GEORGIAN MEDICAL NEWS

ISSN 1512-0112

NO 3 (372) Март 2026

ТБИЛИСИ - NEW YORK

ЕЖЕМЕСЯЧНЫЙ НАУЧНЫЙ ЖУРНАЛ

Медицинские новости Грузии

საქართველოს სამედიცინო სიახლენი

GEORGIAN MEDICAL NEWS

Monthly Georgia-US joint scientific journal published both in electronic and paper formats of the Agency of Medical Information of the Georgian Association of Business Press. Published since 1994. Distributed in NIS, EU and USA.

GMN: Georgian Medical News is peer-reviewed, published monthly journal committed to promoting the science and art of medicine and the betterment of public health, published by the GMN Editorial Board since 1994. GMN carries original scientific articles on medicine, biology and pharmacy, which are of experimental, theoretical and practical character; publishes original research, reviews, commentaries, editorials, essays, medical news, and correspondence in English and Russian.

GMN is indexed in MEDLINE, SCOPUS, PubMed and VINITI Russian Academy of Sciences. The full text content is available through EBSCO databases.

GMN: Медицинские новости Грузии - ежемесячный рецензируемый научный журнал, издаётся Редакционной коллегией с 1994 года на русском и английском языках в целях поддержки медицинской науки и улучшения здравоохранения. В журнале публикуются оригинальные научные статьи в области медицины, биологии и фармации, статьи обзорного характера, научные сообщения, новости медицины и здравоохранения. Журнал индексируется в MEDLINE, отражён в базе данных SCOPUS, PubMed и ВИНИТИ РАН. Полнотекстовые статьи журнала доступны через БД EBSCO.

GMN: Georgian Medical News – საქართველოს სამედიცინო სიახლენი – არის ყოველთვიური სამეცნიერო სამედიცინო რეცენზირებადი ჟურნალი, გამოიცემა 1994 წლიდან, წარმოადგენს სარედაქციო კოლეგიისა და აშშ-ის მეცნიერების, განათლების, ინდუსტრიის, ხელოვნებისა და ბუნებისმეტყველების საერთაშორისო აკადემიის ერთობლივ გამოცემას. GMN-ში რუსულ და ინგლისურ ენებზე ქვეყნდება ექსპერიმენტული, თეორიული და პრაქტიკული ხასიათის ორიგინალური სამეცნიერო სტატიები მედიცინის, ბიოლოგიისა და ფარმაციის სფეროში, მიმოხილვითი ხასიათის სტატიები.

ჟურნალი ინდექსირებულია MEDLINE-ის საერთაშორისო სისტემაში, ასახულია SCOPUS-ის, PubMed-ის და ВИНИТИ РАН-ის მონაცემთა ბაზებში. სტატიების სრული ტექსტი ხელმისაწვდომია EBSCO-ს მონაცემთა ბაზებიდან.

WEBSITE

www.geomednews.com

К СВЕДЕНИЮ АВТОРОВ!

При направлении статьи в редакцию необходимо соблюдать следующие правила:

1. Статья должна быть представлена в двух экземплярах, на русском или английском языках, напечатанная через **полтора интервала на одной стороне стандартного листа с шириной левого поля в три сантиметра**. Используемый компьютерный шрифт для текста на русском и английском языках - **Times New Roman** (**Кириллица**), для текста на грузинском языке следует использовать **AcadNusx.** Размер шрифта - **12**. К рукописи, напечатанной на компьютере, должен быть приложен CD со статьей.

2. Размер статьи должен быть не менее десяти и не более двадцати страниц машинописи, включая указатель литературы и резюме на английском, русском и грузинском языках.

3. В статье должны быть освещены актуальность данного материала, методы и результаты исследования и их обсуждение.

При представлении в печать научных экспериментальных работ авторы должны указывать вид и количество экспериментальных животных, применявшиеся методы обезболивания и усыпления (в ходе острых опытов).

4. К статье должны быть приложены краткое (на полстраницы) резюме на английском, русском и грузинском языках (включающее следующие разделы: цель исследования, материал и методы, результаты и заключение) и список ключевых слов (key words).

5. Таблицы необходимо представлять в печатной форме. Фотокопии не принимаются. **Все цифровые, итоговые и процентные данные в таблицах должны соответствовать таковым в тексте статьи**. Таблицы и графики должны быть озаглавлены.

6. Фотографии должны быть контрастными, фотокопии с рентгенограмм - в позитивном изображении. Рисунки, чертежи и диаграммы следует озаглавить, пронумеровать и вставить в соответствующее место текста **в tiff формате**.

В подписях к микрофотографиям следует указывать степень увеличения через окуляр или объектив и метод окраски или импрегнации срезов.

7. Фамилии отечественных авторов приводятся в оригинальной транскрипции.

8. При оформлении и направлении статей в журнал МНГ просим авторов соблюдать правила, изложенные в «Единых требованиях к рукописям, представляемым в биомедицинские журналы», принятых Международным комитетом редакторов медицинских журналов - http://www.spinesurgery.ru/files/publish.pdf и http://www.nlm.nih.gov/bsd/uniform_requirements.html
В конце каждой оригинальной статьи приводится библиографический список. В список литературы включаются все материалы, на которые имеются ссылки в тексте. Список составляется в алфавитном порядке и нумеруется. Литературный источник приводится на языке оригинала. В списке литературы сначала приводятся работы, написанные знаками грузинского алфавита, затем кириллицей и латиницей. Ссылки на цитируемые работы в тексте статьи даются в квадратных скобках в виде номера, соответствующего номеру данной работы в списке литературы. Большинство цитированных источников должны быть за последние 5-7 лет.

9. Для получения права на публикацию статья должна иметь от руководителя работы или учреждения визу и сопроводительное отношение, написанные или напечатанные на бланке и заверенные подписью и печатью.

10. В конце статьи должны быть подписи всех авторов, полностью приведены их фамилии, имена и отчества, указаны служебный и домашний номера телефонов и адреса или иные координаты. Количество авторов (соавторов) не должно превышать пяти человек.

11. Редакция оставляет за собой право сокращать и исправлять статьи. Корректура авторам не высылается, вся работа и сверка проводится по авторскому оригиналу.

12. Недопустимо направление в редакцию работ, представленных к печати в иных издательствах или опубликованных в других изданиях.

При нарушении указанных правил статьи не рассматриваются.

REQUIREMENTS

Please note, materials submitted to the Editorial Office Staff are supposed to meet the following requirements:

1. Articles must be provided with a double copy, in English or Russian languages and typed or compu-ter-printed on a single side of standard typing paper, with the left margin of **3** centimeters width, and **1.5** spacing between the lines, typeface - **Times New Roman** (**Cyrillic**), print size - **12** (referring to Georgian and Russian materials). With computer-printed texts please enclose a CD carrying the same file titled with Latin symbols.

2. Size of the article, including index and resume in English, Russian and Georgian languages must be at least 10 pages and not exceed the limit of 20 pages of typed or computer-printed text.

3. Submitted material must include a coverage of a topical subject, research methods, results, and review.

Authors of the scientific-research works must indicate the number of experimental biological species drawn in, list the employed methods of anesthetization and soporific means used during acute tests.

4. Articles must have a short (half page) abstract in English, Russian and Georgian (including the following sections: aim of study, material and methods, results and conclusions) and a list of key words.

5. Tables must be presented in an original typed or computer-printed form, instead of a photocopied version. **Numbers, totals, percentile data on the tables must coincide with those in the texts of the articles.** Tables and graphs must be headed.

6. Photographs are required to be contrasted and must be submitted with doubles. Please number each photograph with a pencil on its back, indicate author's name, title of the article (short version), and mark out its top and bottom parts. Drawings must be accurate, drafts and diagrams drawn in Indian ink (or black ink). Photocopies of the X-ray photographs must be presented in a positive image in **tiff format**.

Accurately numbered subtitles for each illustration must be listed on a separate sheet of paper. In the subtitles for the microphotographs please indicate the ocular and objective lens magnification power, method of coloring or impregnation of the microscopic sections (preparations).

7. Please indicate last names, first and middle initials of the native authors, present names and initials of the foreign authors in the transcription of the original language, enclose in parenthesis corresponding number under which the author is listed in the reference materials.

8. Please follow guidance offered to authors by The International Committee of Medical Journal Editors guidance in its Uniform Requirements for Manuscripts Submitted to Biomedical Journals publication available online at: http://www.nlm.nih.gov/bsd/uniform_requirements.html
http://www.icmje.org/urm_full.pdf
In GMN style for each work cited in the text, a bibliographic reference is given, and this is located at the end of the article under the title "References". All references cited in the text must be listed. The list of references should be arranged alphabetically and then numbered. References are numbered in the text [numbers in square brackets] and in the reference list and numbers are repeated throughout the text as needed. The bibliographic description is given in the language of publication (citations in Georgian script are followed by Cyrillic and Latin).

9. To obtain the rights of publication articles must be accompanied by a visa from the project instructor or the establishment, where the work has been performed, and a reference letter, both written or typed on a special signed form, certified by a stamp or a seal.

10. Articles must be signed by all of the authors at the end, and they must be provided with a list of full names, office and home phone numbers and addresses or other non-office locations where the authors could be reached. The number of the authors (co-authors) must not exceed the limit of 5 people.

11. Editorial Staff reserves the rights to cut down in size and correct the articles. Proof-sheets are not sent out to the authors. The entire editorial and collation work is performed according to the author's original text.

12. Sending in the works that have already been assigned to the press by other Editorial Staffs or have been printed by other publishers is not permissible.

Articles that Fail to Meet the Aforementioned Requirements are not Assigned to be Reviewed.

ავტორთა საყურადღებოდ!

რედაქციაში სტატიის წარმოდგენისას საჭიროა დავიცვათ შემდეგი წესები:

1. სტატია უნდა წარმოადგინოთ 2 ცალად, რუსულ ან ინგლისურ ენებზე,დაბეჭდილი სტანდარტული ფურცლის 1 გვერდზე, 3 სმ სიგანის მარცხენა ველისა და სტრიქონებს შორის 1,5 ინტერვალის დაცვით. გამოყენებული კომპიუტერული შრიფტი რუსულ და ინგლისურენოვან ტექსტებში - **Times New Roman (Кириллица)**, ხოლო ქართულენოვან ტექსტში საჭიროა გამოვიყენოთ **AcadNusx.** შრიფტის ზომა – 12. სტატიას თან უნდა ახლდეს CD სტატიით.

2. სტატიის მოცულობა არ უნდა შეადგენდეს 10 გვერდზე ნაკლებს და 20 გვერდზე მეტს ლიტერატურის სიის და რეზიუმეების (ინგლისურ, რუსულ და ქართულ ენებზე) ჩათვლით.

3. სტატიაში საჭიროა გაშუქდეს: საკითხის აქტუალობა; კვლევის მიზანი; საკვლევი მასალა და გამოყენებული მეთოდები; მიღებული შედეგები და მათი განსჯა. ექსპერიმენტული ხასიათის სტატიების წარმოდგენისას ავტორებმა უნდა მიუთითონ საექსპერიმენტო ცხოველების სახეობა და რაოდენობა; გაუტკივარებისა და დაძინების მეთოდები (მწვავე ცდების პირობებში).

4. სტატიას თან უნდა ახლდეს რეზიუმე ინგლისურ, რუსულ და ქართულ ენებზე არანაკლებ ნახევარი გვერდის მოცულობისა (სათაურის, ავტორების, დაწესებულების მითითებით და უნდა შეიცავდეს შემდეგ განყოფილებებს: მიზანი, მასალა და მეთოდები, შედეგები და დასკვნები; ტექსტუალური ნაწილი არ უნდა იყოს 15 სტრიქონზე ნაკლები) და საკვანძო სიტყვების ჩამონათვალი (key words).

5. ცხრილები საჭიროა წარმოადგინოთ ნაბეჭდი სახით. ყველა ციფრული, შემაჯამებელი და პროცენტული მონაცემები უნდა შეესაბამებოდეს ტექსტში მოყვანილს.

6. ფოტოსურათები უნდა იყოს კონტრასტული; სურათები, ნახაზები, დიაგრამები - დასათაურებული, დანომრილი და სათანადო ადგილას ჩასმული. რენტგენოგრამების ფოტოასლები წარმოადგინეთ პოზიტიური გამოსახულებით **tiff** ფორმატში. მიკროფოტოსურათების წარწერებში საჭიროა მიუთითოთ ოკულარის ან ობიექტივის საშუალებით გადიდების ხარისხი, ანათალების შეღებვის ან იმპრეგნაციის მეთოდი და აღნიშნოთ სურათის ზედა და ქვედა ნაწილები.

7. სამამულო ავტორების გვარები სტატიაში აღინიშნება ინიციალების თანდართვით, უცხოურისა – უცხოური ტრანსკრიპციით.

8. სტატიას თან უნდა ახლდეს ავტორის მიერ გამოყენებული სამამულო და უცხოური შრომების ბიბლიოგრაფიული სია (ბოლო 5-8 წლის სიღრმით). ანბანური წყობით წარმოდგენილ ბიბლიოგრაფიულ სიაში მიუთითეთ ჯერ სამამულო, შემდეგ უცხოელი ავტორები (გვარი, ინიციალები, სტატიის სათაური, ჟურნალის დასახელება, გამოცემის ადგილი, წელი, ჟურნალის №, პირველი და ბოლო გვერდები). მონოგრაფიის შემთხვევაში მიუთითეთ გამოცემის წელი, ადგილი და გვერდების საერთო რაოდენობა. ტექსტში კვადრატულ ფჩხილებში უნდა მიუთითოთ ავტორის შესაბამისი N ლიტერატურის სიის მიხედვით. მიზანშეწონილია, რომ ციტირებული წყაროების უმეტესი ნაწილი იყოს 5-6 წლის სიღრმის.

9. სტატიას თან უნდა ახლდეს: ა) დაწესებულების ან სამეცნიერო ხელმძღვანელის წარდგინება, დამოწმებული ხელმოწერითა და ბეჭდით; ბ) დარგის სპეციალისტის დამოწმებული რეცენზია, რომელშიც მითითებული იქნება საკითხის აქტუალობა, მასალის საკმაობა, მეთოდის სანდოობა, შედეგების სამეცნიერო-პრაქტიკული მნიშვნელობა.

10. სტატიის ბოლოს საჭიროა ყველა ავტორის ხელმოწერა, რომელთა რაოდენობა არ უნდა აღემატებოდეს 5-ს.

11. რედაქცია იტოვებს უფლებას შეასწოროს სტატია. ტექსტზე მუშაობა და შეჯერება ხდება საავტორო ორიგინალის მიხედვით.

12. დაუშვებელია რედაქციაში ისეთი სტატიის წარდგენა, რომელიც დასაბეჭდად წარდგენილი იყო სხვა რედაქციაში ან გამოქვეყნებული იყო სხვა გამოცემებში.

აღნიშნული წესების დარღვევის შემთხვევაში სტატიები არ განიხილება.

GEORGIAN MEDICAL NEWS
NO 3 (372) 2026

Содержание:

GEORGIAN MEDICAL NEWS
No 3 (372) 2026

IATROGENIC PNEUMOTHORAX: ETIOLOGY, CLINICAL AND THERAPEUTIC ASPECTS

Aymar Kassa Boukat[1,2,4]*, Massine El Hammoumi[1,4], Yassine Sarboute[3], El Hassane Kabiri[1,4].

[1]*Thoracic Surgery Department, Military Teaching Hospital Mohammed V, Rabat, Morocco.*

[2]*University of Health Sciences and Technical, Libreville, Gabon.*

[3]*Laboratory of Social Medicine, biostatistics laboratory, clinical research and epidemiology, Pedagogy and Research Unit (PRU) of Public health, Faculty of Medicine and Pharmacy of Rabat, Morocco.*

[4]*Faculty of Medicine and Pharmacy of Rabat, Mohammed V University in Rabat, Morocco.*

Abstract.

The development of invasive thoracic procedures performed for diagnostic and/or therapeutic purposes is associated with an increased incidence of iatrogenic pneumothorax.

Objective: To describe the causes, clinical manifestations, and treatment modalities of iatrogenic pneumothorax, with the aim of better understanding the issues related to their prevention and management.

Patients and Methods: Prospective descriptive and analytical observational study with active case notification conducted over a two-year period, from April 1, 2023, to April 1, 2025, at the Mohammed V Military Hospital in Rabat, including all patients with clinically and/or radiologically confirmed iatrogenic pneumothorax.

Results: The study included 82 patients who presented with iatrogenic pneumothorax. The median age was 65 years [54; 70], with extremes ranging from 16 to 92 years. Of the patients, 50 (61%) were male and 32 (39%) female. The procedure causing iatrogenic pneumothorax was mainly therapeutic in 50 (61%). 45 (54.9%) patients had an underlying pulmonary pathology and 37 (45.1%) had an underlying extra-pulmonary pathology. The most frequent causes of iatrogenic pneumothorax were central venous catheterization in 34 (41.5%), followed by CT-guided transthoracic lung biopsy in 17 (20.7%) and barotrauma by mechanical ventilation in 11 (13.4%). The most frequent type of treatment was tube thoracostomy with or without needle aspiration in 45 cases (54.9%), followed by conservative treatment in 30 cases (36.6%). Follow-up under these different types of treatment was complicated in 20.7% of cases. Except for mobilization of the chest drain in the management of pneumothorax persisting beyond 7 days, 5 patients had benefited from pleurodesis, including one in the patient's bed and four by uni-portal video-assisted thoracic surgery (U-VATS). Seven patients out of the 82 cases died, i.e. 8.5%, and there was a statistically significant association between ASA Score and mortality with a P-value of 0.01. **Conclusion:** The increasing frequency of iatrogenic pneumothorax requires heightened vigilance. Identifying and preventing avoidable risk factors must be a priority in order to limit its incidence and strengthen the safety of interventional practices.

Key words. Iatrogenic pneumothorax, chest drain, pleurodesis, thoracoscopy.

Introduction.

Iatrogenic pneumothorax is defined as the presence of gas in the pleural space following an invasive procedure performed for diagnostic and/or therapeutic purposes. These procedures are diverse, but according to the literature, the most frequently encountered are: central venous catheterization, evacuating pleural puncture, pleural biopsy, mechanical ventilation barotrauma and CT-guided transthoracic lung biopsy [1,2].

This condition can be a real emergency characterized by respiratory failure if the pneumothorax is abundant, but can be undetected if asymptomatic or with minim pneumothorax [3]. In this situation, a chest X-ray performed after an invasive procedure is sufficient to establish the diagnosis.

The therapeutic approach to an iatrogenic pneumothorax depends on its symptomatology and volume, ranging from conservative treatment to thoracic drainage, or even surgical intervention in case of post-drainage complications that could jeopardize the patient's prognosis.

The incidence of iatrogenic pneumothorax seems to be higher in training hospital structures than non-training hospital structures [4].

The absence of studies on iatrogenic pneumothorax in our training hospital, leads us to carry out this prospective study, whose aim would be to describing the etiology, clinical and therapeutic aspects of iatrogenic pneumothorax.

Patients and Methods.

Type of study:

Prospective descriptive and analytical observational study with active case notification

Patient recruitment:

Case identification was based on active notification from all medical and surgical departments of the Mohammed V Military Teaching Hospital in Rabat. At the start of the study, all departments were informed of the study objectives and were requested to report any case of suspected or confirmed iatrogenic pneumothorax to the thoracic surgery team. Continuous communication was maintained with the different services throughout the study period to encourage systematic reporting.

All patients with clinically and/or radiologically confirmed iatrogenic pneumothorax who were evaluated or managed at the hospital during the study period were included.

Inclusion criteria:

- Iatrogenic pneumothorax with or without symptoms.
- Patients aged 16 and over, all sexes.
- Iatrogenic pneumothorax of any etiology.
- Patients showing iatrogenic pneumothorax managed by the

thoracic surgery department and/or another medical-surgical department of HMIMV Rabat.

Non-inclusion criteria:

- Patients showing iatrogenic pneumothorax and refusing to do take care at the Mohammed V Military Teaching Hospital Rabat, Morocco.
- Post traumatic pneumothorax.
- Spontaneous and recurrent pneumothorax.
- Postoperative pneumothorax following thoracic or abdominal surgery.

Data collection:

Data were collected using a structured questionnaire, which was completed in front of the conscious patient and/or the doctor in the various intensive care units (for unconscious patients).

The data included the following information:

- Socio-demographic data.
- The department where iatrogenic pneumothorax occurred after the invasive procedure.
- The etiologies of iatrogenic pneumothorax.
- Purpose of the procedure.
- Practitioner status.
- Conditions under which the invasive procedure is performed.
- Indication for invasive procedure.
- Presence of underlying pathology.
- Clinical data: include functional signs, general signs and physical signs.
- Paraclinical data: this includes examinations that have helped to orient or establish the diagnosis of iatrogenic pneumothorax, i.e. Fast-echography, chest X-ray and thoracic CT scan.
- Diagnostic data: includes the diagnosis, specifying its clinical form and its abundance, the interpretation of which is determined by the radiologist on CT scans and by the thoracic surgeon on chest X-rays, taking into account the 2010 British Thoracic Society (BTS) guidelines [5].
- Time in days to onset of iatrogenic pneumothorax after an invasive procedure other than mechanical ventilation and time to onset of iatrogenic pneumothorax in mechanically ventilated patients exposed to barotrauma.
- Treatment-related data: includes type of treatment, in the case of thoracic drainage and duration in days of treatment.
- Morbidity-mortality data: includes unfavorable evolution, type of complications and number of deaths.
- Complication treatment data: includes type of treatment, which may be talc pleurodesis by U-VATS, betadine pleurodesis by U-VATS, 2 cm drain mobilization, chest drainage, betadine pleurodesis at the patient's bedside and air aspiration.

Data analysis.

Data analysis was carried out using jamovi2.3.19 software.

Qualitative variables were expressed as workforce and percentages; quantitative variables will be expressed as mean and standard deviation if the variable's distribution is normal (Gaussian), or as median with interquartile range if the variable's distribution is asymmetric (non-Gaussian).

A bivariate analysis was performed using Chi-two or Fisher statistical tests for qualitative variables and Student's t-test or Mann Whitney for quantitative variables, and the association between variables will be considered statistically significant for a P-value <0.05.

Multivariable regression analysis was not performed due to both limited sample size and number of outcome events (Death, severe complications...)

Ethical considerations.

With regard to ethical considerations, the anonymity and oral consent of patients (conscious) and/or relatives (for patients on mechanical ventilation) will be respected.

The use of verbal consent was approved by the institutional framework of the Mohammed V Military Teaching hospital and considered appropriate due to the non-interventional design and the absence of additional risk to participants.

Results.

Socio-demographic characteristics:

The median age was 65 [54;70], with extremes ranging from 16 to 92 years.

The male gender was concerned 50 patients, a frequency of 61% with a sex ratio of 1.56.

Medical department:

The interventional radiology department was the biggest provider of iatrogenic pneumothorax with 18 cases (22%), followed by the surgical resuscitation department with 15 cases (18.3%) and the thoracic surgery and pneumology departments with 11 cases each (13.4%).

Etiologies of iatrogenic pneumothorax:

The etiology most provider for iatrogenic pneumothorax was central venous catheterization in 34 (41.5%), followed by CT-guided transthoracic biopsy for lung and/or mediastino-pulmonary lesions suspected of malignancy in 17 (20.7%) and barotrauma by mechanical ventilation in 11 (13.4%). Distribution of patients according to etiology is reported in table I.

Type of central venous catheterization:

Among the 34 cases of central venous catheterization, only 4 cases (11.8%) were performed under ultrasound guidance, and the preferred puncture site was the subclavian vein (SCV) in 30 (88,2%), including 15 (44.1%) on the right (RSCV) and 15 (44.1%) on the left (LSCV). (Figure 1). Distribution types of central venous catheterization according to whether performed under ultrasound guidance or not is reported in table II.

Purpose of the invasive procedure:

The purpose was mainly therapeutic in 50 (61%), then diagnostic in 25 (30.5%), and mixed in 7 (8.5%).

Condition of carrying out the invasive procedure:

The majority of iatrogenic pneumothoraxes resulted from procedures performed by seniors in 44 (53.7%), of which 10 (12.2%) were in emergency condition and 34 (41.5%) in scheduled condition.

Underlying pathology:

45 patients (54.9%) had an underlying pulmonary pathology.

Indications of invasive procedures:

The most common indications of invasive procedures at the thorax level were chemotherapy in 14 (17.1%), followed by

Table 1. *Distribution of patients according to etiology of iatrogenic pneumothorax.*

Etiologies*	**Count (N, %)**
Central venous catheterization	34 (41.5%)
CT-guided biopsy	17 (20.7%)
Barotrauma	11 (13.4%)
Evacuatory pleural puncture	7 (8.5%)
Exploratory puncture + Pleural biopsy	7 (8.5%)
Ultrasound-guided lung biopsy	1 (1.2%)
Exsufflation test	1 (1.2%)
Bronchoscopy	1 (1.2%)
Co_2 insufflation from Per oral endoscopic myotomy	1 (1.2%)
Iatrogenic wound of the diaphragm	1 (1.2%)
Pace maker extraction through a laser sheath	1 (1.2%)
Total	**82 (100%)**

** Count and percentage.*

Table 2. *Distribution types of central venous catheterization according to whether performed under ultrasound guidance or not.*

Types of central venous catheterization*	**Echo-guided**	**Count (N, %)**
Implantable chamber catheter	Yes	0 (0%)
	No	14 (41.2%)
Central line catheter	Yes	4 (11.8%)
	No	8 (23.5%)
Dual chamber pacemaker	Yes	0 (0%)
	No	6 (17.6%)
Cardiac stimulation probe	Yes	0 (0%)
	No	2 (5.9%)
Total		**34 (100%)**

** Count and percentage.*

Table 3. *Distribution according to indication for invasive procedure.*

Indication for invasive procedure*	**Count (N, %)**
Chemotherapy	14 (17.1%)
Lung mass	13 (15.9%)
Central venous access for sedation	10 (12.1%)
Large size pleural effusion	6 (7.3%)
Moderate size pleural effusion	5 (6.1%)
Complete atrioventricular block	5 (6.1%)
Bilateral hypoxemic pneumotis	4 (4,9%)
Mediastino-pulmonary mass	3 (3.7%)
Endocarditis on pace maker	3 (3.7%)
Small size pleural effusion	2 (2.4%)
Others	17 (20.7%)
Total	**82 (100%)**

** Count and percentage.*

biopsy of a lung mass suspected of malignancy in 13 (15.9%) and placement of a sedation central line for mechanical ventilation in 10 (12.1%). Distribution according to indication for invasive procedure is reported in table III.

Clinical exams:

Among patients with iatrogenic pneumothorax, 58 (70.7%) were symptomatic. However, 24 (29.3%) were asymptomatic.

Functional signs:

Among the complaints reported by conscious patients, dyspnea came first in 35 (42.7%), followed by chest pain in 27 (32.9%).

General Signs:

Tachycardia and arterial hypotension were present in 4 patients (4.9%). The median of respiratory rate (Fr) was 19 cycles/min [14; 28] with extremes from 12 to 42 cycles/min; that of pulsed oxygen saturation (Spo2) was 92% [88%; 98%] with extremes from 27% to 100%.

For mechanically ventilated patients, the ASA score and gasometry were performed. The ASA3 score was the most found in 10 (41.7%). For gasometry, the median of arterial oxygen pressure (Pao2) was 86% [72%; 100%] with extremes from 55% to 250% and the median of arterial oxygen saturation (Sao2) was 94% [88%; 95%] with extremes from 79% to 99%. Finally, the median of arterial carbon dioxide pressure (Paco2) was 55% [43%; 60%] with extremes between 32% and 61%.

Furthermore, in patients subjected to barotrauma by mechanical

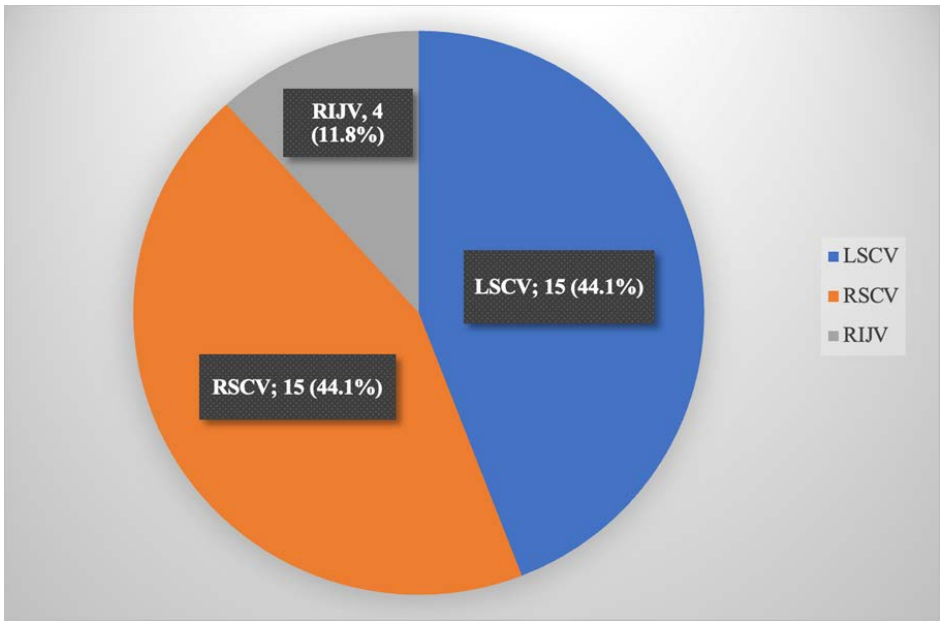

Figure 1. *Distribution according to the site of central venous catheterization.*

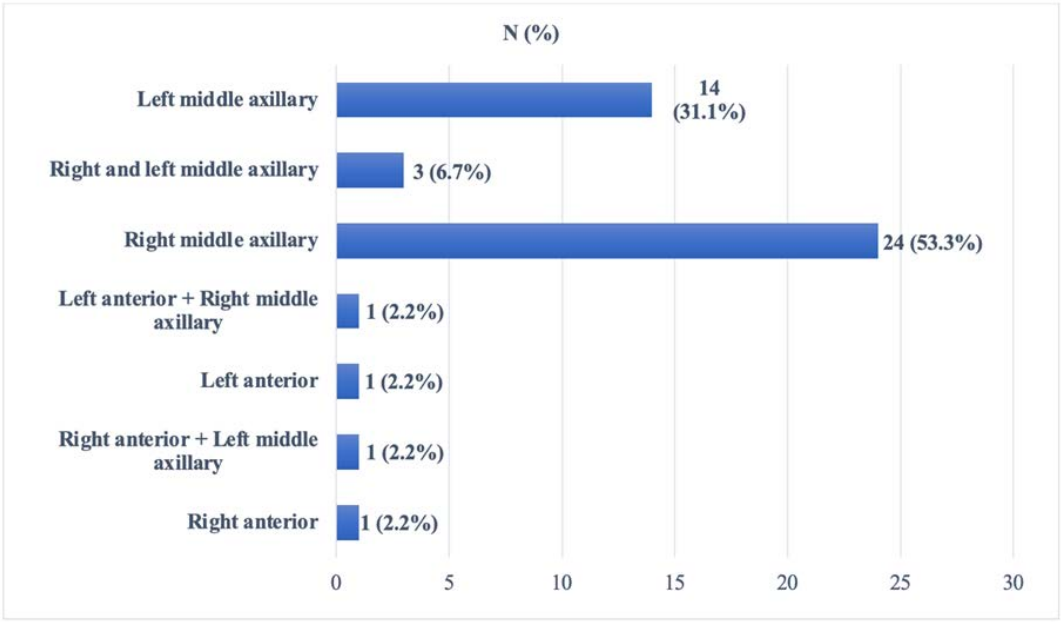

Figure 2. *Distribution according to thoracic drainage route.*

ventilation, elevation of crest pressure as well as a drop in Spo2 was an indicator of the occurrence of pneumothorax. The median of crest pressure was 43% [40%; 47%] with extremes between 35% and 51%.

Physical signs:

On pleuropulmonary examination, the air pleural effusion syndrome was unilateral in 52 (63.4%) and bilateral in 6 (7.4%). Aside from aeric pleural effusion syndrome, liquid pleural effusion syndrome was present in 9 (11%), subcutaneous emphysema in 15 (18.3%) and hypersudation in 4 (4.9%).

Complementary exams:

Chest radiography was the most frequently requested paraclinical examination, confirming or establishing the diagnosis of unilateral, bilateral and/or associated iatrogenic pneumothorax (hemopneumothorax, hydropneumothorax, pneumomediastinum and pneumoperitoneum) in 65 cases (79.3%), followed by thoracic computed tomography (CT) in 18 cases (22%). as for the fast-echography, it was mainly performed in intensive care unit, in 3 cases (3.7%) before X-ray or CT scan.

Diagnosis of iatrogenic pneumothorax:

Non-compressive right pneumothorax was the most frequent diagnosis in 36 (43.9%), followed by non-compressive left pneumothorax in 18 (22%). However, the pneumothorax was suffocating or under tension (compressive) in 4 cases, namely 2 (2.4%) of left-sided tension pneumothorax, 1(1.2%) of bilateral tension pneumothorax associated with pneumo-mediastinum

Table 4. *Distribution according to diagnosis of iatrogenic pneumothorax.*

Clinical forms*	**Diagnosis**	**Count (N, %)**
Unilateral simple form	Right pneumothorax	36 (43.9%)
	Left pneumothorax	18 (22%)
	Anterior left pneumothorax	3 (3.7%)
	Anterior right pneumothorax	1 (1.2%)
Bilateral simple form	Bilateral pneumothorax	4 (4.9%)
Associated form	Right hydropneumothorax	9 (11%)
	Left hydropneumothorax	4 (4.9%)
	Bilateral pneumothoraxbilatéral + PM	2 (2.4%)
	Right hemopneumothorax	1 (1.2%)
Severe form	Left pneumothorax under tension	2 (2.4%)
	Right pneumothorax under tension	1 (1.2%)
	Bilateral Pneumothorax undertension + PM +PP	1 (1.2%)
Total		**82 (100%)**

***** *Count and percentage.*

Table 5. *Distribution of the type of treatment according to the size of iatrogenic pneumothorax.*

Type of treatment	**Size of pneumothorax**	**Count (N, %)**
Chest drainage	Large	30 (36.6%)
	Moderate	11 (13.4%)
	Small	0 (0%)
Needle aspiration + Chest drainage	Large	4 (4.9%)
	Moderate	0 (0%)
	Small	0 (0%)
Needle aspiration + Oxygen therapy	Large	2 (2.4%)
	Moderate	5 (6.1%)
	Small	0 (0%)
Conservative treatment	Large	0 (0%)
	Moderate	11 (13.4%)
	Small	19 (23.2%)
Total		**82 (100%)**

***** *Count and percentage.*

Table 6. *Distribution according to onset of complications.*

Complications*	**Count (N, %)**
Persistent pneumothorax	6 (7.3%)
Aggravation of pneumothorax	4 (4.9%)
Septic shock on pyothorax stage 1	3 (3.7%)
Aggravation of hydropneumothorax	2 (2.4%)
Pyothorax stage 1	1 (1.2%)
Septic shock	1 (1.2%)
Uncomplicated	65 (79.3%)
Total	**82 (100%)**

***** *Count and percentage.*

(PM) and pneumoperitoneum (PP), then 1(1.2%) of right-sided tension pneumothorax. Distribution according to diagnosis of iatrogenic pneumothorax is reported in Table IV.

Time to onset of iatrogenic pneumothorax:

The frequency of occurrence of iatrogenic pneumothorax after an invasive procedure other than barotrauma by mechanical ventilation was 65 (91.5%) on the day of the invasive procedure (D0), 3 (4.2%) after one day, 1 case (1.4%) after 2 days and 2 (2.8%) after more than two days.

Finally, for the 11 patients subjected to barotrauma by mechanical ventilation, the median of time to onset of iatrogenic pneumothorax was 4 days, with [1; 23] and extremes between 0 and 31 days.

Treatment:

Chest drainage was the treatment of choice for the management of pure and/or associated (hydropneumothorax, hemo-pneumothorax and pneumo-mediastinum) large- to moderate-size pneumothorax in 45 cases, including 41 (50%) non-compressive and 4 (4.9%) compressive cases, for which needle aspiration was initially initiated. Followed of conservative treatment in 30 (36.6%), including 19 cases (23.2%) of small size pneumothorax and 11 cases (13.4%) of moderate size

pneumothorax. (Figure 2). Distribution of the type of treatment according to the size of iatrogenic pneumothorax is reported in table V.

Evolution:

Management of iatrogenic pneumothorax, regardless of clinical form, was satisfactory in 65 (79.3%) and complicated in 17 (20.7%). The most frequent complication was persistence of pneumothorax beyond 7 days in 6 (7.3%).

There was a statistically significant association between the duration of thoracic drainage and the occurrence of pyothorax stage 1, with a p-value of 0.005, and between the duration of thoracic drainage and the onset of septic shock, with a p-value of 0.009. Distribution according to onset of complications is reported in table VI.

Treatment of comorbidities:

Among the comorbidities found, 14 out of 17 cases had received non-medical treatment. These included 6 cases of 2 cm chest drain mobilization, 3 cases of thoracic drainage, 3 cases of light decortication and combined to talc pleurodesis by U-VATS, 1 case of betadine pleurodesis by U-VATS, 1 case of betadine pleurodesis in the patient's bed and 1 case of needle aspiration associated with oxygen therapy.

Mortality:

Among patients with tension pneumothorax and comorbidities after different types of management, 7 (8.5%) of death were recorded, with an ASA score of mostly 4. Causes of death included 3 cases of septic shock on pyothorax, 1 case of septic shock from bilateral pneumopathy, 1 case of severe exacerbation of COPD, 1 case of cardiorespiratory arrest secondary to tension pneumothorax and 1 case of hemoptysis associated with hemorrhagic stroke.

There was a statistically significant association between ASA score and the occurrence of mortality for our patients hospitalized in intensive care units, with a P value of 0.01.

Discussion.

In our study, we did not determine the incidence of this complication, but the interventional medicine departments in general, and the interventional radiology department in particular, were the most frequent providers of iatrogenic pneumothorax, with 18 cases (22%). This differs from the study by B. Çelik et al [1], where the anesthesia/intensive care department recorded more cases of iatrogenic pneumothorax, with 38 cases (23.2%).

Central venous catheterization is one of the most frequent causes of this pathology, as confirmed by the studies of M.M El Hammoumi et al [2], in 20 cases (55%) and B. Çelik et al [1], in 72 cases (43.8%). According to the literature, this procedure is generally performed for prolonged venous passage, parenteral nutrition, chemotherapy and/or systemic arterial pressure measurement [6]. In our study, central venous catheterization, which included implantable catheter port placement, central venous catheter, double-chamber pacemaker placement and cardiac stimulation lead placement, was the leading cause of iatrogenic pneumothorax in 34 cases (41.5%). These most frequent indications grouped together, in decreasing order, chemotherapy followed by venous passage of sedation for mechanical ventilation and complete atrioventricular block. This invasive procedure presents both intrinsic patient risks (vascular anatomy, underlying pulmonary pathology and coagulopathy) and extrinsic risks (practitioner experience and three blind venipuncture passes) [6,7]. In our situation, even though this procedure was performed by residents supervised by specialists and/or specialists, it was done blindly (without being guided by ultrasound) for 30 out of 34 patients and the preferred venipuncture site was the subclavian vein in 30 cases or 88.2%. This does not corroborate the data in the literature, which presents the internal jugular vein as a safe puncture site due to its low risk of pneumothorax, which can tend towards zero with the use of ultrasound [8,9]. This could explain why central venous catheterization is the first cause.

The second most common cause of iatrogenic pneumothorax in our study was transthoracic CT-guided biopsy for pulmonary and/or mediastino-pulmonary lesions suspected of malignancy. According to the literature, pneumothorax is the first and almost inevitable complication of this invasive procedure, with an incidence ranging from 23.2% to 27% depending on the type of technique (coaxial or non-coaxial) [10]. This procedure presents unavoidable (pulmonary emphysema, lesion < 2cm, depth of lesion in the parenchyma and basal location of the lesion) and avoidable (frequency of biopsy needle passage and experience of the radiologist) risk factors [10,11]. In our hospital, this innovative invasive procedure for diagnosing lung and/or mediastinal cancer pathologies began in 2023, so apart from other factors that we didn't investigate, the practitioner's experience could be to blame for the occurrence of this complication.

Barotrauma due to mechanical ventilation was the third most frequent cause of pneumothorax in our study, as it was in the study by B. Çelik et al [1]. The literature reports that its incidence ranges from 0.5% in post-operative patients to 87% in those treated for acute respiratory distress syndrome (ARDS) [12,13]. For some authors, the increased incidence of pneumothorax by barotrauma in ARDS patients is linked to the setting of certain ventilatory parameters, including plateau pressure, tidal volume and motor pressure (Pplat - PEP). Thus, an average value of plateau pressure at the end of inspiration > 35 cmH2O and compliance < 30 ml/cmH2O would be strongly incriminated as responsible for the pneumothorax [14].

Moreover, barotrauma iatrogenic pneumothorax usually occurs within the first three days of mechanical ventilation, the most important risk factors being ARDS, COPD, multiple trauma and pneumonia [13,14]. In our study, the median of onset was 4 days with an interquartile range (1 - 21). Of the 11 patients presenting with barotrauma, only 6 cases had a risk factor, including 2 cases of severe pulmonary contusion, 3 cases of bilateral hypoxemic pneumonia and 1 case of COPD exacerbation. We believe that prolonged mechanical ventilation could explain the development of iatrogenic pneumothorax, in patients who had no underlying pulmonary pathology.

The fourth most frequent cause of pneumothorax in our study was respectively due to evacuatory pleural puncture and exploratory puncture associated with pleural biopsy. This

differs from the study by B. Çélik et al [1], where evacuation pleural puncture was the second most frequent cause and pleural biopsy the seventh.

According to the literature, the risk factors for the occurrence of iatrogenic pneumothorax in both situations are common, namely: practitioner experience, coughing during the invasive procedure, underlying pulmonary pathology and the number of pleural punctures performed [15]. In our study, the number of passages, the underlying pulmonary pathology, the evacuation pleural punctures performed under emergency conditions in the face of respiratory distress on large pleural effusion by junior doctors, and the absence of ultrasound use for exploratory puncture of small basal pleural effusion could be incriminated in the occurrence of iatrogenic pneumothorax.

The symptoms and signs of iatrogenic pneumothorax depend on its severity, the patient's underlying pathology and the appearance of associated lesions after an invasive procedure. According to the literature, these symptoms and signs typically include dyspnea, pleural chest pain, tachypnoea, hypoxia, subcutaneous emphysema, decreased vesicular murmur on auscultation and hypersonority on percussion [16]. In our study, apart from these symptoms and signs, we also found a few cases of liquid pleural effusion syndrome in patients with pleurisy prior to the invasive procedure, and signs of severity including hypercapnia related hypersudation and tachycardia associated with hypotension, all related to tension pneumothorax.

Regarding patients subjected to barotrauma by mechanical ventilation, particular attention should be paid to sudden variation in ventilatory pressures and an unexpected decrease in oxygen via the drop in pulse oxygen saturation, as they are often related to iatrogenic pneumothorax [1]. In our situation, the warning signs were an increase in crest pressure and a sudden drop in pulsatile oxygen saturation.

In addition, 24 patients, or 29.3% of our population, were asymptomatic. Among asymptomatic patients discharged after an invasive procedure other than mechanical ventilation, without imaging including chest X-ray, 6 patients had expressed the clinical picture of a pneumothorax 24 to 72 hours later. This corroborates the literature, which reports that pneumothorax can often be asymptomatic and go undetected, only to reveal itself late [3]. After an invasive procedure, it is therefore advisable to perform an ultrasound scan in search of an occult iatrogenic pneumothorax and/or a chest X-ray, or even a chest CT scan in search of an anterior pneumothorax. But above all, these examinations enable us to measure the volume of air which conditions the patient's clinical condition and the therapeutic attitude to adopt.

Pneumothoraxes involving less than 20% of the hemithorax, in an asymptomatic, hemodynamically stable patient, can be safely managed with conservative treatment, combining in hospital observation and oxygen therapy with radiological monitoring 12 to 24 h after diagnosis or if symptoms appear [1,16]. In our study, conservative treatment concerned 30 hemodynamically stable patients, including 19 cases of pneumothorax of small size and 11 cases of pneumothorax of moderate size. Of these patients, only 17 were asymptomatic and 4 worsened clinically and radiologically, requiring chest drainage in 3 cases and needle aspiration in 1. The success rate of conservative treatment was 87%. This result is close to the success rate found in the retrospective study by AM. Kelly et al [17], who reported 154 cases of pneumothorax, of which 91 were treated by outpatient observation, and noted 82 cases resolved without intervention, giving a success rate of 90.1%.

On the other hand, simple aspiration, or needle aspiration of air through the pleural cavity, requires patient selection. This approach is often considered for minimal, symptomatic pneumothorax in patients with no known parenchymal disease [16]. Several authors have reported a success rate for this management, ranging from 75% to 91.7%, and found no difference with thoracic drainage in terms of success rate, length of hospital stay, early failure or number of patients requiring pleurodesis [16,18,19]. In our study, among 7 patients who benefited from simple aspiration (needle aspiration) associated with oxygen therapy for 24 to 48 hours, only 2 cases were asymptomatic, and the volume of pneumothorax in all of them was greater than 20% of the hemithorax. However, only one case of aggravated hydropneumothorax was recorded, requiring talc pleurodesis by U-VATS, giving a success rate of 86% similar to the results reported in the literature.

Finally, with regard to thoracic drainage, the literature reports that it concerns pneumothorax greater than 20% of the hemithorax or which causes symptoms [16]. In our study, the majority of patients were drained, as in the study by M.M. El Hammoumi et al [2]. Of the 55 cases of large and/or medium-abundance pneumothorax that were drained, 4 cases of tension pneumothorax were preceded by exsufflation. The preferred drainage route was the middle axillary route, as recommended by several authors, because it is described as a safety zone [20,21]. However, ventral thoracic drainage was only performed that by the thoracic surgeon for cases of anterior pneumothorax. This corroborates the literature, which states that if a non-lateral approach is chosen, it should be performed by a thoracic surgeon [22,23]. This type of treatment was the most morbid in our study, the most frequent being infectious complications and persistent pneumothorax, responsible for a 7.5% mortality rate, mainly in patients hospitalized in intensive care units with an ASA score of mostly 4.

This study has several limitations. First, no predefined standardized prospective protocol was implemented at study initiation, and consecutive patient inclusion could not be formally verified. Second, the small sample size and limited number of events prevented adjustment for multiple covariates and the use of multivariable regression. Case identification depended on referral to the thoracic surgery team, which may have missed asymptomatic or minor pneumothoraces. Third, the lack of systematic post-procedural screening likely led to under-detection, so findings reflect clinically recognized cases rather than true incidence and lastly, Ventilatory parameters such as positive end-expiratory pressure (PEEP), tidal volume, and plateau pressure were not recorded at the time of pneumothorax occurrence. This limits the ability to assess the contribution of mechanical ventilation settings to the development of barotrauma in our study.

Conclusion.

With the expansion of interventional medicine in teaching hospitals, invasive thoracic procedures are increasingly performed for diagnostic and therapeutic purposes, leading to a parallel rise in cases of iatrogenic pneumothorax.

The most frequently involved procedures include central venous catheterization, CT-guided transthoracic biopsy, barotrauma related to mechanical ventilation, evacuating pleural puncture, and exploratory pleural puncture with biopsy. Practitioner experience remains a major risk factor.

However, ultrasound-guided percutaneous puncture of the internal jugular vein for venous cannulation; the use of ultrasound for pleural puncture in cases of pleurisy or for pleural biopsy are effective preventive measures that can reduce the incidence of pneumothorax.

Most cases are symptomatic; however, in mechanically ventilated patients, sudden changes in ventilatory pressures or oxygen desaturation should prompt immediate imaging.

Management depends on severity and symptoms, ranging from conservative measures to chest drainage, often increasing hospital stay, costs, and the risk of serious complications.

No conflict of interest to declare.

Written approval of patients was obtained.

REFERENCES

1. Çelik B, Sahin E, Nadir A, et al. Iatrogenic pneumothorax: etiology, incidence and risk foctors. Thorac Cardiov Surg. 2009;57:286-290.
2. El Hammoumi M.M, Driss G, Achir A, et al. Kabiri. Iatrogenic pneumothorax: experience of a Moroccan emergency center. Rev Port Pneumol. 2013;19:65-69.
3. Bauman M.H, Noppen M. Pneumothorax. Respirology. 2004;9:157-164.
4. Jhon J, Seifi A. Incidence of Iatrogenic pneumothorax in the United States in teaching vs non-teaching hospitals from 2000 to 2012. Journal of Critical Care. 2016;34:66-68.
5. Mac Duff A, Arnold A, Harvey J, et al. Management of spontaneous pneumothorax: Britsh thoracic society pleural guideline 2010. Thorax. 2010;65:ii18- ii31.
6. Bailey S.H, Shapiro S.B, Mone M.C, et al. Is immediate chest radiograph necessary after central venous catheter placement in a surgical intensive care unit? Am J Surg. 2000;180:517-521.
7. Molgaard O, Nielson MS, Handberg BB, et al. Routine X-ray control of upper central venous lines: is it necessary? Acta Anaesthesiol Scand. 2004;48:685-689.
8. Cavanna L, Anselmi E, Di Nunzio C. Ultrasound guidance of venous catheterization: Towards a zero risk of iatrogenic pneumothorax. Thorac Cardiov Surg. 2010;58:255.
9. Pikwer A, Baath L, Perstoft I, et al. Routine chest X-ray is not required after a low-risk central venous cannulation. Acta Anaesthesiol Scand. 2009;53:1145-1152.
10. Nour-Eldin N-EA, Alsubhi M, Emam A, et al. Pneumothorax complicating coaxial and non-coaxial CT-guided lung biopsy: Comparative analysis of determining risk factors and management of pneumothorax in a retrospective review of 650 patients. Cardiovasc Intervent Radiol. 2016;39:261-70.
11. Topal U, Ediz B. Transthoracic needle biopsy: factors effecting risk of pneumothorax. Eur J Radiol. 2003;48:263-267.
12. de Lassence A, Timsit JF, Tafflet M, et al. Pneumothorax in the intensive care unit: incidence, risk factors, and outcome. Anesthesiology. 2006;104:5-13.
13. Ricard JD. Barotrauma during mechanical ventilation: why aren't we seeing any more? Intensive Care Med. 2004;30:533-535.
14. Boussarsar M, Thierry G, Jaber S, et al. Brochard. Relationship between ventilatory settings and barotrauma in the acute respiratory diress syndrome. Intensive Care Med. 2002;28:406-413.
15. Bartter T, Mayo PD, Pratter MR, et al. Lower risk and higher yield for thoracentesis when performed by experienced operators. Chest. 1993;103:1873-1876.
16. Loiselle A, Parish J.M, Wilkens J.A, et al. Managing iatrogenic pneumothorax and chest tubes. Journal of Hospital Medicine. 2013;8:402-408.
17. Kelly AM, Kerr D, Clooney M. Outcomes of emergency department patients treated for primary spontaneous pneumothorax. Chest. 2008;134:1033-1036.
18. Deluis RE, Obeid FN, Horst HM, et al. Catheter aspiration for simple pneumothorax: experience with 114 patients. Arch Surg. 1988;124:833-836.
19. Faruqi S, Gupta D, Aggarwal AN, et al. Role of simple needle aspiration in the management of pneumothorax. Indian J Chest Dis Allied Sci. 2004;46:183-190.
20. Symbas PN. Chest drainage tubes. Surg Clin North Am. 1989;69:41-46.
21. Tomlinson MA, Treasure T. Insertion of a chest drain: how to do it. Br J Hosp Med. 1997;58:248-252.
22. Advanced trauma life support for doctors-student course manual. 7th ed. Chicago: American College of Surgeons; 2004.
23. Tang AT, Velissaris TJ, Weeden DF. An evidence-based approach to drainage of the pleural cavity: evaluation of best practice. J Eval Clin Pract. 2002;8:333-340.