Spontaneous Hemothorax During Pregnancy: A Comprehensive Review of the Literature

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Abstract

Spontaneous hemothorax is a rare, but life-threatening emergency. It is an uncommon cause of respiratory distress during pregnancy and postpartum. Hemothorax is defined as pleural fluid with a hematocrit greater than 50% of the peripheral hematocrit. In pregnancy, the diagnosis is most often confused with pulmonary thromboembolism. Pregnancy causes significant changes on the cardiopulmonary system that may complicate or delay diagnosis and treatment. Delayed diagnosis and treatment increases the risk of mortality. There are many causes of spontaneous hemothorax but pneumothorax is the most common cause. Diagnosis and treatment is discussed. A review of the literature of causes, presentations, diagnosis, and treatment of hemothorax is presented along with a comprehensive outline of etiologies. Spontaneous hemothorax is a rare, life-threatening emergency that does occur during pregnancy. Recommendations for women pregnant or considering pregnancy and have risk factors for hemothorax are discussed.

INTRODUCTION

Spontaneous hemothorax is a rare, but life-threatening emergency (1, 2). A hemothorax is pleural fluid with a hematocrit >50% of the peripheral hematocrit (3). A spontaneous hemothorax is an uncommon cause of respiratory distress during pregnancy and postpartum and often occurs without evidence of external trauma (4, 5). It is most often confused with a pulmonary thromboembolism in which case the patient is started on anticoagulants (4). Once a diagnosis of a hemothorax is established, anticoagulation must be reversed before treatment of the hemothorax can begin (4). Hemothorax was first reported at autopsy by Laennec in 1828 (6). Delayed diagnosis and treatment increases the mortality (7). Almost always a chest thoracostomy is used to evacuate blood and clots in the chest cavity (8). Transfusion of blood products is often necessary. In any pregnant or postpartum patient with a hemothorax, choriocarcinoma should be excluded as an etiology (9).

DIAGNOSIS AND TREATMENT

A patient with a hemothorax may be asymptomatic or present with chest pain, dyspnea, shortness of breath, hemoptysis, epistaxis, ripping or tearing substernal chest pain (4). Findings on examination include cyanosis, decreased or no breath sounds on auscultation of the chest of the affected side, dullness to percussion, pulmonary bruit, and mediastinal shift (4). The definitive diagnosis is made with a contrast-enhanced computed tomography and pulmonary angiography (4). A comprehensive review of etiologies is found in Table 1. Usually, tube thoracostomy with evacuation of blood and clots is necessary, followed by thoracoscopy or thoracotomy (10).Transfusion of blood products may be necessary. Treatment of a significant hemothorax is usually an emergency procedure since a hemothorax can be life-threatening (1, 2). Video-Assisted Thorascoscopic Surgery (VATS) has become the standard of care for treatment (4, 10). Specific treatment depends on the etiology (6).

Resection of exostosis, endometriosis, ectopic pregnancy, bullae, arteriovenous malformations and lung or pleural tissue may be necessary (4, 6, 11). Embolization or embolotherapy with spring coils has been successful in the past, including during pregnancy (12). Aortic and blood vessel repair may necessitate vascular grafts (13). Trophoblastic invasion may be treated with chemotherapy (14). Treatment of an aortic rupture may require delivery if the fetus is viable. For pregnancies greater than 30 weeks gestational age, cesarean section followed by cardiac surgical repair of an aortic rupture has been recommended (13). Untreated or

insufficiently treated hemothorax puts the patient at risk for infection, chronic fibrothorax from scarring, lung entrapment, and impaired pulmonary function (6).

ETIOLOGIES OF SPONTANEOUS HEMOTHORAX

A comprehensive list of etiologies of spontaneous hemothorax is found in Table 1 (1-76).

SPONTANEOUS HEMOPNEUMOTHORAX

Pneumothorax

Pneumothorax is the most common cause of hemothorax (1, 2, 3, 6, 7, 15-22). First reported at autopsy by Laennec in 1828 (6), a spontaneous hemopneumothorax has been defined as > 400 milliliters of blood in the pleural space in conjunction with a pneumothorax (6). A hemothorax is pleural fluid with a hematocrit greater than 50% of the peripheral hematocrit (3). Surgical pneumoperitoneum for laparoscopy can also cause a pneumothorax (15). Bleeding from a torn pleural adhesion, rupture of a vascularized bullae or a torn aberrant vessel between the pleura and bullae have all been reported as possible mechanisms for bleeding (6, 17). Chest tube placement with evacuation of blood and clots followed by video-assisted thoracoscopic surgery and excision or repair of the etiology of bleeding is the current treatment for hemopneumothorax (21).

VASCULAR

Vascular abnormalities account for the majority of spontaneous hemothoraces (6). They include pulmonary arteriovenous malformations (PAVM) (4, 6), Hereditary Hemorrhagic Telangiectasia (HHT) or Osler-Weber-Rendu Syndrome (OWR) (4, 23), dissection and/or rupture of arterial aneurysms (3, 24), Type IV Ehlers-Danlos Syndrome (6), and neurofibromatosis (NFM) or von Recklinghausen's Disease (VRD) (3, 6, 25).

Pulmonary Arteriovenous Malformations (PAVM)

Pulmonary Arteriovenous Malformations (PAVM) can be congenital or acquired (6, 11, 12, 23, 26-30). PAVMs account for a large portion of spontaneous hemothoraces (6). PAVMs are small, thin-walled, subpleural direct communications between arteries and veins without intervening pulmonary capillaries and lung tissue (4) They rupture spontaneously and bleed into the pleural space causing a hemothorax (4, 23, 28, 29). Eighty percent of these are congenital (4, 26). Almost 50% are associated with bleeding during pregnancy (6). More than 50% of cases of PAVM are associated with Osler-Weber-Rendu Syndrome (12). Acquired PAVMs are associated with trauma, schistosomiasis, hepatic cirrhosis and carcinoma (12). PAVMs are often not visualized at surgery due to their small size (31). They may even be missed at autopsy and histopathology. PAVMs have been treated with spring embolotherapy (26), excision of the AVMs (26), lobectomy (26), wedge resection (32) and video-assisted thoracoscopic surgery (VATS) (32).

Hereditary Hemorrhagic Telangiectasia (Osler-Weber-Rendu Syndrome)

Hereditary Hemorrhagic Telangiectasia (HHT) or Osler-Weber-Rendu Syndrome (OWR) is a rare, autosomal dominant, inherited disease characterized by epistaxis and multiple thin-walled arteriovenous malformations involving the skin and mucous membranes that rupture spontaneously (4, 6, 11, 12, 23, 26, 30). HHT was previously known as Hereditary Epistaxis (23). The incidence is 1 in 100,000 (30). Most congenital pulmonary arteriovenous malformations are associated with hereditary hemorrhagic telangiectasia (50%) (11, 12, 29, 33). Pregnancy causes an increase in size of AVMs and hypoxia by shunting or rupture (11). PAVMs grow over time due to the increased blood flow in pregnancy (26). Fifteen percent of HHT patients have PAVMs (34). Pregnancy is implicated as a cause of rupture of AVMs (23). PAVMs have been treated with spring embolotherapy (26).

Rupture of Aneurysms

Pregnancy accounts for 50% of ruptured arterial aneurysms in women under the age of 40 (35, 36). Rupture of any arterial aneurysm can be catastrophic and life-threatening. Rupture of thoracic aneurysms into the pleural cavity usually causes a hemothorax (3, 6, 25, 34, 37, 38). Rupture is thought to be due to hemodynamic and endocrine changes during pregnancy including hypertension (38). Causes of rupture include chronic aortitis (39, 40), Marfan's Syndrome, Ehlers-Danlos Syndrome, a bicuspid aortic valve, familial forms of aortic dissection, annuloaortic ectasia and pregnancy (25, 36, 39, 41). The risk of dissection increases with gestational age accounting for most ruptures in the third trimester (51%) and peripartum (20%) (36, 37). Aortic dissection is associated with cystic medial necrosis of aorta (36, 37). Patients with Marfan's Syndrome and aortic root diameter greater than four centimeters should be counseled about high risk of dissection (36). The mortality risk with aortic root diameter greater than four centimeters is 25-50% (13).

Hemothorax has been reported following rupture of an internal thoracic artery aneurysm after a vaginal delivery (8, 42), rupture of splenic artery aneurysm with erosion of the diaphragm into the pleural cavity (29, 43) and rupture of an internal mammary artery aneurysm (6, 44). Rupture of the left subclavian artery dissection with hemothorax has been reported in a patient with von Recklinghausen's Disease (45). Hemothorax from rupture of an intercostal vein (46, 47) and rupture of a venous aneurysm in a patient with Neurofibromatosis has been reported (48). Developmental anomalies such as hypoplasia and coarctation of the aorta contribute to dissection of an aneurysm (38). Dissection less than 30 weeks gestation requires immediate repair and dissection greater than 30 weeks requires cesarean delivery followed by cardiovascular repair (36). Sometimes, aortic replacement with a graft is necessary (37).

Type IV Ehlers-Danlos Syndrome

Type IV Ehlers-Danlos Syndrome (EDS) is a rare inherited connective disorder with five distinct varieties characterized by hypermobility, skin hyperextensibility and bruising (49). Some varieties are at risk of vascular accidents (49). It is usually autosomal dominant and one variety is X-linked (49). EDS has been associated with rupture of an internal mammary artery aneurysm leading to a hemothorax (6). Deficient or defective type III collagen leading to hemothorax is typical of EDS (6). Rupture of arteries can be catastrophic (44).

Neurofibromatosis (von Recklinghausen's Disease)

Neurofibromatosis (NFM) or von Recklinghausen's Disease (VRD) is a hereditary, autosomal dominant disorder with an incidence of 1 in 3,000 births (24). NFM occurs from a mutation in a gene on the arm of chromosome 17 (17q11.2) (45). Neurofibromatosis can cause a hemothorax by eroding blood vessels (3, 6, 24, 42, 48) or direct rupture of a schwannoma (6). Pregnancy exacerbates neurofibromatosis (24). Hormonal changes alter the connective tissue of the friable vasculature and increases the risk of rupture (6, 24). VRD is often treated with exploratory laparotomy and thorascopy/thoracotomy with ligation of vessels (24). Graft replacement of vessels is often necessary (45).

HEMATOLOGIC ABNORMALITIES

Hematologic abnormalities can be congenital or acquired (6). Treatment is aimed at correction of the coagulopathy (6).

Congenital Coagulopathies

Congenital coagulathopathies are inherited blood dyscrasias such as hemophilia and Glanzmann's Thrombasthenia (6, 50). These are disorders of blood coagulation and abnormalities of platelets or vessels (3). They are congenital hemorrhagic disorders that may cause a hemothorax (6). Hemophilia is an X-linked disorder bleeding disorder characterized by deficient Factor VIII levels (51). Glanzmann's Thrombasthenia is an autosomal recessive disorder resulting a bleeding tendency due to variation in platelets (30).

Acquired Coagulopathies

Acquired coagulopathies include anticoagulation for venous thrombosis (6, 52). Hemothorax rarely occurs with anticoagulation therapy but when it does, it occurs in the setting of treatment for pulmonary thromboembolism for which hemothorax is often confused (3, 4, 6, 53). The infarcted lung with anticoagulation ruptures into the pleural cavity (54, 55).

Extramedullary Hematopoiesis

Extramedullary hematopoiesis is the formation of blood cells outside of the bone marrow (56). It is a rare hematologic cause of hemothorax (6). Pleural hematopoiesis has been reported to cause a massive hemothorax (56). The hemothorax was treated with thoracostomy and sclerosis with tetracycline initially followed by irradiation since hematopoietic tissue is the very radiosensitive (56). A similar case of hemothorax due to intrathoracic extramedullary hematopoiesis has also been reported (57).

Recombinant Tissue-like Plasminogen Activator (rt-PA)

Recombinant tissue-type plasminogen activator (rt-PA) has been used in children to treat vascular thromboembolism. Bleeding complications with development of hemothorax may occur with the use of rt-PA (6, 52). In this case, thrombolytic therapy was used to treat an extended thrombosis of major vessels (52).

NEOPLASIA

Malignant Tumors

Thoracic malignancies, both primary and secondary, have been associated with the development of hemothoraces (15, 58). These include mesotheliomas (3), adenocarcinoma (3), Ewing's Sarcoma (3), myelocytic leukemia (3), sarcomas (6), angiosarcomas (6), hepatocellular carcinoma (6), synovial sarcoma (59), choriocarcinoma (18), schwanommas (24, 3, 6), carcinoma of the lung (6), germ cell tumors (6), primitive neuroectodermal tumors (6), hemangiopericytoma (60), costochondromas (45, 58), Malignant Gestational Trophoblastic Disease (31), and hepatocellular carcinoma (6). These may involve the lung or the pleura (3). Most malignancies are treated with surgical excision (37). Pulmonary metastatic choriocarcinoma has been treated with methotrexate, actinomycin-D and cyclophosphamide (9, 26).

Benign Tumors and Growths

Benign metastatic gestational trophoblastic disease and pleural adhesions with anticoagulation have caused hemothorax (3, 6, 61). Hemothorax can be caused by pleural involvement of benign gestational trophoblastic disease with anticoagulation (61, 43). Hemothorax due to benign thymoma has been reported along with thymic growths and cysts (6, 62). Venous hemangiomas have also been reported with hemothorax (18). Treatment of most of these is surgical.

COMPLICATIONS OF PREGNANCY

Ectopic Pregnancy

A primary diaphragmatic ectopic pregnancy has been reported to cause a hemothorax by trophoblastic implantation and erosion of the diaphragm leading to bleeding into the thoracic cavity (14). An ovarian ectopic pregnancy has been reported to present with hemothorax (63, 64). Treatment is usually laparoscopic or laparotomy (63, 64. Ectopic pregnancy of the diaphragm has been treated medically with Actinomycin D following thoracoscopic excision (14).

Gestational Trophoblastic Disease

Gestational trophoblastic disease metastatic to both the lung and pleura in patients who are already anticoagulated can cause a hemothorax (43, 61). The lungs and pleura are common sites of metastasis (65, 66).

Metastatic pulmonary chroriocarcinoma following delivery has been reported to cause a spontaneous hemothorax and massive bilateral hemothoraces complicating a carcinomatous pleural effusion (65).

Peripartal Hemoperitoneum

Spontaneous rupture of the uterine vessels during pregnancy has been reported to cause both a hemoperitoneum and a hemothorax due to the sudden increase in venous pressure (67).

Rupture of Subcapsular Hematoma

Postpartum rupture of a subcapsular hematoma of the liver from pregnancy-induced hypertension can cause a hemoperitoneum and subsequent hemothorax, which can be fatal (68).

THORACIC DISEASES

Rupture of Pleural Adhesions

Rupture of pleural adhesions (15), bleeding from a torn pleural adhesion, rupture of a vascularized bullae and torn aberrant vessel between the pleura and bullae have all been reported as possible mechanisms for bleeding from the pleura. (6).

Pulmonary Infarction from Thromboembolism

Pulmonary infarction from thromboembolism on anticoagulation may cause a hemothorax when the infarct ruptures into the pleural cavity (6, 15, 46, 54, 55, 69, 70, 71). A second mechanism occurs late when there is spontaneous bleeding from the pleural surface (54). Rupture of a pulmonary infarction may also occur spontaneously (55). Rupture may be due to overzealous anticoagulation or disseminated intravascular coagulation (55).

Pulmonary Infections

Pulmonary tuberculosis typically can cause bloody pleural effusions and rarely hemothoraces (15, 32, 33, 46). Necrotizing lung infection and varicella can also cause a hemothorax (3, 69).

Costal Exostosis

Costal Exostosis tears pleura and diaphragm leading to pneumothorax and hemothorax (3, 6, 72). New growths form on the contour of the outer bone (72). They may occur as part of Hereditary Multiple Exostosis (72). Sharp margins of bony growths tear pleura and diaphragm (72). These are managed by excision.

Pulmonary Sequestration

Pulmonary sequestration is a congenital disorder in which a segment of dysplastic nonfunctioning lung tissue is separate from normal lung and is supplied by abnormal systemic circulation from the aorta (73). These have the possibility of bleeding. Pulmonary infarction of a sequestered segment of lung has been reported to cause a hemothorax (71). These are usually treated by thoracoscopy or thoracotomy, segmental resection and ligation of the vascular supply (71).

COMPLICATIONS INVOLVING THE DIAPHRAGM

Fenestrations

Diaphragmatic fenestrations are tiny communications between the peritoneum and thorax through which blood and air can flow under a pressure gradient (15, 63). They are commonly associated with peritoneal dialysis but may occur during pregnancy (15). Pregnancy increases intra-abdominal pressure resulting in fenestration of the diaphragm which are openings covered with pleura or peritoneum (15). More occur on the right side of the diaphragm than on the left (67). Blood can move through fenestrations from the abdominal to thoracic cavity after abdominal surgery or diagnostic laparoscopy leading to pneumothorax or hemothorax (15). Diaphragmatic fenestrations are common in patients receiving peritoneal dialysis (15). Closed drainage and thoracoscopy have been used to treat fenestrations (74).

Endometriosis

Diaphragmatic implantation of endometriosis, leads to central necrosis and a defect in the diaphragm creating a hemothorax or catamenial hemothorax (6, 15, 63). Endometriosis is transported to the lungs by diaphragmatic fenestrations and micro-embolization through pelvic veins (63, 75). Thoracic endometriosis is treated with a chest tube, pleural biopsy, video-assisted thoracic surgery (VATS) and pleurodesis (63). Most patients receive suppression of menses with oral contraceptives, medroxyprogesterone acetate or leuprolide followed by total abdominal hysterectomy with bilateral salpingo-oophorectomy (63).

Implantation of Primary Ectopic Pregnancy

Primary ectopic pregnancies involving the diaphragm are described above (14). Trophoblasts invade the diaphragm creating a defect or fenestration with bleeding into the thorax (14).

THERAPEUTIC COMPLICATIONS

Iatrogenic interventions are known to inadvertently cause a hemothorax as a complication of the procedure (76). These include central line placement (3, 6), translumbar aortography (3), pleural biopsy (6), thoracentesis (6), and gastrointestinal surgery (6). A diagnostic laparoscopy with a pneumoperitoneum can lead to a tension pneumothorax and possible hemoperitoneum and hemothorax (15).

IDIOPATHIC SPONTANEOUS HEMOTHORAX

Idiopathic spontaneous hemothorax is a diagnosis of exclusion when every known cause has been investigated. It is rare not to find one of the causes discussed in this paper (3, 6, 31, 69). The first report was in 1982 in a patient following heavy lifting with an increase in abdominal pressure (31, 69). Only 3 or 4 cases are present in the literature by 2010 (6). The diagnosis is often missed at autopsy or surgical pathology.

DISCUSSION

PHYSIOLOGIC CHANGES OF PREGNANCY

The cardiovascular system undergoes major changes and stresses during pregnancy (4, 7, 8, 11, 13, 15, 23, 25, 26, 27, 34, 36, 41, 67). Cardiovascular disease may be exacerbated pregnancy as pregnancy causes hemodynamic stress on the cardiovascular system which can be threatening to the pregnancy (13). Pregnancy accounts for 50% of ruptured arterial aneurysms in women under the age of 40 (34). With advancing gestational age, there is a greater tendency for aneurysmal rupture due to hemodynamic, hormonal and other physiologic changes of pregnancy (8). Advancing pregnancy causes increasing demands on cardiovascular system accounting for most cardiovascular changes occurring late in pregnancy (13). AVMs regress after pregnancy (27). The maternal cardiovascular changes during pregnancy include increases in blood volume, heart rate, stroke volume, cardiac output, left ventricular wall mass, blood pressure, venous pressure, and end diastolic dimensions (8, 15, 25, 67). Increased growth of AVMs during pregnancy is due to increased cardiac output and hormonal changes (26). Physiological changes increase pulmonary blood flow and cause dilatation and rupture of PAVMs (32).

Hormonal changes lead to histologic changes in the aorta (25, 36). Estrogens during pregnancy cause spider telangiectasia (27). Elevated steroids during pregnancy cause rupture of AVMs by increasing vascular fragility (4, 27). High levels of estrogen and progesterone during pregnancy are associated with venous distensibility (15, 32). Progesterone dilates small arteries and reduces vascular resistance (4). There are histopathological changes associated with pregnancy include biochemical composition and morphological structure of arterial wall (41). Histologic changes in wall of aorta in patients with bicuspid aortic valve syndrome increases risk of rupture during pregnancy (36).

Pregnancy causes increase in size of AVMs by increasing the cardiac output and hypoxia by shunting or rupture (4, 11). Pregnancy has been implicated as a cause of rupture of AVMs and may even be associated with the development of aneurysms (8, 23, 27). PAVM grow over time due to increased blood flow (26). Pregnancy increases risk of hemorrhage (32). Rupture is thought to be due to hemodynamic and endocrine changes during pregnancy (25). The maternal cardiovascular changes during pregnancy include increases in blood volume, heart rate, stroke volume, cardiac output, left ventricular wall mass, and end diastolic dimensions (25).

TREATMENT CONSIDERATIONS

The diagnosis of hemothorax during pregnancy is difficult because it is rare, especially without evidence of external trauma. Without evidence of fetal distress and especially remote from term, diagnosis and management should be centered around the maternal pulmonary and hemodynamic status. Some of treatment methodologies described above have been utilized during pregnancy. Treatment of a massive hemothorax with substantial mediastinal shift, requires emergency treatment regardless of management of the pregnancy. If fetal compromise occurs during conservative treatment, delivery may be needed to be performed.

Reproductive age women with the diagnosis of PAVM should be addressed and evaluated before attempting pregnancy (32). Treatment of reproductive age women may prevent life-threatening maternal and fetal complications (11). Women with hereditary hemorrhagic telangiectasia (HHT) considering pregnancy should have a workup to exclude PAVM; however, their presence is often unrecognized (26). In any pregnant or postpartum woman with a hemothorax, metastatic choriocarcinoma should be considered as an etiology (9). Women with neurofibromatosis in pregnancy are high risk because lesions are hard to diagnose (24). Women who have cardiovascular disease should be evaluating before conceiving (13). Prognosis depends on the cardiac lesion (13).

SUMMARY

Spontaneous hemothorax is a life-threatening emergency that occurs during pregnancy, however rare. It is commonly misdiagnosed as a pulmonary thromboembolus which is much more common. A review of the literature reviewing the causes, presentations, diagnosis, and treatment of hemothorax is presented. Physiologic changes of pregnancy influencing the cardiovascular system are outlined. Recommendations for women pregnant or considering pregnancy are discussed.

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Table 1: Comprehensive List of Etiologies of Spontaneous Hemothorax

COMPREHENSIVE LIST OF ETIOLOGIES OF SPONTANEOUS HEMOTHORAX

I. **Hemopneumothorax** (4, 15, 3, 6, 16, 17, 18, 19, 20, 21, 1, 2, 22, 7, 63, 64)

II. **Vascular** (4, 25, 24, 3, 6, 23)

A. Pulmonary Arteriovenous Malformation (32, 11, 26, 27, 6, 23, 12, 28, 29, 30)

1. Congenital (4, 32, 11, 26, 27, 6, 23, 12, 28, 29, 30)

2. Acquired (12, 31)

B. Hereditary Hemorrhagic Telangiectasia (Osler-Weber-Rendu Syndrome) (4, 11, 33, 26, 23, 12, 29, 30)

C. Dissection or Rupture of Aneurysms (25, 36, 13, 37, 38, 34, 35)

1. Aorta (25, 36, 13, 37, 27, 38, 34, 35, 39, 40)

2. Pulmonary Artery (34)

3. Splenic Artery (34, 43, 29)

4. Internal Thoracic Artery (8, 42)

5. Internal Mammary Artery (6, 44)

6. Subclavian Artery (45)

7. Ovarian Artery (34)

8. Uterine Artery (34)

9. Intercostal Vein (46, 47)

10. Venous Aneurysms (48)

D. Ehlers-Danlos Syndrome Type IV (6, 44, 49)

E. Neurofibromatosis (von Recklinghausen's Disease) (24, 3, 6, 42, 45)

III. **Hematologic Abnormalities** (4, 3, 6, 54, 53, 55, 52)

A. Congenital Hemorrhagic Disorders (8, 3, 6, 50)

B. Acquired Coagulation (4, 3, 6, 54, 55, 52)

C. Extramedulary Hematopoiesis (6, 56, 57)

D. Recombinant Plasminogen Activator (rt-PA) (67, 45, 6)

IV. **Neoplasia** (15, 24, 65, 3, 6, 59, 60, 72, 58)

A. Malignant Tumors

1. Mesothelioma (3)

2. Adenocarcinoma (3)

3. Ewing's Sarcoma (3)

4. Myelocytic Leukemia (3)

5. Sarcomas (6)

6. Angiosarcoma (6)

7. Hepatocellular Carcinoma (6)

8. Synovial Sarcoma (59)

9. Choriocarcinoma (65)

10. Schwanommas (17, 3, 6)

11. Carcinoma of the Lung (6)

12. Germ Cell Tumors (6)

13. Primitive Neuroectodermal Tumors (6)

14. Hemagiopericytomas (60)

15. Costochodromas (72, 58)

16. Malignant Gestational Trophoblastic Disease (9, 43)

B. Benign Tumors and Growths (61, 3, 43, 51, 18)

1. Benign GTDz (61, 3)

2. Thymic Growths and Cysts (6)

3. Benign Thymoma (62)

4. Venous Hemangioma (18)

V. **Complications of Pregnancy** (6, 32, 14, 61, 65, 43, 68, 63, 64)

A. Ectopic Pregnancy (14, 63, 64)

B. Gestational Trophoblastic Disease (32, 61, 65, 6, 66)

C. Peripartal Hemoperitoneum (67)

D. Rupture of Subcapsular Hematoma (68)

VI. **Thoracic Diseases** (4, 3, 6, 69, 54, 46, 72, 55, 53, 31)

A. Rupture of Pleural Adhesions (15, 6, 69, 54, 46, 55, 53)

B. Pulmonary Infarction from Thromboembolism (15, 6, 69, 54, 46, 55, 70, 16)

C. Pulmonary Infection (15, 3, 69, 46, 31)

D. Costal Exostosis (3, 6, 72)

E. Pulmonary Sequestration (73, 71)

VII. **Complications Involving the Diaphragm** (15, 67, 14, 74, 75, 63)

A. Fenestrations (15, 67, 74, 63)

B. Endometriosis (15, 75, 63)

C. Implantation of Primary Ectopic Pregnancy (14)

VIII. **Therapeutic Complications** (76, 15, 3, 6)

A. Central Line Placement (3, 6)

B. Translumbar Aortography (3)

C. Pleural Biopsy (6)

D. Thoracentesis (6)

E. Gastrointestinal Surgery (6)

F. Laparoscopic Procedures (15)

IX. **Idiopathic Spontaneous** (3, 6, 69, 31)