility in polar solvents and low solubility in water. It is rarely present in nature in high quantities, except in oil or during combustion processes such as volcanic eruptions or fire.
The main sources of exposure to the general population are cigarette smoke and air contaminated by high levels of benzene due to vehicular traffic or near petrol stations (1, 2).
The main sources of occupational origin, however, derive from the following uses of benzene: additive in fuels, industrial synthesis of organic compounds such as ethylbenzene (precursor of styrene, used to produce polymers, copolymers, plastic and latex resins), cumene (converted to phenol for the production of adhesives and resins), cyclohexane (used in the production of certain types of nylon), nitrobenzene (for the production of aniline, paints and other products), alkylbenzene (for the production of detergents) and chlorobenzene (polymers, pesticides, paints) (2).
Benzene is responsible for various toxic effects on human health, both acute and chronic (3-5). There is sufficient evidence that benzene is carcinogenic to humans and, in particular, it can cause acute myeloid leukemia and acute non-lymphocytic leukemia. Benzene exposure was also positively associated with acute lymphocytic leukemia, chronic lymphocytic leukemia, multiple myeloma, non-Hodgkin lymphoma (6).
Cortisol is a steroid hormone produced by the adrenal glands, particularly involved in the body's response to physical and psychic stress. In fact, cortisol can act on

almost all cells of the body, promoting the correct addition of fatty acids and glucose and optimizing energy metabolism in organs such as the heart, lungs and muscles. In addition to metabolism regulation, cortisol has important effects on the immune system, promoting anti-inflammatory reactions. In stressful situations, cortisol also helps maintaining proper blood pressure and normal nervous and cerebral activity. Circulating cortisol is predominantly inactive, or linked to plasma proteins. Only a small percentage of the hormone is active at cellular level and in this form is also present in saliva.

Cortisol secretion follows a 24-hour circadian rhythm and has a peak in the morning until it reaches the lowest values around 10-12 PM. Its regulation is based on corticotropin, a hormone secreted by hypophysis: a reduction in the level of cortisol in the blood results in an increase in corticotropin secretion which in turn stimulates the adrenal cortical with a consequent increase in the cortisol rate in blood.

The cortisol role in mediating stress response is well known, but several studies in literature indicate that many physical and chemical pollutants can play an important role by altering hormone levels (7, 8). In addition, cortisol levels may also be influenced by several other factors (9).

Ethanol, for example, can affect glucocorticoid levels; the ingestion of moderate amounts of ethanol causes an increase in cortisol concentration. In addition, high levels of cortisol are found in subjects with chronic ethylosis, both during alcoholic intoxication and during abstinence (10-12).

Cigarette smoking is associated with an increase in cortisol levels, in fact Steptoe and Ussher (13) have shown that smokers have higher levels of this hormone than non-smokers.

Certain studies on animals and humans showed an increase in cortisol levels due to the exposure to physical environmental pollutants such as noise (14) or chemicals such as benzene, toluene (15), carbon monoxide and manganese (16, 17), while vibrations seem to cause a decrease in hormone levels (18).

Several Authors studied plasma cortisol levels in workers exposed to outdoor pollution (19-21), hypothesizing a relationship between hormone levels and outdoor pollution.

The purpose of our study is to assess whether individual exposure to low-dose benzene in urban air may affect the plasma concentrations of cortisol in a population of outdoor workers in a large Italian city.

Materials and methods

Population studied

Workers who performed outdoor tasks and professionally exposed to urban polluters were selected from an initial population of 1594 municipal policemen of Rome. Workers have been randomly identified from 8 different areas of the city (considered to be representative of traffic) and a similar group of workers (35 subjects per area) was taken from each of them for a total of 280 workers, in order to reduce confusion bias. For the inclusion in the study and in order to identify the confounding factors, a physician administered a clinical-anamnestic questionnaire to each participant to investigate age, residence area over the last 5 years, physiological history (especially focused on cigarette smoking and dietary habits), current and recent history of work, remote and near pathological history (with particular regard to the possible presence of pathologies in the pituitary-adrenal axis and more generally of the endocrine system) and information about the possible extra-working exposure to benzene.

Workers who have been resident for at least five years in the same urban area, where they also worked and were similar to dietary habits and water consumption, were included. Furthermore, the studied population lived in homogeneous (Mediterranean country) environments for furnishings, dwelling types, carpets, etc. where the release of benzene is low and negligible (2).

Roadmill workers were assigned to traffic control in roads and areas with high and medium rate of traffic, monitoring and traffic control at crossroads, parking areas and restricted traffic areas; their job was mainly on foot (22). Other policemen were assigned to traffic control and to intervene in specific cases such as road accidents and other activities requesting the driving of a car or of a motorcycle, as a driver or “second in a patrol”. For other outdoor activities, workers had different roles such as Environmental Police and External Commercial Activities (22). Most of these activities were carried out in outdoor environments, while drivers stayed in the car for at least 80% of working time (7 hours a day for 5 days a week).

All workers normally work in the morning and they were monitored during the morning shift (07:00 AM - 02:00 PM) at the end of the working week.

With regard to cigarette smoke exposure, we have taken into account the World Health Organization (WHO) classification, considering smokers like all the people who had already reported having smoked at least 100 cigarettes in their lives, currently smoking or having stopped smoking for less than six months. All workers who stated that they had stopped smoking for more than 6 months were considered non-smokers (WHO, 2014).

In order to avoid the influence of confounding factors, we have excluded from the study the workers exposed to solvents, lubricants, detergents, etc. during non-working activities (23, 24), drug users and alcoholic drinkers (alcohol consumption more than 2 alcoholic units per day for men and 1 alcoholic unit for women; 1 alcoholic unit is about 12 grams of ethanol) (25, 26), subjects with pre-existing or ongoing endocrine disorders (adeno-physiological pathologies, adrenal pathologies). Workers who used (in the six months prior to the study) drugs that can alter the levels of cortisol (e. g. corticosteroids, estroprogestin, potassium-sparing

diuretics, metoclopramide) (27-30) and who carried out outdoor tasks for less than 1 year, were also excluded.

The final sample of the study included 100 workers (77 men and 23 women, 28 smokers and 72 non-smokers), divided according to the job of 62 roadblocks and 38 workers with other outdoor tasks (e. g. drivers).

The characteristics of the study population are shown in Table 1.

The division of smokers and non-smokers has proved to be necessary since cigarette smoking has been shown to be associated with an increase in cortisol levels (13). All subjects were informed that the research protocol data would be treated in an anonymous and collective manner, using scientific methods and for scientific purposes, according to the principles of the Helsinki Declaration.

Environmental monitoring: personal dosimetry

Eight personal dosimetry, selected from 8 workstations considered representative of the topographic distribution of the workers studied, as well as 4 representative personal dosimeters for drivers in service cars in with at least 2 agents for each shift (so even though only one worker wore the dosimeter, the results were considered representative of the colleague's exposure, because he was in the car with him). The sampling lasted for the whole working shift. Air and blood samples were collected in parallel in the study participants to avoid the influence of weather and seasonal conditions on personal exposure to air benzene.

Workers have been equipped with passive personal dosimeters, attached as badges to the worker's neck at the beginning of each sampling day, in order to measure the concentration of benzene in the breathing area.

Table 1 - Characteristics of the study population divided for task.

Variables	Traffic policemen	Policemen with other outdoor activities
Number of subjects	(n.62)	(n.38)
Gender Male n° (%) Female n° (%)	49 (79) 13 (21)	27 (71) 11 (29)
Smoking habit N° (%)	15 (24,2)	13 (34,2)
Age (ys) Mean (SD) Geometric Mean Min-Max Median	46,83 (9,85) 45,78 29-64 46,5	42,94 (7,73) 42,25 28-60 42
Working life (ys) Mean (SD) Geometric Mean Min-Max Median	18,09 (10,82) 14,79 6-37 17	14,76 (7,01) 13,29 6-35 16,5
Benzene Mean (SD) Geometric Mean Min-Max Median	360,71 (319,40) 236,16 75-1338 246	377,84 (470,87) 216,70 75-1926 184
Cortisol Mean (SD) Geometric Mean Min-Max Median	155,35 (50,17) 144 34-362 153	148,85 (49,73) 140,32 62-259 143
Air benzene Number of subjects Mean (SD) Geometric Mean Min-Max Median	8 17,28 (10,42) 13,88 5-36,6 16,2	4 10,81 (7,85) 6,63 1-24,8 11,2

After sampling, the passive dosimeters were prepared for desorption by adding CS^2 (carbon sulphide) to the badges. Benzene analysis was performed by capillary gas chromatography (GC) with the "Dani gas-chromatograph 1000" equipped with a flame ionization detector (FID) for quantification.
The detection limit for benzene (LoD) was 0.001 ppm (3.19 µg/m^3). The observed concentrations of benzene were expressed as mean weighted values over a period of 8 hours.

Dosage of cortisol and blood benzene
For each worker, the blood draw for the determination of blood benzene was performed after 5 continuous working days at the end of the working shift during the same day of personal benzene sampling in the air. Blood benzene monitoring was performed after the distribution of an informative note containing the recommendation to abstain from the active and passive smoking, the consumption of certain foods (offal, chicken, fish and nuts) and the intake of alcoholic or super alcoholic beverages (2, 25).
All workers included in the study were subjected to cortisol dosage via RIA (radioimmunoassay): from each worker a sample of 10 ml of venous blood was taken at 08.00 AM o'clock at fasting. Blood samples were stored in the refrigerator at -4°C until the time they were transferred (in a suitable container and at the same temperature) to the laboratory where they were centrifuged immediately and subsequently stored at -20°C until analyzed (within 3 days).
The normal ranges used in laboratory analysis were 50-230 ng/ml (cortisol values at 08:00 AM).
The laboratory performed the tests by the extraction method with SPME technique (extraction with ethyl acetate and esterification) and gas chromatography with mass spectrometry detector (GC-MS) with a detection limit of <150 ng/L (28).

Statistic analysis
For the statistical evaluation, the following factors were considered: sex, habit of smoking cigarettes, job, age and seniority. The normality of the distribution of the different variables was verified by the Kolmogorov-Smirnov test, which was statistically significant for both cortisol and blood benzene; then the parameters analyzed were in a non-normal distribution and so they were converted into logarithmic form.
The results of the environmental monitoring (atmospheric benzene), biological monitoring (blood benzene) and cortisol were expressed in terms of mean, standard deviation (SD), median and range (min-max). The concentrations below the LoD were replaced by the middle of LoD.
The comparison of the averages was done by Student's T-test for independent variables for 2-mode variables (sex, cigarette smoking habit and working job) and ANOVA for variables with more than 2 modes (age, seniority).
In the total sample and after the subdivision according to sex, smoking, and occupational activity, Pearson correlation index was calculated to verify the level of association between blood benzene values and cortisol values.
The results were considered significant when p values were less than 0.05. The statistical analysis was done using the SPSS® Advanced StatisticalTM 24.0 software.

Results

Environmental monitoring of benzene: personal dosimetry
Individual benzene exposure values in the air are shown in Table 1. None of the subjects smoked for the previous 5 days and during the sampling period. No sample exceeded the limit value of 1.6 mg/m^3 of benzene, as proposed by the American Conference of Governmental Industrial Hygienists (16) for subjects with professional exposure.
Dosimetry also showed atmospheric benzene values above 5 µg/m^3 (in Italy, this is the limit value for human health protection, laid down by Ministerial Decree 60/2002, based on Directive 2000/69/EC), for 6 roadblocks on 8 and for 2 drivers on 4.

Cortisol, blood benzene and characteristics of the studied population
The characteristics of the studied population, blood and atmospheric levels of benzene and cortisol, are shown in Table 1. A statistically significant difference between the cortisol and the smoking habit was observed by Student's T test while a non statistically significant relationship with sex and work; even with regard to blood benzene parameters, no statistically significant difference was observed either with respect to sex or with respect to cigarette smoke and working life.

Blood benzene and cortisol
Pearson correlation analysis between blood benzene levels and plasma cortisol values did not indicate the existence of statistically significant correlation in both the total sample and all subgroups (Table 2).

Discussion

In literature it has been found that the exposure to urban physical and chemical stress, interacting with psychosocial factors and lifestyle, may have an influence on cortisol levels in road policemen (19). There is also evidence that benzene in the air affects both the hormonal system (22, 29) and other organs and apparatuses (31-33). Other studies, finally, observed the action on the neuroendocrine system, *in vivo* and *in vitro*, of the exposure to other hydrocarbons and organic solvents (34).
Our study did not show statistically significant correlations between blood benzene levels and cortisol in none of the groups studied.

Table 2 - Pearson correlation coefficient (R) between log cortisol values and log total blood benzene in the total sample and after subdivision on the basis of sex, cigarette smoking and kind of task.

Variables	Biological indicator (Mean ± SD)	Cortisol
Total sample	302.76 ± 297.55	r: -,312 [a] p: 0,000 [b]
Male subjects	333.17 ± 337.9	r: -,532 [a] p: 0,000 [b]
Female	249.34 ± 194.6	r: -,607 [a] p: 0,000 [b]
Smoker subjects	332.03 ± 372.31	r: -,492 [a] p: 0,000 [b]
Non smoker subjects	290.35 ± 259.95	r: -,382 [a] p: 0,000 [b]
Police drivers	337.58 ± 398.8	r: -,208 [a] p: 0,097 [b]
Policemen with other outdoor activities	183.44 ± 46.32	r: -,754 [a] p: 0,000 [b]

For this reason, this must be considered a preliminary study; it is not possible to assert with certainty that there is no correlation between the variables studied, since the sample considered is quite small, although some evidence indicates the correlation between urban pollutants and cortisol (19, 20). Therefore, our results induce us to expand the studied population, deepening the study on the possible correlation between benzene levels in the air and plasma cortisol levels.

References

1. IPCS. Benzene. Geneva, World Health Organization, International Programme on Chemical Safety. International Chemical Safety Card 0015. 2004. Available from: http://www.inchem.org/documents/icsc/icsc/eics0015.htm
2. Duarte-Davidson R CC, Rushton L, Levy L. Benzene in the environment: an assessment of the potential risks to the health of the population. Occup Environ Med. 2001;58:2-13.
3. Mehlman MA. Benzene health effects: Unanswered questions still not addressed. American Journal of Industrial Medicine. 1991;20(5):707.
4. ATSDR, Agency for Toxic Substances and Disease Registry. (2007). Toxicological Profile for Benzene. US Department of Health and Human Service, Public Health Service. Available from: https://www.atsdr.cdc.gov/toxprofiles/tp3.pdf
5. Sancini A, Caciari T, Di Pastena, et al. Meta-analysis: cardiovascular effects in workers occupationally exposed to urban pollution. Prevention and Research. 2012;1(1):8-20.
6. Myron A. Mehlman. Carcinogenic Effects of Benzene: Cesare Maltoni's Contributions. Annals of the New York Academy of Sciences. 2006;982:137-148.
7. Miraglia N, Genovese G, Basilicata, et al. A case study of benzene urinary biomarkers quantification: the comparison between pre- and postshift samples improves the interpretation of individual biological monitoring data. Prevention and Research. 2014;3(4):142-147.
8. Chida Y, Steptoe A. Cortisol awakening response and psychosocial factors: A systematic review and meta-analysis. Biol Psychol. 2009;80:265-278.
9. Odermatt A, Gumy C, Atanasov AG, et al. Disruption of glucocorticoid action by environmental chemicals: Potential mechanisms and relevance. J Steroid Biochem MolBiol. 2006;102:222-231.
10. Eriksson M, Fahlke C, Hansen S, et al. No effect of the cortisol-synthesis inhibitor metyrapone on alcohol drinking: A pilot study. Alcohol. 2001;25:115-122.
11. Adinoff B, Ruether K, Krebaum S, et al. Increased salivary cortisol concentrations during chronic alcohol intoxication in a naturalistic clinical sample of men. Alcohol Clin Exp Res. 2003;27:1420-1427.
12. Rachdaoui N, Sarkar DK. Effects of alcohol on the endocrine system. Endocrinol Metab Clin North Am. 2013;42(3):593-615.
13. Steptoe A, Ussher M. Smoking, cortisol and nicotine. Int J Psychophys. 2006;59:228-235.
14. Tomei F, Ruffino MG, Tomao E, et al. Acute experimental exposure to noise and hormonal modifications. J Environ Sci Health. 2000;35:537-555.
15. Hsieh GC, Sharma RP, Parker RD. Hypothalamic pituitary-adrenocortical axis activity and immune function after oral exposure to benzene and toluene. Immunopharmacology. 1992;21:23-31.
16. Raff H, Goldmann RW, Kindwall EP. Adrenocortical function after acute carbon monoxide exposure in humans. Arch Environ Health. 1985;40:88-90.
17. Li C, Taneda S, Suzuki AK, et al. Effects of 3-methyl-4- nitrophenol on the suppression of adrenocortical function in immature male rats. Biol Pharm Bull. 2007;30:2376-2380.
18. Bosco C, Iacovelli M, Tsarpela O, et al. Hormonal responses to wholebody vibration in men. Eur J Appl Physiol. 2000;81:449-454.
19. Rosati MV, Sancini A, Tomei F, et al. Plasma cortisol concentrations and lifestyle in a population of outdoor workers. International Journal of Environmental Health Research. 2010;21(1):62-71.

20. Tomei F, Rosati MV, Ciarrocca M, et al. Plasma cortisol levels and workers exposed to urban pollutants. Industrial Health. 2003;41:320-326.
21. Tomei F, Rosati MV, Baccolo TP, et al. Plasma concentration of adrenocorticotropic hormone in traffic policemen. J Occup Health. 2003;45(4):242-247.
22. Ciarrocca M, Tomei G, Fiaschetti M, et al. Assessment of occupational exposure to benzene, toluene and xylenes in urban and rural female workers. Chemosphere. 2012;87: 813-819.
23. Arnold SM, Angerer J, Boogaard PJ, et al. The use of biomonitoring data in exposure and human health risk assessment: benzene case study. Critical reviews in toxicology. 2013;43:119-153.
24. Baccarelli A. Occupational agents and endocrine function: an update of the experimental and human evidence. La Medicina del lavoro. 1999;90:650-670.
25. Saunders JB, Aasland OG, Babor TF, et al. Development of the Alcohol Use Disorders Identification Test (AUDIT): WHO Collaborative Project on Early Detection of Persons with Harmful Alcohol Consumption-II. Addiction. 1993;88: 791-804.
26. Rachdaoui N, Sarkar DK. Effects of alcohol on the endocrine system. Endocrinology and metabolism clinics of North America. 2013;42:593-615.
27. Andersson KE. Adrenoceptors-classification, activation and blockade by drugs. Postgrad Med J. 1980;56(Suppl 2):7-16.
28. Hoet P, De Smedt E, Ferrari M, et al. Evaluation of urinary biomarkers of exposure to benzene: correlation with blood benzene and influence of confounding factors. International archives of occupational and environmental health. 2009;82:985-995.
29. Crebelli R, Tomei F, Zijno A, et al. Exposure to benzene in urban workers: environmental and biological monitoring of traffic police in Rome. Occupational and environmental medicine. 2001;58:165-171.
30. Tomei G, Rosati MV, Martini A, et al. Assessment of subjective stress in video display terminal workers. Industrial health. 2006;44:291-295.
31. Casale T, Sacco C, Ricci S, et al. Workers exposed to low levels of benzene present in urban air: Assessment of peripheral blood count variations. Chemosphere. Jun 2016;152:392-398.
32. Bulka C, Nastoupil LJ, McClellan W, et al. Residence proximity to benzene release sites is associated with increased incidence of non-Hodgkin lymphoma. Cancer. 2013;119 (18):3309-3317.
33. Polychronakis I, Dounias G, Makropoulos V, et al. Work-related leukemia: a systematic review. J Occup Med Toxicol. 2013;8(1):14.
34. Gelbke HP, Banton M, Leibold E, et al. A critical review finds styrene lacks direct endocrine disruptor activity, Critical Reviews in Toxicology. 2015;45(9):727-764.

Work-related stress: volunteer and employee drivers/rescuers

Francesco Tomei [1]
Gianfranco Tomei [2]
Maria Valeria Rosati [3]
Luciana Fidanza [3]
Franco Pagliara [3]
Claudia Di Pastena [3]
Roberto Giubilati [1]
Benedetta Pimpinella [1]
Alessandra Di Marzio [3]
Francesco Massoni [4]
Giuseppe Buomprisco [3]
Carmina Sacco[1]
Serafino Ricci [4]

[1] Spin off of "Sapienza", University of Rome, Italy
[2] Department of Psychiatric and Psycological Science, "Sapienza" University of Rome, Italy
[3]Department of Anatomy, Histology, Legal Medicine and Orthopaedics, O.U. of Occupational Medicine, "Sapienza" University of Rome, Italy
[4] Department of Anatomy, Histology, Legal Medicine and Orthopaedics, O.U. of Legal Medicine, "Sapienza" University of Rome, Italy

Corresponding Author
Francesco Tomei
Spin-off of "Sapienza", University of Rome
Viale Regina Elena 336
00161 Rome, Italy
E-mail: francesco.tomei@uniroma1.it

Abstract

***Introduction*: In the health field, volunteer staff, unpaid and not moved by economic reasons, support more often the workers, sharing the same stressful factors. The study aims to assess subjective stress by comparing 119 volunteer drivers/rescuers and 119 employee drivers/rescuers, belonging to a big Italian healthcare company.**
***Materials and methods*: Stress was evaluated through the "questionnaire-indicating tool" validated by HSE (Health and Safety Executive). The research was conducted on a working population of 119 employee rescuers/drivers made comparable as for sex and age (p = 0.8831) to 119 volunteer rescuers/drivers.**
***Results*: Our study showed a critical situation in the fields "Demand", "Control" and "Relationship" for the employee rescuers drivers and in the fields "Demand" and "Relationship" for the volunteer rescuers drivers.**
The main differences were in "Control" and "Support from managers" between the two groups.
On the basis of gender, employee women had a more critical situation than men in "Control" and "Change"; the same situation was observed for volunteer women only in "Control".
***Discussion*: Our study shows that the employee drivers/rescuers had a performance worse than the volunteers in "Support from managers" and "Control".**
Volunteers and employees had a negative performance in "Demand" and "Relationship".
Women showed critical conditions in "Control" and, only employees, in "Change".

KEY WORDS: employee drivers/rescuers, health workers, indicator tool, subjective stress, volunteer drivers/rescuers, work-related stress.

Introduction

In the last decades, deep changes radically modified the organizational and productive structure of the working world.
Parallel to these changes, the psychosocial risk factors, which are those aspects of the content and the context of work that cause stress (1), assumed greater and greater importance in the workplace.
Currently, stress is defined as a non-pathologic response of adaptation of the organism against external stimuli of different nature (2).
It affects more than a fifth of European Union workers, representing the second most common work-related health problem, affecting about 22% of EU-27 workers (3).
Although stress represents a physiological process of adaptation to environmental solicitations, when these exceed the capacities of the subject to cope with them, it manifests what it is called distress. There is in fact also the opposite condition characterized by the presence of eustress when the subject experiences an effective adaptation to external stimuli.
Health workers are a working group particularly subject to work-related stress, due to the peculiarity of their job (4).
Several factors could act as stressors in the complex workplace of the health care workers:

- psychological pressure from superiors, from patients and from family;
- overload work (5-9);

- prolonged working time (6, 7);
- uncooperative and / or "difficult" patients (10, 11);
- night work (12, 13);
- perception of a risk to themselves in the workplace (14);
- limited free time to spend on after work activities (8, 15, 16);
- limited support from colleagues (17);
- to have few days off (12);
- organizational constraints (18);
- hierarchical scale (highes stress in the leader workers and in the youngest and inexperienced) (19);
- having to give bad news to patients and having to cope with their suffering (20);
- low social support (9);
- low decision making authority (21);
- little economic resources in the structure where they work (22).

In the health field, the workers directly dependent on the health structures, are more and more frequently supported, by other unpaid workers, that is volunteers, who carry out their work for non-economic reasons and who sometimes represent a significant percentage of the health staff.

The European Agency for Safety and Health at Work (23) defines the work-related stress as a condition that "occurs when the demands in the workplace exceed the employees' ability to cope with it".

In the assessment of this work-related stress, it is crucial to identify the factors that generate it and increase it in order to identify the categories of subjects at risk and to plan interventions of prevention, elimination or reduction of risk.

The necessity of assessing the risk of work-related stress arises from the fact that it can lead to the onset, in the long term, of pathogenic consequences able to affect not only the workers' health, but also the satisfaction of the patients, and the performance and the efficiency of the company (24).

The analysis of the literature data showed that for the assessment of work-related stress we can use: physiological and biological methods (catecholamines, cortisol, heart rate, blood pressure), epidemiological methods (assessing sick leave), objective and subjective stress evaluations (25-28).

Subjective stress assessment is carried out through the use of questionnaires, which search for potential sources of stress, identify the risk factors, assess the working organization, identify protective factors or factors able to reduce the degree of stress.

We use the HSE questionnaire, which allows us to investigate the subjective causes of stress in a simple and quick way, even on large and different working populations.

The purpose of this study is to assess the subjective distress by comparing 119 volunteer drivers/rescuers and 119 employee drivers/rescuers, belonging to a large Italian healthcare company.

Stress is assessed by the administration of the HSE "indicator tool", composed of 35 item.

This tool allows us to investigate and compare the different perception of stress, both in the employee group and in the group of volunteers, focusing on the seven fields identified by the questionnaire.

Materials and methods

For the assessment of the subjective stress, it was used the "questionnaire-indicating tool" validated by HSE (Health and Safety Executive) (29) consisting of 35 items. It is an easily administered questionnaire and a guarantee of anonymity, usable in all companies with more than 10 workers, compatible with the indication for the assessment of work-related stress and in compliance with the Italian regulations in force, because it provides results related to groups of workers and not to individual workers (30).

The initial sample of employee drivers/rescuers consisted of 161 subjects, of which 119 have correctly filled out the questionnaire. From an initial population of 366 volunteer drivers/rescuers, we excluded those who had not properly filled out the questionnaire and were selected 119 volunteers, paired by sex and age to the employees.

The research was carried out on a working population of 119 employee drivers/rescuers made comparable by gender and age ($p = 0.8831$) to 119 volunteer drivers/rescuers, belonging to the same big Italian healthcare company.

In the category of employee drivers/rescuers there were 88 men aged between 20 and 70 years (mean: 46.42; SD: 9.21) and 31 women aged between 30 and 65 years (mean: 47.38 ; DS: 8.89); in the category of voluntary drivers/rescuers there were 88 men aged between 20 and 70 years (mean 46, SD: 9.23) and 31 women aged between 30 and 54 years (mean: 47; DS: 8, 97).

The study was conducted in the period between November 2015 and June 2016.

A driver/rescuer is the operator who, as a result of the certificate of qualification obtained pursuant to the Italian legislation, is authorized to carry out the following activities: conducting health emergency vehicles equipped with acoustic alarm signalers and bright blue flashing lights maintenance of the safety of the occupants of such vehicles; maintenance of efficiency and safety of the rescue vehicle entrusted; collaboration in the intervention of health assistance in the various stages of its development with particular attention to safety measure.

The employee drivers/rescuers worked for 5 days a week, for a total of 36 weekly working hours, voluntary drivers/rescuers worked for about a third compared to the employees.

The questionnaire was administered during the surveillance health visits required by current legislation and it was self-compiled. The administration of the questionnaire is preceded by compiling a short survey form of socio-demographic data. The characteristics of the HSE indicator tool is in Tomei et al. 2016 (4).

The questionnaire investigates the workers' subjective

perception of stress in the last 6 months.
238 questionnaires were used for the research, all suitable for inclusion in the analysis of the data.
We evaluated, for the purpose of the study, the total results for the two categories, the performance of individual items for each of the different dimensions reviewed. Finally, the assessment was repeated by dividing the results obtained, in both men and women, to highlight any difference related to gender.

Data analysis

The data obtained from the questionnaire were analyzed using the specific HSE software, which allows the comparison with the reference population and the production of a table with a numerical value and its reference color ("color code") for each of the six fields (29). The HSE software processes automatically the data, by calculating the percentiles and allows you to compare the organizational performance in the job stress management correlated with ideal conditions/ states to gain.

For each color obtained, a symbol is chosen:

▲= green
□= blue
▼= yellow
∇ = red

Red indicates a serious situation that requires immediate corrective action, and whose values are below the 20th percentile.
Yellow indicates a clear need for corrective action, that is characterized by values below average but above the 20th percentile.
Blue color indicates the presence of a good level of performance that nevertheless requires interventions, with a score between the 50th and the 80th percentile.
Green indicates an optimal situation with satisfaction of the management standard with a score higher than the 80th percentile, and to be maintained over time.
For each working population, both genders have been analyzed, firstly together and then separately.
All workers agreed with the processing of their personal data, stating their awareness of the presence of "sensitive data"; they agreed to treat the data obtained by the protocol in an anonymous and collective way, through scientific procedures, according to the principles of the Helsinki Declaration.

Results

Total results by category

In the drivers/rescuers employees population examined, the ideal standard (green area) is achieved for the fields "Support from colleagues", "Role" and "Change". The fields "Demand", "Control" and "Relationships" are far from the standard, while "Support from managers" is near the standards (score between the 50th and the 80th percentile, blue area) (Table 1).
In the drivers/rescuers volunteers population, the ideal standard are achieved in the areas of "Support from managers", "Support from colleagues", "Role" and "Change" (score higher than the 80th percentile), the field of "Control" falls in the blue area, while the fields "Demand" and "Relationships" are critical, falling in the red area (Table 2).

Results of each item by category

Employees

In the drivers/rescuers employees, the field of the "Support from managers" achieved an overall score between the 50th and the 80th percentile (blue area). Only two of the five questions of this field, that is: "I can talk to my line manager about something that has upset or annoyed me about work " and "My line manager encourages me at work", obtained a score lower than the 20th percentile, falling in the red area.
The field "Demand" achieved a total score lower than the 20th percentile (red area). Even though this result constitutes a situation which requires immediate action, it should be noted that two of the eight items of this area, that is: "I have to work very intensively" and "I have to work very fast", got a higher score at the 80th percentile (green area).
The field of "Change" achieved an overall score above the 80th percentile (green area); in this field, the single

quali colori?

Table 1 - HSE drivers/rescuers employees.

	Employee		Men		Women	
Demand	2,38	Δ	2,40	Δ	2,32	Δ
Control	3,14	Δ	3,26	▼	2,82	Δ
Managers' Support	3,49	□	3,50	□	3,47	□
Peer Support	4,19	▲	4,25	▲	4,02	▲
Relationships	1,96	Δ	1,94	Δ	2,02	Δ
Role	4,59	▲	4,60	▲	4,56	▲
Change	3,52	▲	3,62	▲	3,22	□

Table 2 - HSE drivers/rescuers volunteers.

	Volunteers		Men		Women	
Demand	2,28	Δ	2,30	Δ	2,21	Δ
Control	3,56	□	3,62	□	3,41	▼
Managers' Support	4,01	▲	4,01	▲	3,99	▲
Peer Support	4,20	▲	4,19	▲	4,23	▲
Relationships	1,86	Δ	1,87	Δ	1,85	Δ
Role	4,38	▲	4,36	▲	4,42	▲
Change	3,91	▲	3,89	▲	3,96	▲

question "I have sufficient opportunities to question managers about change at work" got a score between the 50th and the 80th percentile, falling in the blue area.

Volunteers

In the group of volunteers drivers/rescuers, the field "Demand" had an overall score below the 20th percentile (red area). Analyzing each item belonging to this area, we can see that two of the eight questions obtained a total score above the 80th percentile (green area): the questions are "I have to work very intensively" and "I have to work very fast".

The field "Support from managers" obtained an overall score higher than the 80th percentile (green area). Even though, the question on the encouragement by the managers falls into the red area.

The field "Role" achieved an overall score higher than the 80th percentile, but the question "I understand how my work fits into the overall aim of the organization" falls into the red area.

In the field "Change", the ideal standard is achieved in all items.

Analysis of total results and of each item by gender and category

Employees

The evaluation of results was repeated to highlight any differences after division by gender.

In the sample of employees divided by gender we did not observe significant differences in the overall results in the field "Demand", "Support from managers", "Support from colleagues", "Relationships" and "Role", while there are differences in the fields "Control" (red for women, yellow for men) and "Change" (blue for women, green for men).

In the field "Control", between men and women there are differences with regard to the individual items, especially in relation to the questions: "I have a say in my own work speed" (blue area for men and red for women) and "I have a choice in deciding what I do at work" (blue area for men and red for women).

In the field "Support from the managers", we found the most significant difference in the question "I can rely on my line manager to help me out with a work problem" (blue area for women and yellow for men) and "I can talk to my line manager about something that has upset or annoyed me about work" (yellow area for women and red for men).

The field "Support from colleagues" obtained for men a great level of performance, while for women the questions "I get help and support I need from colleagues" and "My colleagues are willing to listen to my work-related problems " relapsed in blue area, achieving a score between the 50th and 80th percentile.

In the field "Relationships", both groups achieved a score, for each item and totally, below the 20th percentile; in particular, the question "I am subject to bullying at work" reveals a significantly critical situation in both genders.

In each item of the field "Role", we found a difference in the question about goals or objectives of work, with a score between the 20th and the 50th percentile in women (yellow area) and a score above the 80th percentile in men (green area).

In the field "Change", there is a significant difference between men and women has to the questions: "I have sufficient opportunities to question managers about change at work" (red area for women, blue for men) and "Staff are always consulted about change at work " (blue area for women, green for men).

Volunteers

In the volunteers drivers/rescuers population, the overall scores in the individual fields are the same for the two genders in the field "Demand" (red area), "Support from managers" (green area), "Support from colleagues" (green area), "Relationships" (area red), "Role" (green area) and "Change" (green area), while they are different in the field "Control" (blue for men and yellow for women).

In the field "Demand", the results of individual items do not show any difference between the genders.

As to the field "Control", we found significant differences between men and women in the questions: "I have a say in my own work speed" (green area for men and red area for women) and "I have some say over the way I work" (blue area for men and red for women).

In the field "Support from managers", there is no differ-

ence in the overall results and in the results for the individual items (green area for both).
In the field "Support from colleagues", the scores for each item in males and females are the same (all in the green area).
In the overall scores and in the individual item of the field "Relationships", there is no difference, but the question "I am subject to bullying at work" results in both genders a significantly critical situation.
The field "Change" showed no difference in the individual items between the two groups (green area for all items).

Discussion

Drivers/rescuers are a category of workers at high-risk group for the development of work-related stress (4, 5, 12, 13).
Many factors related to the context and the kind of the work, influence the development and perpetuation of a stress condition.
Our research shows that, in the field "Demand", the two groups have a similar overall score, falling into the red area. We may consider that this result is linked to the heavy workload and the kind of tasks often not suited to their abilities, which could be a cause of dissatisfaction and, sometimes, lead to interruption of the working activity (5, 6, 12, 14, 31, 32). Even though this situation can lead to take targeted strategies, the workers of both groups achieve a score higher than the 80th percentile in two of the eight items of this area, as it emerges in our results denoting they are not subject to intense and very fast work.
Although volunteers work fewer hours compared to employees, they are still subject to work-related stress because of the workload concentrated in time, because of the increased frequency of night shifts and the less organized work compared to the employee workers.
In the field "Control" the results falls in the red area for employees and in the blue area for volunteers.
Actually, an important factor for the onset of occupational stress is the lack of decision-making autonomy and the lack of autonomy on how to approach users because of the peculiar pyramidal structure of subordinate employment. Though follow in the provisions imposed by managers, volunteers have more autonomy (11, 21, 22, 32).
A study conducted by Argentero et al. showed that health care employee operators suffer psychological pressure regarding decision-making processes more than volunteers, showing less involvement and more frequent burnout syndrome (32).
The group of employee drivers/rescuers obtained a score between the 50th and the 80th percentile (blue area) in the field "Support from managers"; by analyzing the individual items, the results suggest that the lack of encouragement from the boss is a significant source of stress for both groups (red area), while the opportunity to talk to the boss, in the event that labor issues occur appears to be a cause of occupational stress only for employees. The scientific literature documents that some of the main factors causing work-related stress are the lack of support from the managers, the psychological pressure of managers and the duty to submit to a hierarchy (5, 19). In addition, the lack of encouragement and support from colleagues are a significant source of stress too (33); while, the measures for the management and the communication and collaboration between colleagues, are preventive strategies to reduce the occurrence of physical and emotional tension at work (34).
Our results show that, in the field "Support from colleagues", the ideal situation is reported; satisfaction of standard management (overall score above the 80th percentile), both for volunteers and employees; we obtained this result for males and females of both groups and for each item of the area. This result encourages to maintain a work environment characterized by collaboration and dialogue (5, 34).
The field "Relationships" obtained in both groups a score below the 20th percentile; in particular, the question "I am subject to bullying at work" reveals in both groups a significantly critical situation, in fact 97.5% of the workers interviewed, answered "sometimes", "often" or "always", as literary studies reported (5).
Our study showed that both groups scored above the 80th percentile in the field "Role" and "Change". This situation must be maintained over time, as it is clear that a poor understanding of the individual role and responsibilities as well as the lack of involvement in decision-making in a case of organizational changes, represent a source of internal conflict at work (18, 21).
In the field "Role" volunteers workers showed same difficulties because our results show that, despite the good overall level, the item on the understanding of the general aims of the organization, fell in red area.
Job satisfaction and promotion of personal and social resources are strategies that can be implemented in order to reduce stress (35, 36).
As regards the distinction between the two genders, our study shows that the drivers/rescuers female employees and volunteers got less positive results than men in the fields "Control" and "Change". While in the other areas, female performed the overall scores were similar. In the field of "Control" the items that underlined major differences between men and women were: "I have a say in my own work speed" (blue area for men and red for women) and "I have a choice in deciding what I do at work" (blue area for men and red for women); these results seem to be related to little disposition to organizational change and decision-making autonomy of women, because of their dual role, at work and at home and even the presence of too many men in leadership roles (37-42). In the group of volunteers, men got a worse performance on the question "My working time can be flexible" (blue area for men and green for women), because they are less prone to vary their working hours in relation to family needs.
In the field "Support from managers" the questions "I

can rely on my line manager to help me out with a work problem" turned out in the blue area for women and in the yellow area for men and the question "I can talk to my line manager about something that has upset or annoyed me about work" in the yellow area for women and in the red area for men. The literature shows that men suffer mostly of the company hierarchical structure and, consequently, rarely turn to their superiors for issues concerning the work activities (19).

In the field "Role", a difference appared in the question about the goals or aims of the work department, with a score between the 20th and the 50th percentile in women (yellow area), and a score above the 80th percentile in men (green area) (36).

Among the volunteers, the two genders achieved similar overall scores matched, except in "Control" where women achieved an overall score between the 20th and 50th percentile, while men got a score between the 50th and the 80th percentile, documenting that women have a lack of autonomy on how to carry out their work.

The results obtained showed that despite they work less than the employees, the volunteers are also subjected to work-related stress. This result suggests that additional future efforts should be focused on finding correlations between the kind of work and the conditions in which this work is to be carried out also considering additional variables (blood pressure, b.m.i., alcohol intake and cigarette smoking) in this category of workers, because the analysis of the literature shows that few studies have focused on the assessment of stress in volunteer health workers. Furthermore, this study aims to help the Occupational physicians to assess the stress in job categories not yet been sufficiently investigated as those of volunteers.

References

1. Hacker W. Objective work environment: analysis and evaluation of objective work characteristics. Paper presented to "A Healthier Work Environment": Basic Concepts & Methods of Measurement. Hogberg, Lidingo, Stockholm. 1991.
2. Selye H. The stress of life. McGraw-Hill Book Co, New York. 1956.
3. European Agency for Safety and Health at Work. 2009. OSH in figures: stress at work — facts and figures. Luxembourg: Office for Official Publications of the European Communities. Available at: https://osha.europa.eu/en/tools-and-publications/publications/reports/TE-81-08-478-EN-C_OSH_in_figures_stress_at_work
4. Tomei G, Ricci S, Fidanza L, et al. Work-related stress in healthcare workers. Ann Ig. 2016;28:36-49.
5. Averlid G, Axelsson SB. Health-promoting collaboration in anesthesia nursing: a qualitative study of nurse anesthetists in Norway. AANA J. 2012;80:S74-S80.
6. Rutledge T, Stucky E, Dollarhide A, et al. A real-time assessment of work stress in physicians and nurses. Health Psychol. 2009;28:194-200.
7. Suresh P, Matthews A, Coyne I. Stress and stressors in the clinical environment: a comparative study of fourth-year student nurses and newly qualified general nurses in Ireland. J Clin Nurs. 2013;22:770-779.
8. Flowerdew L, Brown R, Russ S, et al. Teams under pressure in the emergency department: an interview study. Emerg Med J. 2012;29:e2.
9. Malinauskiene V, Leisyte P, Romualdas M, et al. Associations between self-rated health and psychosocial conditions, lifestyle factors and health resources among hospital nurses in Lithuania. J Ad Nurs. 2011;67:2383-2393.
10. Boran A, Shawaheen M, Khader Y, et al. Work-related stress among health professionals in northern Jordan. Occup Med (Lond). 2012;62:145-147.
11. De Andrés-García S, Sariñana-González P, Romero-Martínez A, et al. Cortisol response to stress in caregivers of offspring with autism spectrum disorder is associated with care recipient characteristics. Stress. 2013;16:510-519.
12. Győrffy Z, Adám S. Somatic and mental morbidity of young female physicians. Does emotional exhaustion constitute the missing link? Orv Hetil. 2013;6:20-27.
13. Wong IS, Ostry AS, Demers PA, et al. Job strain and shift work influences on biomarkers and subclinical heart disease indicators: a pilot study. J Occup Environ Hyg. 2012; 9:467-477.
14. Golubic R, Milosevic M, Knezevic B, et al. Work-related stress, education and work ability among hospital nurses. J Adv Nurs. 2009;65:2056-2066.
15. McClelland LE, Switzer FS 3rd, Pilcher JJ. Changes in nurses' decision making during a 12-h day shift. Occup Med (Lond). 2013;63:60-65.
16. Tomei G, Di Marzio A, Sacco C, et al. Stress in atlete. Prevent Res .2015;4:75-79.
17. Altounji D, Morgan H, Grover M, et al. A self-care retreat for pediatric hematology oncology nurses. J Pediatr Oncol Nurs. 2013;30:18-23.
18. Kath LM, Stichler JF, Ehrhart MG, et al. Predictors and outcomes of Nurse Leader job stress experienced by AWHONN members. J Obstet Gynecol Neonatal Nurs. 2013;42:E12-E25.
19. Hayasaka Y, Nakamura K, Yamamoto M, et al. Work environment and mental health status assessed by the general health questionnaire in female Japanese doctors. Ind Health. 2007;45:781-786.
20. Sehlen S, Vordermark D, Schäfer C, et al. Job stress and job satisfaction of physicians, radiographers, nurses and physicists working in radiotherapy: a multicenter analysis by the DEGRO Quality of Life Work Group. Radiat Oncol. 2009;6:6.
21. Adriaenssens J, De Gucht V, Van Der Doef M, et al. Exploring the burden of emergency care: predictors of stress-health outcomes in emergency nurses. J Adv Nurs. 2011; 67: 317-1328.
22. Zaghloul AA, Abou El Enein NY. Nurse stress at two different organizational settings in Alexandria. J Multidiscip Healthc. 2009;15:45-51.
23. European Agency for Safety and Health at Work. 2000. Research on Work-related Stress. Luxembourg: Office for Official Publications of the European Communities. Available at: https://osha.europa.eu/en/tools-and-publications/publications/reports/203
24. Li L, Hu H, Zhou H, et al. Work stress, work motivation and their effects on job satisfaction in community health workers: a cross-sectional survey in China. BMJ Open. 2014; 4:e004897.
25. Massoni F, Simeone C, Ricci P, et al. Papillary thyroid carcinoma and medicolegal considerations. Minerva Med. 2013;104:493-494.
26. Tomei F, Di Marzio A, Suppi A, et al. Work-related stress and cardiovascular effects. Prevent Res. 2016;5:61-65.

27. Massoni F, Ricci P, Simeone C, Ricci S. Cardiac death in aortic valve sclerosis and coronary artery disease. An autopsy report. Acta Medica Mediterr. 2014;30:77-80.
28. Ricci S, Massoni F, Di Meo M, et al. Correlation among measures of stress, indicators of biohumoral nature and medico-legal considerations. Riv Psichiatr. 2013;48:113-120.
29. HSE. 2007. HSE Analysis Tool for Work Related Stress. Available at: www.hse.gov.uk/stress/standards/pdfs/analysistool.xls
30. Iavicoli S, Natali E, Rondinone BM, et al. Contestualizzazione e validazione in Italia del modello Management Standards HSE quale contributo all'individuazione delle indicazioni per la valutazione dello stress lavoro correlato. G Ital Med Lav Erg. 2010;32:130-133.
31. Feeney S, O'Brien K, O'Keeffe N, et al. Practise what you preach: health behaviours and stress among non-consultant hospital doctors. Clin Med (Lond). 2016;16:12-18.
32. Argentero P, Bonfiglio NS, Pasero R. Burnout in volunteer health workers. G Ital Med Lav Ergon. 2006;28:77-82.
33. Shin SY, Lee SG. Effects of Hospital Workers' Friendship Networks on Job Stress. PLoS One. 2016;11:e0149428.
34. St Ledger U, Begley A, Reid J, et al. Moral distress in end-of-life care in the intensive care unit. J Adv Nurs. 2013;69:1869-1880.
35. Nam SJ, Chun HJ, Moon JS, et al. Job Stress and Job Satisfaction among Health-Care Workers of Endoscopy Units in Korea. Clin Endosc. 2016;49:266-272.
36. Golbasi Z, Kelleci M, Dogan S. Relationships between coping strategies, individual characteristics and job satisfaction in a sample of hospital nurses: cross-sectional questionnaire survey. Int J Nurs Stud. 2008;45:1800-1806.
37. Andolhe R, Barbosa RL, Oliveira EM, et al. Stress, coping and burnout among Intensive Care Unit nursing staff: associated factors. Rev Esc Enferm USP. 2015;49:58-64.
38. Kan D, Yu X. Occupational Stress, Work-Family Conflict and Depressive Symptoms among Chinese Bank Employees: The Role of Psychological Capital. Int J Environ Res Public Health. 2016;13:E134.
39. Tomei G, Sancini A, Capozzella A, et al. Perceived stress and stress-related parameters. Ann Ig. 2012;24:517-526.
40. Tomei G, Ciarrocca M, Scimitto L, et al. Mental health and women's work: Is balance possible? Minerva Psichiatrica. 2012;53:79-89.
41. Sancini A, Tomei F, Schifano MP, et al. Stress characteristics in different work conditions: Is it possible to identify specificity of risk factors by the questionnaire method? Eur J Inflamm. 2010;8:117-123.
42. Tomei G, Rosati MV, Ciarrocca M, et al. Anxiety, musculoskeletal and visual disorders in video display terminal workers. Minerva Med. 2006;97:459-466.