2) 自己管理（0-6 点）	3.01	1.914
3) 薬（0-5 点）	0.75	0.887
4) 禁煙（0-3 点）	0.03	0.162
5) 運動（0-5 点）	1.15	0.730
6) 栄養（0-2 点）	0.99	0.507
合計点	7.25	3.480

在宅酸素療法に関するアンケートの項目から HOT 使用方法に関する情報量を含んだ質問項目を抽出し，HOT 項目のスコアを試案した（表 2）.

表２．HOT 関連の指標の候補

質問項目		配点
Q. 現在使用している酸素の処方量を教えて下さい	流量を知っている	0
	流量が判らない	1
Q. これまでに酸素が急に使えなくなった場合の対応について医師から説明を受けたことがありますか	ある	0
	ない	1
	わからない	1
Q. これまでに酸素が急に使えなくなった場合の対応について看護師から説明を受けたことがありますか	ある	0
	ない	1
	わからない	1
Q. これまでに酸素が急に使えなくなった場合の対応について酸素業者から説明を受けたことがありますか	ある	0
	ない	1
	わからない	1
Q. もしも急に酸素が使えなくなると，自分の体の具合はすぐに悪くなると思いますか	すぐに悪くなると思う	0
	すぐに悪くなるとは思わない	1
	あまり変らない	1
	わからない	2

HOT の流量に関しては，「流量を知っている」が 99％であった。また，「これまでに酸素が急に使えなくなった場合の対応について説明を受けたことがありますかの問い」では，「医師から説明を受けている」，「看護師から説明を受けている」，「業者からの説明を受けている」のそれぞれ項目において「受けたことがある」と回答したのは，それぞれ 17％，21％，39％であった。

この HOT 項目の合計スコアの range は 0-6 であり，平均値（SD）は 3.20（1.252），最頻値 4 で 49％であった.

HOT 項目の合計スコアは HOT の使用年数や酸素の効果の感じ方との相関は認められなかった.

HOT 項目のスコアと LINQ 合計とは弱い相関を認めた（r^2=0.096，p=0.0067）（図１）

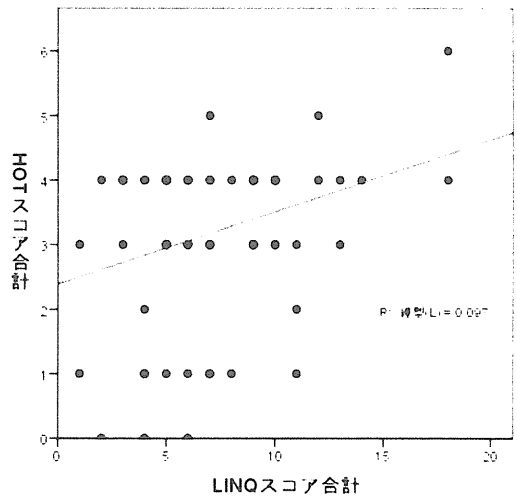

図１．HOT と LINQ の相関

D．考察

酸素流量についてはほとんどの患者が理解をしていた．一方で，酸素が使用できなくなった時の対応方法について，医師や看護師から受けていた患者は約 20％，酸素業者からは約 40％であった．現在，HOT の管理方法の説明に関しては，酸素業者からの説明によるものが多く，医師や看護師からの指導が十分

でないことが示唆された.質問項目としては,医師,看護師からの説明はほぼ同率であったことから1つの項目にまとめることができる.実際のケアでは,医療従事者と酸素業者と連携し,HOT 患者に自己管理方法,災害時の対応方法など包括的にケアされることが期待される.

また,酸素が使えなくなっても,すぐに悪くなるとは思わないが約90%を占めており,多くの患者が酸素が急に使えなくなっても,具合がすぐに悪くなるとは思っておらず,災害時など患者の対応が遅れる可能性がある.今回の質問項目では,「酸素が使えなくなった時」という状況に対する質問項目だけであったため,今後,調子が悪くなった時や呼吸困難が悪化した時、火気に関する質問項目を追加し,HOT の自己管理に関しても追加する必要がある.

LINQで評価したセルフマネジメントに関する情報の少ない患者は,HOT に関する情報も少ない傾向が認められた.

HOT に関する情報量は HOT 使用年数との関連を認めず,患者は情報を十分に得ていないまま HOT を継続している可能性がある.HOT 使用年数にかかわらず,HOT の教育は必要であり,情報量の少ない患者は HOT に関する項目だけでなく,包括的なセルフマネジメントに関する情報を得られない傾向にあり,増悪回数の増加や緊急時の対応ができない可能性がある.

HOT-LINQ を作成するにあたり,今後の課題として1)今回挙げた HOT-LINQ の評価候補について,その項目およびスコア配分の妥当性についての検証,2)HOT-LINQ における HOT 項目の追加項目の検討,3)HOT-LINQ による患者評価と各種臨床アウトカム,重症度との関係についての検討が必要である.

E. 結論

LINQ と HOT に関する患者の教育知識は関連しており,HOT 患者には COPD 全般の教育と同様に HOT に関する教育を行うべきである.

文献

1. American Thoracic Society / European Respiratory Society Task Force. Standards for the Diagnosis and Management of Patients with COPD. http://www.thoracic.org/go/copd.
2. Bourbeau J, Julien M, Maltais F, et al. Reduction of hospital utilization in patients with chronic obstructive pulmonary disease - A disease-specific self- management intervention. Archives of Internal Medicine 2003; 163:585-591.
3. Bourbeau J, Nault D, Dang-Tan T. Self-management and behaviour modification in COPD. Patient Educ Couns. 2004; 52: 271-277.
4. Wakabayashi R, Motegi T, Yamada K, et al. Efficient integrated education for older patients with chronic obstructive pulmonary disease using the Lung Information Needs Questionnaire. Geriatr Gerontol Int. 2011; 11: 422-430.
5. 日本呼吸器学会. COPD(慢性閉塞性肺疾患)診断と治療のためのガイドライン 第3版. メディカルレビュー社. 2009. http://www.jrs.or.jp

F. 研究発表

該当なし

G. 知的財産権の出願・登録状況

該当なし

厚生労働科学研究費補助金（循環器疾患・糖尿病等生活習慣病対策総合研究事業）
分担研究報告書

東日本大震災後の呼吸器疾患、HOT患者への対応、COPD自己管理支援に関する被災地調査

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研究要旨：東日本大震災後の60日間、石巻赤十字病院では呼吸器疾患緊急入院が例年同時期の3倍に増えた。震災後に緊急入院が増えた疾患は、肺炎、COPD増悪、気管支喘息であり、肺癌進行やその他の呼吸器疾患は不変だった。多数のHOT患者が、津波被害による酸素供給の断絶のため酸素吸入目的で石巻赤十字病院に来院し、外来で酸素吸入を受けた。スペースと酸素配管不足のため、リハビリセンターに酸素濃縮器を30台設置し、HOTセンターとした。震災後2週間で、20%のHOT患者が、呼吸不全増悪のため入院治療を要した。石巻地域では震災前からCOPD医療連携を行っているが、連携システムでCOPD教育を受けていた患者は、震災後もCOPD自己管理が良好だった。

A．研究目的

石巻医療圏（石巻市、東松島市、女川町）は、宮城県東部の太平洋沿岸に位置する人口22万人の地域から成るが、東日本大震災で、死者・不明者6000人、津波による瓦礫量500万トンと甚大な津波被災を被った。石巻赤十字病院は、医療圏の災害拠点病院として、殆どの医療機関が壊滅・診療停止された中で、震災直後より災害医療を担った。

津波の最大被害地であり、65歳以上の高齢化率28％と日本平均を超える石巻医療圏で、災害医療を担った石巻赤十字病院における呼吸器診療、HOT患者への対応、COPD自己管理支援の効果を調査した。この調査結果を今後の大規模災害時の呼吸器診療、HOT患者を含む慢性呼吸器疾患患者への対策に役立てることが本研究の目的である。

B．研究方法

1）　震災後60日間の呼吸器疾患の緊急入院調査は、診療録・看護記録、同院呼吸器内科のカンファレンスで蓄積されたデータ、同院の震災記録チームが作成したデータを用いた。

2）同院に開設したHOTセンターの調査は、診療録、HOT担当看護師の記録を用いた。

3）COPD自己管理支援の効果の調査は、石巻地域COPDネットワーク（ICON）の基幹病院である石巻赤十字病院でのICON外来での診療録、聞き取り調査を用いた。

4）気仙沼市立病院における震災前後（2010.3~2011.6）の市中肺炎による入院患者の実態調査を行った.

C．研究結果

1）石巻赤十字病院では、ゴールデンウィーク明けの5月9日まで、予約入院は行わず、災害医療のための緊急入院対応に専念した。この震災後60日間の呼吸器内科入院患者数は316名であり、2010年、2009年の同時期の緊急入院患者数の約3倍に増えた（図1）。

2010年、2009年と比べ、震災後に入院治療を要する患者が増えた疾患は、肺炎、COPD増悪、気管支喘息発作であった。震災後60日間を10日ずつ6旬に分けると、呼吸器内科入院患者は、肺炎が2

旬目、COPD 増悪、喘息発作が３旬目にピークを認めた（図 2）。

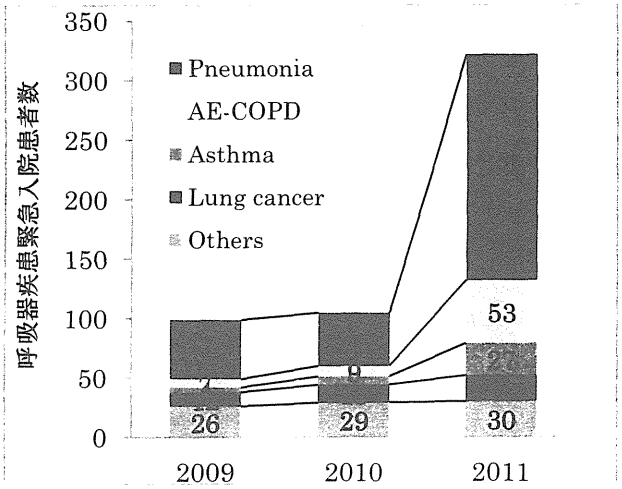
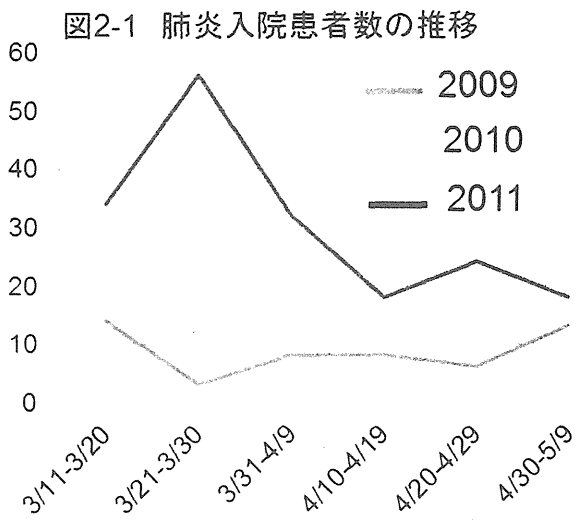
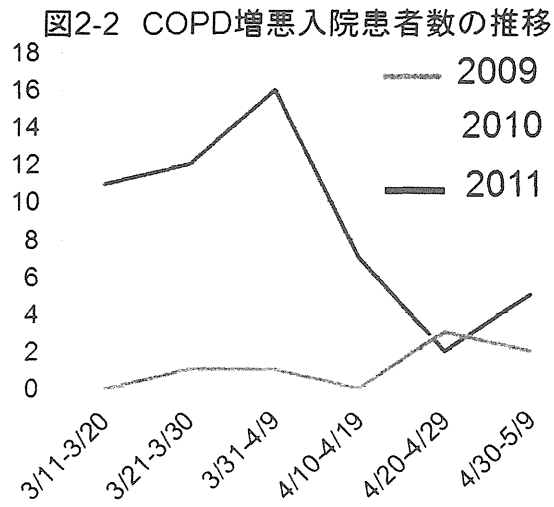
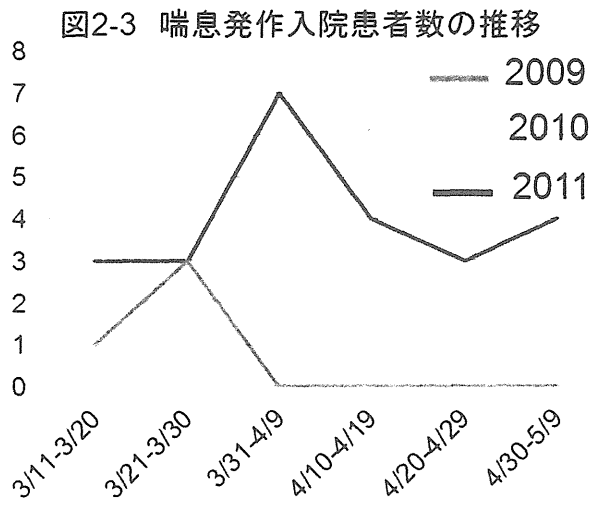


図 1. 疾患別緊急入院患者数の比較（2011. 3. 11-5. 9 と 2009, 2010 の同時期）







２）巨大津波により沿岸部は壊滅的被害を受け、広汎な家屋倒壊、瓦礫による道路の遮断、数日に及ぶ浸水の被害を被った。

阪神淡路大震災を教訓に、災害時には、在宅酸素療法（HOT）患者に対して酸素供給業者が患者個人に連絡を取り、患者の居住場所に酸素ボンベを供給するという災害対応マニュアルが確立された。今回の震災では、広範で甚大な被害、通信の断絶、交通の分断により、特に沿岸部でマニュアルに沿った HOT 患者への対応は困難であった。その結果、HOT 患者が自主的に到達できる医療機関や市役所に避難するという現象が起こった。

石巻医療圏には約 250 名の HOT 患者がいたが、その 3 分の 1 に当たる 88 名（そのうち 8 名は在宅非侵襲的人工換気 NPPV 療法も併用）が石巻赤十字病

院に来院した。

震災後、重症被災患者が多数搬送され、入院病床が足りず、中央処置室や健診センターに臨時病床50床を増床して対応した状況で、酸素が必要なだけでHOT患者を入院させる余裕はなかった。最初は、酸素配管のある外来診療室、予定を全てキャンセルして使用可能になった外来化学療法室、さらには病棟の4人部屋に臨時病床を作り、外来扱いでHOT患者を収容した。震災4日目に、リハビリテーション室に酸素濃縮器30台を設置し、HOTセンターを作りHOT患者を収容した（図3）。震災後のHOT来院患者と院内滞在患者の推移を図4に示す。自宅や親族宅に行くか、後方病院に搬送され、2週間でHOTセンターを終了できたが、その間、呼吸器内科医とHOT担当看護師が毎日回診し、必要な薬の処方、呼吸不全増悪の有無をチェックしたにもかかわらず、約2割のHOT患者が呼吸不全増悪を発症して入院治療を要した。

図3. HOTセンターを開設

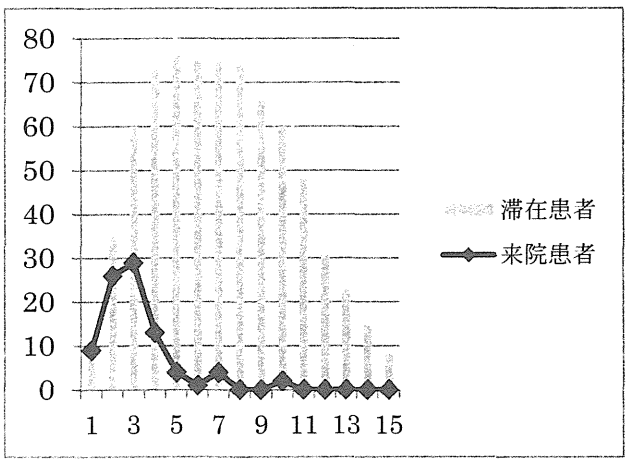


図4．来院したHOT患者数

3）石巻では、2009年に石巻地域COPDネットワーク(ICON)が設立された。石巻赤十字病院を基幹病院として60医療機関でCOPD医療連携を行っている。半年～1年毎の基幹病院でのICON外来では、看護師、療法士、薬剤師、栄養士による患者教育・指導に重点を置いている。このICON外来での診療録と聞き取り調査を用いて、震災前後にICON外来で患者教育を受けたCOPD患者106人の自己管理行動の可否について、大規模半壊以上の家屋被害と受けた患者群(50人)とそれ以外の患者群(56人)で調査した。評価した項目は、禁煙・運動・療養手帳の活用、吸入・HOTの5項目である。震災前の自己管理行動の良否を図5に示すが、震災前に自己管理行動が良好だった患者を以下の解析に用いた。甚大被災群とそれ以外の群で、病期分類、年齢に有意差は無かった。震災後も禁煙できた患者は両群ともに95%前後と高率だった(図6)。運動を継続できた患者は、甚大被災群で70%と少ない(図7)が、避難所居住や周囲の崩壊した環境の影響と考えられる。療養手帳の記載を継続できた患者は、甚大被災群では半分に満たない(図8)が、津波による手帳の流出、避難所生活のために記載できなかったと考えられる。吸入治療に関しては、被災の少ない群ではほぼ全例で継続できたのに、甚大被災群では30%の中断があった(図9)のは、薬を津波で流されたためであった。HOTの継続率が両群で80%を超えた(図10)ことは、被災の少ない群でも長期間の停電があったことを考慮すると驚異的である。石巻赤十字病院のHOTセンターに避難した患者も含まれている。

図5. 震災前の自己管理行動の良否

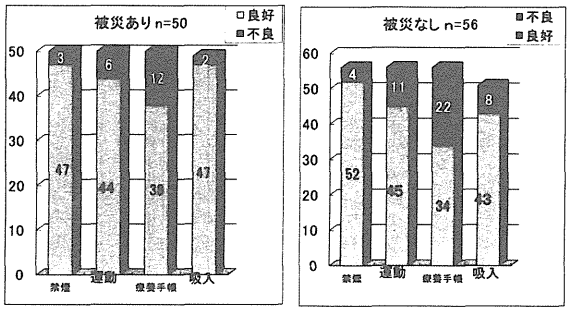


図6. 禁煙継続できた患者

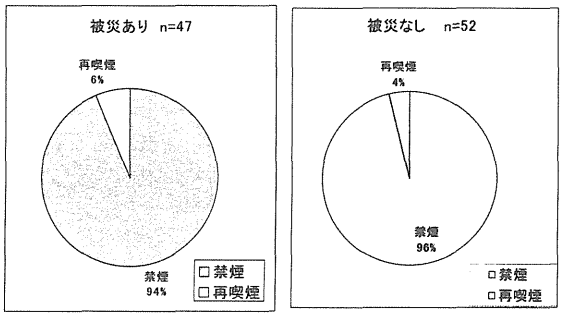


図7. 運動継続できた患者

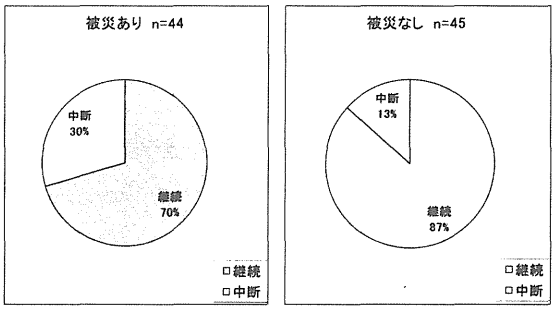


図8. 療養手帳記入継続できた患者

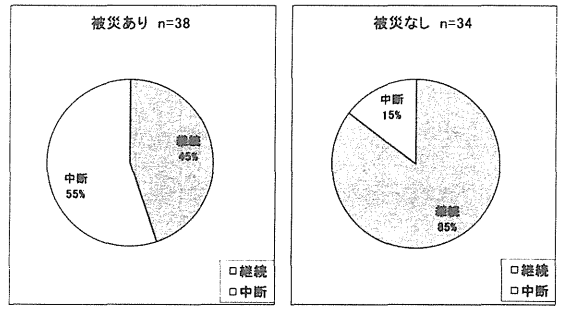


図9. 吸入継続できた患者

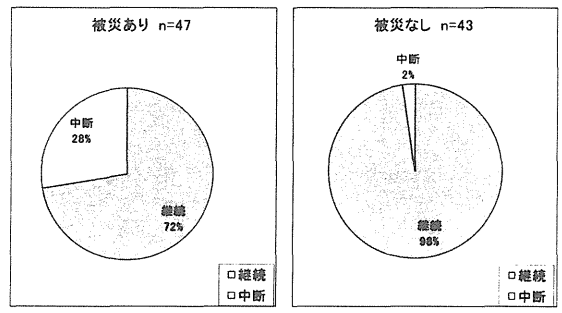
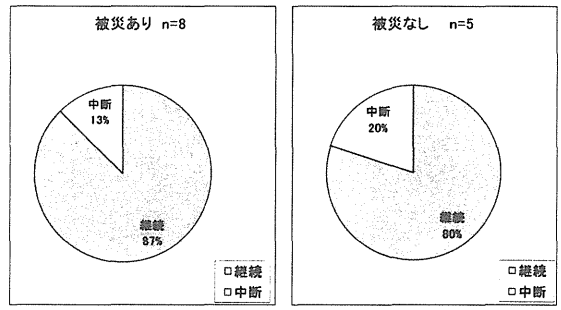


図10. HOTを震災中も継続管理できた患者



4）気仙沼市立病院における肺炎入院患者の調査により，発災から3ヶ月間に肺炎患者が増加しており，大半が高齢者であった．肺炎による入院は震災前の5.7倍に，また死亡が8.9倍に増加していた．自宅よりも，ナーシングホームや避難施設の患者に肺炎発症，死亡者が多かった．一方，津波による溺水が原因の患者はわずかに3.6%であった．

D．考察

1）震災後の急性期～亜急性期に入院治療を要する患者が増えた呼吸器疾患は、肺炎、COPD 増悪、気管支喘息発作であった。

肺炎患者の多くは、避難所や被災家屋での劣悪な環境下での ADL 低下、口腔衛生の悪化、栄養不良などが原因の高齢者肺炎だった。粉塵吸入による肺炎もみられ、急性期には津波肺もみられた。

COPD 増悪、気管支喘息増悪入院の増加は、吸入を中心とした薬物治療の中断、大気汚染、再喫煙の増加などが原因と考えられた。

震災後、肺癌の悪化や気胸、喀血などの疾患による入院は、2010 年、2009 年と同様であった。震災後 2 ヶ月間は、当院での肺癌の化学療法、手術、放射線治療は全て中止されたが、肺癌悪化による入院が増えなかったのは、治療中断期間が短かったためかもしれない。震災後、検診でスクリーニングされる胸部異常影の患者、肺癌手術の件数は震災後、大きく減少している。震災後、被災地での健診受診率が減少したが、その影響かと思われる。今後、手術不能な進行肺癌患者の増加が危惧される。

2）石巻赤十字病院では、HOT センターを設置して避難してきた HOT 患者を収容したが、わずか 2 週間で 2 割の HOT 患者が呼吸不全増悪により入院治療を要した。①津波被水を受けたこと、②被水は免れても寒い環境に置かれたこと、③酸素吸入を中断されたこと、④吸入薬、内服薬を津波で流されたこと、⑤病院滞在中に HOT 患者や家族が一定空間に密集したことなどが、HOT 患者での呼吸不全増悪の増加の原因と考えられる。

今回の経験を踏まえて、広域災害を想定した HOT 患者災害対策が必要であろう。その中には、①地域に HOT 患者が避難する HOT センターを予め決めておく（自治体、公共施設、病院など）、②HOT センターには、予め（または災害発生時に）酸素ボンベ、充電設備と燃料、酸素濃縮器、液体酸素、簡易ベッド（段ボールベッドなど）を設置する、③HOT 業者は、患者ごとではなく HOT センターごとを担当する、④HOT 患者は自治体や医師会に全員登録し、広域災害発生時には、安否確認や HOT センターへの誘導に活用する、特に高流量酸素吸入が必要で酸素断絶が致命的になる HOT 患者へは緊急的対応するような対策を取る、⑤HOT 患者は、出来るだけ早く被災地外に二次避難させ、呼吸不全増悪を予防することで、患者の救済および被災地病院負担の軽減を図る、などを盛り込んだマニュアルの作成が必要である。

また、災害時に酸素吸入をどこまで減量できるかを確認しておく、呼吸法で歩行時の動脈血酸素飽和度の低下を最小限に留める方法を習得するなど、予め HOT 患者の災害時アクションプランを立てておくことも重要である。

3）ICON 外来で COPD 教育・指導を受けた患者の 95%が震災後も禁煙を継続できたことは評価される。震災後に再喫煙した被災者が多いと言われている。震災 1 年後の石巻赤十字病院の喫煙対策委員会の調査では、職員の喫煙率は 9%だが、現喫煙者の 71%が震災後の再喫煙とのデータがある。その他の自己管理行動の項目でも、ICON 外来で教育・指導された患者は、震災後も出来る範囲で良好な自己管理行動をしていたことが確認された。平常時の患者教育が、災害時の自己管理行動の維持にも役立つことが示唆される。

4）石巻市と同様に気仙沼市における調査でも発災後 3 ヶ月間に肺炎入院と死亡者の増加を認めた. 高齢者に多く，また自宅ではない避難生活というストレスの多い環境が影響したと考えられる．早期から肺炎球菌ワクチンの接種，生活環境の迅速な改善，避難施設内でも早期の健診，口腔ケアの励行などの対策が必要である.

E．結論

東日本大震災から 2 年が経過した今、復旧・復興から取り残されている地域も未だ多い。

本年 4 月に復興庁は仮設住宅入居期間を再延長し、4 年間まで可能とした。今後、2 年間は仮設住宅に居住する被災者も多い。医療施設へのアクセ

スが悪く、狭い居住空間で長期間暮らすことの精神衛生、身体活動性への影響を、高齢者、とくに慢性呼吸不全患者等の慢性疾患を持つ患者で調査し、必要な介入を行う必要がある。

F．研究発表

該当なし

G．知的財産権の出願・登録状況

該当なし

研究成果の刊行に関する一覧

書籍

著者氏名	論文タイトル名	書籍全体の編集者名	書　籍　名	出版社名	出版地	出版年	ページ
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Yamanda S, Yanai M et al.	The impact of the 2011 Great East Japan Earthquake on hospitalisation for respiratory disease in a rapidly aging society: a retrospective descriptive and cross-sectional study at the disaster base hospital in Ishinomaki	BMJ open	3	e000865	2013
Daito H, Hagiwara K, et al.	Impact of the Tohoku earthquake and tsunami on pneumonia hospitalisations and mortality among adults in northern Miyagi, Japan: a multicenter observational study	Thorax	68	544-550	2013
Kobayashi S, Hanagama M, Yamanda S, Yanai M.	Home oxygen therapy during natural disasters:lessons from the Great East Japan Earthquake.	Eur Respir J	39	1047-1048	2012

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Original article

The impact of a large-scale natural disaster on patients with chronic obstructive pulmonary disease: The aftermath of the 2011 Great East Japan Earthquake

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ABSTRACT

Background: A large-scale natural disaster may exacerbate chronic respiratory diseases, such as chronic obstructive pulmonary disease (COPD). The aftermath of a natural disaster can include poor access to medication, medical equipment, and medical supplies. Little is known about the impact on patients with COPD.

Methods: A retrospective cohort study was conducted at a regional medical center in Ishinomaki, the area affected most severely by the Great East Japan Earthquake in 2011. The study was performed 6 months after the disaster. The characteristics, clinical courses, and outcomes of COPD patients hospitalized after emergency visits during the study period were investigated and compared.

Results: One hundred patients (112 episodes) were identified. Within a few days after the disaster, patients undergoing oxygen therapy at home came to the hospital to receive oxygen. In the subacute phase (from the third to the fifth week), the number of hospitalizations due to COPD exacerbations was significantly increased compared to the numbers observed before the earthquake ($p<0.05$). On admission, COPD patients reported significantly reduced participation in the activities of daily living (ADLs) after as compared to before the disaster. The incidence of cases of exacerbated COPD normalized 6 weeks after the earthquake.

Conclusions: The large-scale natural disaster that hit Japan in 2011 had a serious negative impact on the clinical outcomes of COPD patients in the disaster-affected area.

Abbreviations: ADL, activities of daily living; FEV1, forced expiratory volume in 1 s; FVC, forced vital capacity; GOLD, Global Initiative for Chronic Obstructive Lung Disease; NPPV, noninvasive positive pressure ventilation

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1. Introduction

Large-scale natural disasters, such as earthquakes or tsunamis, destroy buildings, vital infrastructure, communication technology, and transportation facilities, often resulting in many deaths and traumatic injuries. Medical resources and public health services are also often severely impaired. These disasters may exacerbate chronic respiratory diseases, such as chronic obstructive pulmonary disease (COPD). In the aftermath of the disaster, COPD patients often endure limited access to medication, medical equipment, and/or medical supplies. However, no systematic investigation has examined the impact of natural disasters on patients with COPD.

An earthquake of magnitude 9.0 occurred in Japan on March 11, 2011, most severely affecting the Tohoku region on the northeast coast of the country. A devastating tsunami followed the earthquake and caused widespread damage on Japan's eastern coast. Approximately 20,000 people were killed or went missing, and over 380,000 houses were destroyed [1]. In the aftermath of this catastrophe, we dealt with respiratory emergencies at a regional medical center set up in Ishinomaki to deal with the disaster's aftermath. We conducted a retrospective cohort study to evaluate the impact of the disaster on clinical outcomes among COPD patients.

2. Material and methods

2.1. *Study design*

We conducted a retrospective cohort study at the Japanese Red Cross Ishinomaki Hospital in Ishinomaki, Japan. The institution is a 402-bed tertiary hospital, which provides medical services to over 220,000 people in Ishinomaki and the surrounding cities. Ishinomaki is a port town located in the coastal area of Tohoku region and was one of the most affected cities by this disaster. The Japanese Red Cross Ishinomaki Hospital was designated as the region's primary medical center after this disaster. Although other medical facilities in Ishinomaki were either destroyed or damaged by the tsunami, the Japanese Red Cross Ishinomaki Hospital continued to operate at full capacity [2]. Remarkably, the electronic medical record system remained functional as well. Clinical laboratory and radiology services were also available. In the first 7 days after the disaster, we were able to treat 3938 emergency patients at the hospital.

This study was carried out in accordance with the Declaration of Helsinki and was approved by the Ethics Committee at the Japanese Red Cross Ishinomaki Hospital (December 5, 2011).

2.2. *Inclusion and exclusion criteria*

We reviewed the medical records of patients who made an emergency visit and required a hospital stay during the period from March 11 to September 10, 2011, and identified patients diagnosed with COPD in accordance with the GOLD criteria [3]. Each patient presenting with aggravated symptoms underwent a comprehensive assessment that included a physical examination, pulse oximetry, chest radiography, and electrocardiography. COPD exacerbation was defined as a sudden worsening of symptoms such as increased breathlessness, coughing, or sputum production, thereby requiring additional treatments [3]. Patients with symptoms exacerbated by congestive heart failure were excluded from the study. Patients with advanced cancer whose disease stabilization could not be achieved were also excluded. Patients who had received oxygen therapy at home and required emergency visits were included. We reviewed the medical records of COPD patients hospitalized due to exacerbations in the corresponding periods of 2009 and 2010 as controls.

2.3. *Data collection*

Sociodemographic characteristics, smoking status, and maintenance treatments at baseline were recorded for each patient. The presence of comorbidities, including congestive heart failure, ischemic heart disease, chronic liver disease, chronic renal disease, diabetes, and cancer was also assessed [4]. Pulmonary function tests were performed under stable conditions within a year before the emergency visit or after recovery from the symptoms induced by the disaster. The severity of COPD was defined in accordance with the GOLD criteria [3]. The ADLs of patients upon admission and before the earthquake were evaluated by interviewing patients or their caregivers. ADLs were classified as "good" if they could live without support, "fair" if they could not leave their residence without support or "poor" if they spent days in bed or in a chair and had lost the ability to move independently. Data relating to symptom exacerbation including the final diagnosis, treatment, and length of hospital stay were collected as well.

Patients were followed up at the outpatient clinic for over 3 months after discharge. If a patient was referred to another hospital, we contacted the institution and inquired about the patient's clinical course.

2.4. *Statistical analyses*

Individual comparisons were performed using the Wilcoxon signed-rank test. The non-parametric Wilcoxon rank sum test was used for the comparisons of categorical variables. Simple regression analysis was performed using the least squares method. P values less than 0.05 were considered significant. All analyses were performed using JMP software (SAS Institute Inc., NC).

3. Results

We identified 100 COPD patients (112 episodes) who presented at the emergency department and required hospitalization within 6 months after the disaster. The characteristics of the patients are shown in Table 1. The diagnosis and clinical course of each patient is presented in Tables 2 and 3. The details are provided below.

Table 1 – Patient characteristics.

Age (years)	78 (10)
Sex, male/female	89/11
Residence	
Home	84
Community evacuation center	12
Nursing home	3
Other hospital	1
Smoking history, pack-year[a]	55 (40)
Pulmonary function test[b]	
FEV1, L	0.93 (0.75)
%FEV1 (%)	45.1 (29.3)
FEV1/FVC	0.41 (0.18)
GOLD stage[b]	
Stage I/II/III/IV	6/29/20/29
Comorbidities	
Congestive heart failure	14
Ischemic heart disease	3
Chronic liver disease	4
Chronic renal disease	1
Diabetes	7
Cancer	10
Long-term oxygen therapy	46

Each data-point is presented as a number or median (interquartile range).
FEV1: forced expiratory volume in 1 s, %FEV1: percentage of predicted FEV1.
[a] Smoking history was not available in 11 patients.
[b] Pulmonary function testing was not available for 16 patients.

Table 2 – Diagnoses and clinical courses of 112 episodes.

Diagnosis	
Exacerbations of COPD	68
Oxygen-dependent evacuee	36[a]
Pneumothorax	8
Pulmonary embolism	0
Introduction of ventilator support	
NPPV	7
IMV	2
Length of hospital stay (days)	10 (8)
Prognosis	
In-hospital death	6
Death within 90 days[b]	10

Each data-point is presented as a number or median (interquartile range).
NPPV: noninvasive positive pressure ventilation, IMV: invasive mechanical ventilation.
[a] One patient who lost his oxygen equipment visited after closure of the temporary evacuation center.
[b] At 90 days, 10 patients were lost to follow-up.

3.1. *Patients receiving oxygen therapy*

During the period from March 11 to 17, 35 COPD patients who received long-term oxygen therapy at home (including 3 patients using NPPV) presented at the hospital after loss of a stable oxygen supply due to power failure or equipment damage (Fig. 1). Only 12 of these patients were treated at our hospital, with the remaining patients receiving regular treatment by general practitioners ($n=14$) or at other hospitals ($n=9$). These patients were triaged and then transferred to a temporary evacuation center established inside the hospital [5]. None of them showed exacerbated symptoms upon presentation to the hospital, but 20% (7/35) experienced exacerbations requiring additional treatment during their time at the evacuation center. These patients showed exacerbated symptoms on March 15 ($n=4$), 16 ($n=2$), and 17 ($n=1$). Rapid diagnostic tests were used to confirm that none of the patients had influenza. There was no difference between the exacerbated group and the non-exacerbated group in terms of age or gender. Since we could not obtain the results of pulmonary function tests for patients treated at other hospitals, differences in pulmonary function were not evaluated. Patients who were stable returned home when their local-area electricity was restored or were sent to rearward hospitals if they had lost their houses or means of survival. The median length of hospital stay was 9 days; the evacuation center was closed on March 26.

3.2. *Exacerbations of COPD*

During the 6-month study period, 63 patients with exacerbations (68 episodes) presented at the emergency department requiring hospitalization. Five patients were hospitalized twice during the study period. The number of patients hospitalized due to COPD exacerbations each week is shown in Fig. 2. The total number increased 1.5- and 1.3-fold compared to the corresponding periods in 2010 and 2009, respectively.

The number of patients increased during the period from 3 to 5 weeks after the earthquake and then decreased. We classified the patients into 3 groups in terms of the time of hospitalization after the disaster: the acute phase (first 2 weeks after the earthquake), the subacute phase (from weeks 3 to 5), and the chronic phase (from 6 weeks to 6 months). The number of patients admitted while in the subacute phase significantly increased compared to the corresponding periods in 2010 and 2009 ($p<0.05$). There were no significant differences between the patients in the acute plus subacute phase group as compared to those in the chronic phase group in terms of age, FEV1, percentage of predicted FEV1, regular medication, or long-term oxygen therapy. However, the deterioration in ADL upon admission was significantly different between the groups. The ADLs of patients were significantly decreased compared to that before the earthquake in the acute phase and subacute phase group ($p<0.01$) (Fig. 3a). In contrast, no reduction in ADL was observed during the chronic phase (Fig. 3b).

All patients with exacerbations were treated in accordance with the consensus guidelines [3]. Mechanical ventilation was required in 7 patients with NPPV and 1 patient with invasive mechanical ventilation. The in-hospital and 90-day mortalities of patients with exacerbations of COPD were 5.9% (4/68) and 13.6% (8/59), respectively. At 90 days, 9 patients had been lost to follow-up .

3.3. *Other pulmonary complications*

Eight patients with pneumothorax were identified during the study. None of these cases were associated with chest

Table 3 – The characteristics and clinical courses of patients with exacerbated COPD symptoms.

	All (n=68)	Acute and subacute phases (n=36)	Chronic phase (n=32)
Age (years)	77.5 (8.8)	77.0 (12.3)	78.0 (7.0)
Sex, male/female	61/7	31/5	30/2
Residence			
Home	52	25	27
Community evacuation center	12	9	2
Nursing home	3	0	3
Other hospital	1	1	0
Smoking history, pack-year	50 (39)	52.5 (39)	41.9 (40)
Pulmonary function test[a]			
FEV1, L	0.96 (0.67)	0.96 (0.42)	0.99 (0.92)
%FEV1 (%)	49.0 (28.5)	47.4 (26.6)	50.4 (30.1)
FEV1/FVC	0.44 (0.22)	0.42 (0.17)	0.49 (0.23)
GOLD stage[a]			
Stage I/II/III/IV	6/24/18/13	2/13/10/8	4/11/8/5
Comorbidities			
Congestive heart failure	14	8	7
Ischemic heart disease	4	4	0
Chronic liver disease	2	1	1
Chronic renal disease	1	1	0
Diabetes	6	3	3
Cancer	11	6	5
Regular treatment			
Anticholinergic	46	24	22
Long-acting beta agonist	44	26	18
Inhaled corticosteroid	23	15	8
Theophylline	16	13	3
Macrolide	5	5	0
Oral prednisolone	5	4	1
Long-term oxygen therapy	15	7	8
Chest infiltrate	36	18	18
Length of stay (days)	11 (11.5)	9 (11.3)	13 (14)
Prognosis			
In-hospital death	4	1	3
Death within 90-days[b]	8	4	4

Each data-point is presented as a number or median (interquartile range).
FEV1: forced expiratory volume in 1 s, %FEV1: percentage of predicted FEV1.
[a] Pulmonary function testing was not available in 7 patients.
[b] At 90 days, 9 patients had been lost to follow-up.

trauma. Six patients were treated conservatively, and 2 patients underwent thoracoscopic surgeries. Seven patients were cured, but 1 patient with very severe COPD required invasive mechanical ventilation and died due to complicating pneumonia. Six and 7 patients with pneumothorax were identified in the years 2009 and 2010, respectively. No patient included in the study experienced a pulmonary embolism.

4. Discussion

The findings of our study indicate that the Great East Japan Earthquake had a strong negative impact on clinical outcomes among COPD patients. In the acute phase of the disaster, patients with very severe COPD sought refuge in our hospital and were provided with oxygen therapy. A population 3 times as big was admitted due to exacerbated symptoms. During the chronic phase, the frequency of admission due to exacerbations returned to baseline levels.

During the acute phase, most of the COPD patients who presented at the hospital were seeking oxygen therapy. In Japan, home oxygen therapy is widely used for patients with chronic respiratory failure and is covered by the national healthcare insurance system [6]. Since the Hanshin–Awaji earthquake in 1995, medical personnel and oxygen-service providers have recognized the importance of managing oxygen-dependent patients during a disaster and have established emergency operation measures. The wide-scale disaster of 2011, however, was more catastrophic than predicted in even the most pessimistic scenarios. Fortunately, we were able to accept many oxygen-dependent patients who were normally treated at other clinics in addition to our own outpatients.

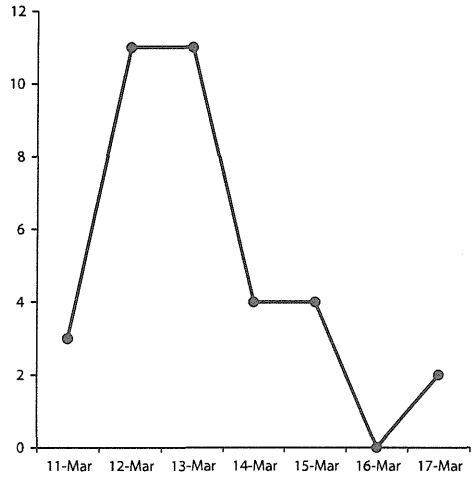

Fig. 1 – Number of oxygen-dependent patients who visited the hospital after the earthquake.

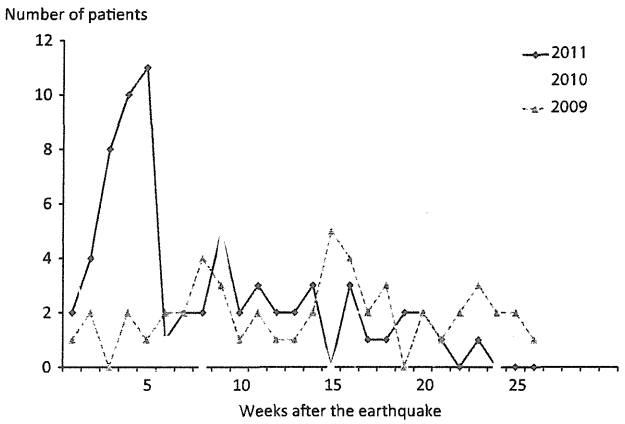

Fig. 2 – Numbers of patients hospitalized due to COPD exacerbations per week for 6 months after the disaster, and during the corresponding periods in 2010 and 2009.

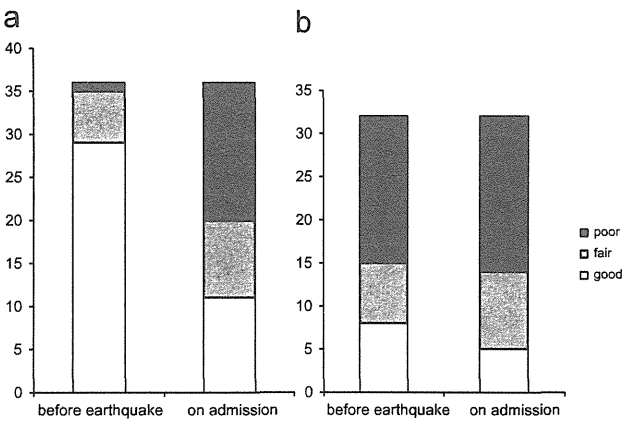

Fig. 3 – Comparison of patient ADL values prior to the earthquake, upon admission in the acute plus subacute phases group (a) and in the chronic phase group (b). ADL was classified as good, fair, or poor (see the text for more detail).

The evacuees were not hospitalized because all of the hospital beds were occupied by casualties who were seriously ill. Instead, each COPD patient was provided with a continuous oxygen supply via the central gas piping system in the outpatient ward. The unexpectedly high number of patients exceeded the facility's capacity for sound care. Therefore, on March 14, we established a temporary oxygen therapy center inside the hospital using electric oxygen concentrators. This area had been used as a rehabilitation center before the disaster and lacked an oxygen piping system [5]. Trained nurses in the Respiratory Medicine Department were assigned to the evacuation center to provide medical care, and respiratory physicians visited each outpatient every day. Nevertheless, there was a high incidence of symptom exacerbation among those patients staying at the evacuation center. Symptom severity was likely exacerbated by the facility's poor insulation [7,8] and the interruption of regular treatment [9]. Some patients had been drenched by the tsunami, while others, prior to their hospital visit, stayed in houses or shelters that not only lacked oxygen supplies but also lacked heating systems or water supplies. Some patients were also deprived of their prescribed drugs, and this interruption of regular treatment may have partly contributed to the worsening of symptoms.

The symptoms of many patients worsened during the subacute phase. The number of patients hospitalized due to exacerbated symptoms was 3 times higher than those hospitalized during the corresponding period in 2009 or 2010. First, interruption of regular treatment may have resulted in increase in exacerbations of COPD [9]. In addition to the factors cited above, tracheobronchial infections may be associated with worsened COPD symptoms. Previous reports demonstrated that respiratory infections increased in the aftermath of a massive earthquake [10,11]. In Ishinomaki and the surrounding areas, habitants suffered insufficient fuel supplies, power failures, water and food shortages, and an inability to maintain the appropriate level of personal hygiene. These conditions were compounded by cold winter temperatures and damaged houses or emergency shelters [2]. Such unfavorable conditions are likely to result in the increased occurrence of respiratory infections. The inhalation of dust and fine particles from rubble and tsunami-sludge also make breathing difficult. It has been reported that air pollution is an important risk factor for the exacerbation of COPD [12,13]. Many buildings in Ishinomaki were destroyed by the tsunami, and the entire area was covered by a thick layer of mud. Thus, chemicals, particulates, and biological materials from debris and tsunami-sludge may have contributed to the worsening of respiratory symptoms among COPD patients in the area hit by the tsunami.

The deterioration of ADLs in the acute and subacute phases after the disaster resulted in increased number of hospitalizations (Fig. 3a). It was previously reported that physical disability was an independent risk factor for death after the Hanshin–Awaji earthquake [14] and the 1999 Taiwan earthquake [15]. However, those reports investigated mortality in the acute phase, but not hospitalizations in the subacute or chronic phases. Recent reports have also demonstrated that physical inactivity is a risk factor for symptom aggravation and mortality in COPD [16,17]. After the earthquake and

tsunami in the Ishinomaki region, over 40,000 evacuees stayed at crowded emergency shelters, where they had to lie down on the floor without beds. Elderly patients with COPD were largely sedentary, which led to ADL deterioration. Furthermore, impaired ADLs and poor oral hygiene induced swallowing dysfunction, which can in turn exacerbate COPD [18].

The number of patients presenting with COPD exacerbations declined in the chronic phase as compared to the subacute phase. The recovery of water and food supplies, the restoration of vital infrastructure and medical services, and the improvement in living conditions may have contributed to this phenomenon. In Ishinomaki and the surrounding cities, medical relief teams circulated around community evacuation centers and prescribed medications for patients with chronic disease [2]. These efforts minimized the interruption of treatment during the chronic phase.

Diagnoses of pneumothorax [19] and pulmonary embolism [20] should be considered in COPD patients reporting exacerbated symptoms, even in the aftermath of natural disasters. In this study, we identified 8 patients with pneumothorax, and none with pulmonary embolism. Patients whose symptoms had worsened underwent comprehensive evaluation, including chest radiography, which led to the detection of pneumothorax in several patients.

The major limitation of our study is its single-center, retrospective design. The Japanese Red Cross Ishinomaki Hospital is the only regional respiratory center in the Ishinomaki medical-care zone. In 2009, we established a regional medical liaison system to provide patients with comprehensive care in Ishinomaki and the surrounding region. This collaboration involved general practitioners, pharmacies, rehabilitation clinics, and home-visit nursing stations. The system was set up so that our hospital accepted all COPD patients with respiratory emergencies who were located in the Ishinomaki medical care-zone and required hospital management. Therefore, the results of our study will accurately reflect the impact of the disaster on COPD symptoms.

Another limitation of this study was that some data were not available due to disruptions caused by the disaster. We had to exclude some patients who had chronic respiratory symptoms and emphysema as diagnosed by chest radiography, but did not confirm the diagnosis with a pulmonary function test. Although we tried to contact the hospital to ascertain patient outcomes, some patients that were referred to rearward hospitals could not be followed up.

To our knowledge, this is the first retrospective study to determine outcomes in patients with COPD who experienced a large-scale natural disaster in a developed nation with an aging population. Although pulmonary complications, such as chest trauma or respiratory infection, are commonly recognized after natural disasters [21,22], the impact on the outcomes of COPD patients had not previously been clarified [23]. The results of our study indicate that patients with COPD will suffer substantially in the aftermath of natural disasters.

In conclusion, the present study demonstrates that large-scale natural disasters have a negative impact on clinical outcomes among COPD patients in the affected area. Further studies are required to determine how various types of natural disasters influence clinical outcomes. Our results suggest that respiratory physicians, in cooperation with disaster specialists, should develop strategies for the management of COPD patients in the aftermath of natural disasters.

Conflict of interest

The authors have no potential conflict of interest.

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REFERENCES

[1] National Police Agency of Japan. Damage situation and police countermeasures associated with 2011 Tohoku district—off the Pacific Ocean Earthquake. 〈http://www.npa.go.jp/archive/keibi/biki/higaijokyo_e.pdf〉 [accessed 03.03.2012].
[2] Ishii T. Medical response to the Great East Japan Earthquake in Ishinomaki City. WPSRJ 2011. http://dx.doi.org/10.5365/wpsar.2011.2.4.005.
[3] Global Initiative for Chronic Obstructive Lung Disease. Global strategy for the diagnosis, management and prevention of COPD. Updated 2010. 〈http://www.goldcopd.org〉 [accessed 11.08.2011].
[4] Barnes PJ, Celli BR. Systemic manifestations and comorbidities of COPD. Eur Respir J 2009;33:1165–85.
[5] Kobayashi S, Hanagama M, Yamanda S, et al. Home oxygen therapy during natural disasters: lessons from the Great East Japan Earthquake. Eur Respir J 2012;39:1047–8.
[6] Kida K. Home oxygen therapy in Japan: clinical application and considerations for practical implementation. JMAJ 2011;54:99–104.
[7] Donaldson GC, Seemungal TA, Jeffries DJ, et al. Effect of environmental temperature on symptoms, lung function and mortality in COPD patients. Eur Respir J 1999;13:844–9.
[8] Donaldson GC, Goldring JJ, Wedzicha JA. Influence of season on exacerbation characteristics in patients with COPD. Chest 2012;141:94–100.
[9] Jarad NA, Wedzicha JA, Burge PS, et al. An observational study of inhaled corticosteroid withdrawal in stable chronic obstructive pulmonary disease. Respir Med 1999;93:161–6.
[10] Maeda H, Nakagawa M, Yokoyama M. Hospital admissions for respiratory diseases in the aftermath of the great Hanshin earthquake. Nihon Kyobu Shikkan Gakkai Zasshi 1996;34:164–73.
[11] Takakura R, Himeno S, Kanayama Y, et al. Follow-up after the Hanshin-Awaji earthquake: diverse influences on pneumonia, bronchial asthma, peptic ulcer and diabetes mellitus. Intern Med 1997;36:87–91.
[12] Anderson HR, Spix C, Medina S, et al. Air pollution and daily admissions for chronic obstructive pulmonary disease in 6 European cities: results from the APHEA project. Eur Respir J 1997;10:1064–71.
[13] Sunyer J, Saez M, Murillo C, et al. Air pollution and emergency room admission for chronic obstructive pulmonary disease: a 5-year study. Am J Epidemiol 1993;137:701–5.

[14] Osaki Y, Minowa M. Factors associated with earthquake death in the great Hanshin-Awaji earthquake. Am J Epidemiol 1995;153:153–6.
[15] Chou YJ, Huang N, Lee CH, et al. Who is at risk of death in an earthquake? Am J Epidemiol 2004;160:688–95.
[16] Garcia-Aymerich J, Farrero E, Felez MA, et al. Risk factors of readmission to hospital for a COPD exacerbation: a prospective study. Thorax 2003;58:100–5.
[17] Waschki B, Kirsten A, Holz O, et al. Physical activity is the strongest predictor of all-cause mortality in patients with COPD: a prospective cohort study. Chest 2011;140:331–42.
[18] Kobayashi S, Kubo H, Yanai M. Impairment of the swallowing reflex in exacerbations of COPD. Thorax 2007;62:1017.
[19] Emerman CL, Cydulka RK. Evaluation of high-yield criteria for chest radiography in acute exacerbation of chronic obstructive pulmonary disease. Ann Emerg Med 1993;22:680–4.
[20] Rizkallah J, Man SF, Shin DD. Prevalence of pulmonary embolism in acute exacerbations of COPD: a systematic review and metaanalysis. Chest 2009;135:786–93.
[21] Robinson B, Alatas MF, Robertson A, et al. Natural disasters and the lung. Respirology 2011;16:386–95.
[22] Bartels SA, VanRooyen MJ. Medical complications associated with earthquakes. Lancet 2012;379:748–57.
[23] Ishihara K, Fujii H, Watanabe I, et al. The Kobe earthquake and pulmonary disease. Kokyu 1996;15:93–8.

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The impact of the 2011 Great East Japan Earthquake on hospitalisation for respiratory disease in a rapidly aging society: a retrospective descriptive and cross-sectional study at the disaster base hospital in Ishinomaki

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ABSTRACT

Objective: To investigate the impact in an aging society of the 2011 Great East Japan earthquake on hospitalisation for respiratory disease at the disaster base hospital.

Design: Descriptive and cross-sectional study.

Setting: Emergency care in Japanese Red Cross Ishinomaki Hospital, a regional disaster base hospital in Miyagi, Japan.

Participants: 322 emergency patients who were hospitalised for respiratory disease from 11 March to 9 May 2011, and 99 and 105 emergency patients who were hospitalised in the corresponding periods in 2009 and 2010, respectively.

Main outcome measures: Description and comparison of patient characteristics and disease distribution in terms of age, time after the disaster and activities of daily living (ADL).

Results: 1769 emergency patients were admitted to our hospital during the study period (compared to 850 in 2009 and 1030 in 2010), among whom 322 were hospitalised for respiratory disease (compared to 99 in 2009 and 105 in 2010). Pneumonia (n=190, 59.0%) was the most frequent cause of admission for pulmonary disease, followed by acute exacerbation of chronic obstructive pulmonary disease (AE-COPD) (n=53, 16.5%), asthma attacks (n=27, 8.4%) and progression of lung cancer (n=22, 6.8%). Compared with the corresponding periods in 2009 and 2010, the increase in the absolute numbers of admissions was highest for pneumonia, followed by AE-COPD and asthma attacks. At hospitalisation, 195 patients were 'dependent' and 54 patients were 'partially dependent'. Respiratory admissions accompanied by deterioration of ADL after the disaster were more frequent in elderly and female patients.

Conclusions: After the Great East Japan Earthquake, admissions for pneumonia and exacerbation of chronic respiratory disease in the elderly increased at the disaster base hospital.

ARTICLE SUMMARY

Article focus

- The Great East Japan Earthquake affected one of the most rapidly aging societies in the world.
- We describe how the disaster affected respiratory diseases in the worst affected area, which has one of the highest ratios of elderly people in Japan.
- The study provides lessons for use after natural disasters in an aging society.

Key messages

- After the earthquake and tsunami, admissions for pneumonia and exacerbation of chronic respiratory disease increased among the elderly.
- Harsh conditions and poor activities of daily living status after the disaster may be associated with increased hospitalisation for respiratory diseases in elderly people.

Strengths and limitations of this study

- We were able to obtain detailed patient data after a disaster.
- We only studied hospitalised patients, but there were also numerous outpatients, many of whom died.

INTRODUCTION

On 11 March 2011, at 14:46 h Japanese time, the Pacific coast of Japan's Tohoku (north-eastern) region was struck by a huge earthquake (The Great East Japan Earthquake) measuring 9.0 on the Richter scale.[1] The earthquake triggered a devastating tsunami which destroyed many towns and villages close to the sea. The epicentre was estimated to be about 130 km east of Oshika Peninsula in Miyagi Prefecture. Officially, over 19 000

people were killed or are missing and there were more than 550 000 refugees.[2]

Ishinomaki city, located on the Pacific coast of Honshu Island, lost the most victims in the disaster, with 3280 people killed and 669 still missing. A huge number of casualties, more than 10 000 patients in the first 30 days, were treated at Japanese Red Cross Ishinomaki Hospital, a regional disaster base hospital in Ishinomaki which preserved its hospital function during and after the catastrophe.

Japan is one of the most rapidly aging societies in the world. In 2010, 23% of Japanese citizens were aged 65 or over,[3] while 26.6% of people living in Ishinomaki city in the Tohoku region were aged 65 or over. Although several reports showed a significant association between age and death following the earthquake and tsunami,[4–8] few reports have investigated the impact of a huge disaster on the elderly in an aging society.[9 10]

As respiratory diseases are common in the elderly, investigating the impact of the disaster on respiratory health will help elucidate the problems of an aging society. Thus, we carried out a retrospective descriptive and cross-sectional analysis of the medical and epidemiological data of patients requiring hospitalisation for respiratory disease after the Great East Japan Earthquake and subsequent tsunami.

METHODS

This study was a retrospective descriptive and cross-sectional analysis of data obtained from the medical records at Japanese Red Cross Ishinomaki Hospital. We reviewed the medical records of patients admitted to the hospital for respiratory diseases during the first 60 days after the Great East Japan Earthquake, when the hospital only accepted emergency patients. We also reviewed the medical records of patients who required unscheduled hospitalisation for respiratory disease in the corresponding periods in 2009 and 2010.

Japanese Red Cross Ishinomaki Hospital has 402 inpatient beds and is located 4.5 km inland from the Pacific. It serves approximately 220 000 people (Ishinomaki City, Onagawa Town and Higashi-matsushima City) and was designated a regional disaster base hospital. It normally accepts most emergency respiratory patients in the region because it has a respiratory department and employs pulmonary specialists.

Information on date of admission, age, sex, diagnosis and place of residence was extracted from the medical records for the 2011 study period. We also investigated activities of daily living (ADL) before the earthquake and at hospitalisation. The number of unscheduled hospitalisations during the corresponding periods in 2009 and 2010 were counted for comparison.

Pneumonia was defined as the presence of infiltrates on chest radiograph together with one or more of the following signs or symptoms: fever, cough, sputum production, breathlessness, pleuritic chest pain or signs consistent with pneumonia on auscultation.

Chronic obstructive pulmonary disease (COPD) and bronchial asthma were determined according to spirometric data, patient self-report or physician diagnosis based on patient history, physical examination and radiological findings. An acute exacerbation of COPD (AE-COPD) was defined as an increase in or new onset of more than one symptom of COPD (cough, sputum, wheezing, dyspnoea or chest tightness) without pneumonia or pneumothorax. An attack of asthma was defined as wheeze or severe cough in asthma patients without pneumonia. Progression of lung cancer was defined as a requirement for admission for a lung cancer-associated condition such as dehydration, respiratory failure or uncontrolled pain. Obstructive pneumonia due to lung cancer was considered to be progression of lung cancer. Chest trauma and traumatopnea were deemed to be chest injury rather than respiratory disease.

ADL was assessed based on information provided by the patient, the patient's family or the patient's caregiver, and the patient classified into one of three categories: 'independent'(living without particular support), 'partially dependent' (unable to leave home without support), 'dependent' (spending the day in bed or in a wheelchair and unable to move about independently). To investigate the impact of the disaster on ADL, we defined as 'originally dependent' those who were dependent or partially dependent before the disaster, and as 'newly dependent' those who became dependent or partially dependent after the disaster.

Data analysis

All data were entered into a personal computer and analysed using Microsoft Excel software. Statistical analysis was performed using JMP9 (SAS Institute, Cary, North Carolina, USA). A missing value in a medical record was treated as 'unknown'. Results were given as means±SD for numerical variables and as proportions for categorical variables. To analyse sequential changes in the effects of the disaster, we divided the 60 days of the study period into six groups of 10-day bins. To investigate the risk of hospitalisation for respiratory disease after the earthquake and tsunami, we compared patient characteristics for the 2011 study period with the combined data for the corresponding periods in 2009 and 2010. We used a two-sided Student t test for numerical variables and the χ^2 test for categorical variables. Statistical significance was set at $p<0.05$.

RESULTS

For the first 60 days following the earthquake, all scheduled admissions to Japanese Red Cross Ishinomaki Hospital were cancelled and only emergency admissions were accepted. During this period, 1769 patients were admitted to the hospital, 322 of whom were hospitalised for respiratory disease. In the corresponding periods in 2009 and 2010, there were 850 (99 for respiratory disease) and 1030 (105 for respiratory disease)

unscheduled admissions, respectively. Patients hospitalised for respiratory disease accounted for 18.2% of total admissions during the 2011 study period. This proportion was significantly higher than that in 2009 (11.6%; p<0.001) or 2010 (10.2%; p<0.001). While the number of admissions in 2011 was approximately twice that in 2009 or 2010, hospitalisation for respiratory disease in 2011 was three or more times greater than in 2009 or 2010. The overall number of hospitalisations peaked during the first 10 days, while the number of admissions for respiratory disease continued to increase for the first 20 days (figure 1A,B).

We compared the numbers and proportions of patients hospitalised for respiratory disease between 2011, 2010 and 2009 (figure 2). Pneumonia was the most frequent disease (n=190, 59.0%), followed by AE-COPD (n=53, 16.5%), asthma attacks (n=27, 8.4%) and progression of lung cancer (n=22, 6.8%). One case of AE-COPD and seven cases of asthma attacks were physician diagnoses. The category 'others' included pneumothorax, restrictive thoracic disease, pleural effusion, influenza, drowning, primary pulmonary hypertension, requirement for mechanical ventilation for neuromuscular disease, etc. One patient diagnosed with pneumonia who also had an asthma attack, and two patients with COPD exacerbated by pneumonia were treated for both conditions and counted as pneumonia. In comparison with the previous 2 years, the increase in the number of hospitalisations was greatest for pneumonia, followed by AE-COPD and asthma attacks. The numbers of hospitalisation for progression of lung cancer and for 'others' were similar to those in the previous 2 years. In 2011, 39.4% of patients were hospitalised from emergency shelters.

To investigate the disease-specific effect of the earthquake, the age and sex of each patient with a particular disease were compared between the study period in 2011 and the corresponding periods in the previous 2 years. The mean age of patients hospitalised for respiratory disease was significantly higher in 2011 than in the preceding 2 years (75.7±12.5 vs 73.2±13.4 years old; p=0.03). There were fewer males in 2011 compared to the previous 2 years (59.6% in 2011, 67.2% in 2010 and 2009; p=0.08). Specifically, pneumonia patients and AE-COPD patients were significantly older in 2011 compared to 2010 and 2009 (pneumonia patients were 77.6±11.8 vs 74.3±12.8 years old; p=0.03, while AE-COPD patients were

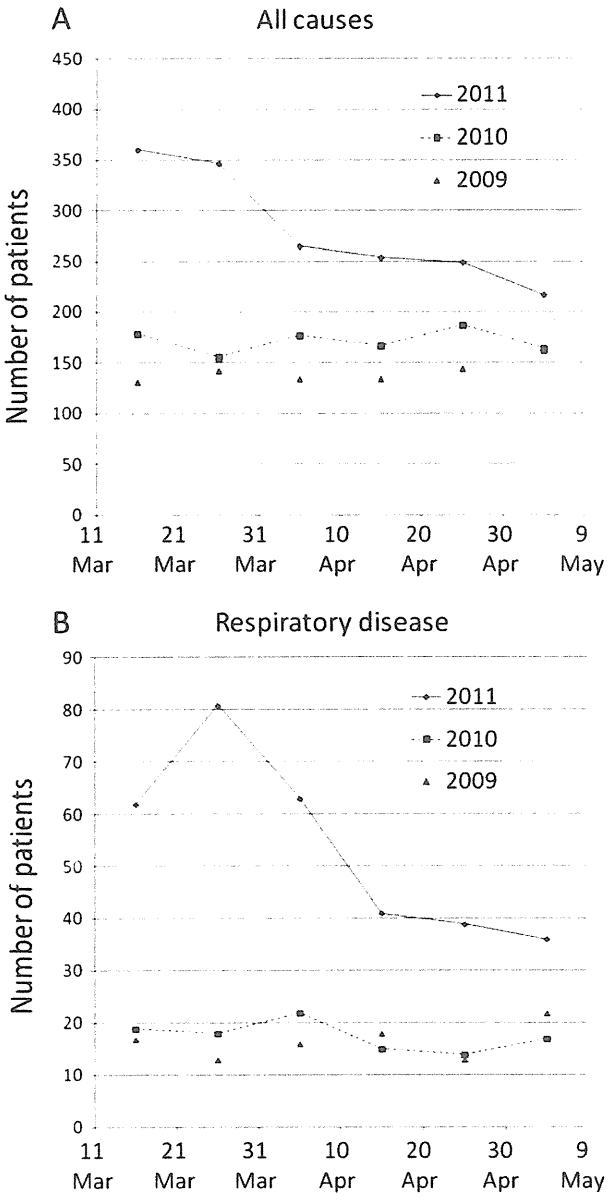

Figure 1 Number of unscheduled admissions for all causes (A) and for respiratory disease (B) from 11 March to 9 May in 2009, 2010 and 2011, presented in 10-day bins.

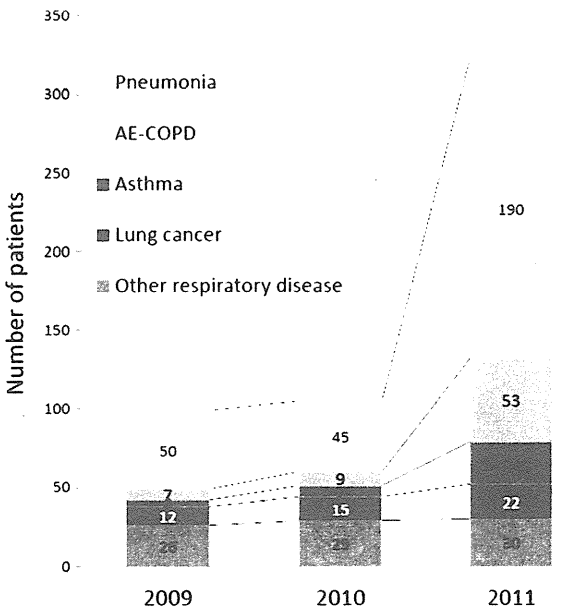

Figure 2 Number and proportion of patients hospitalised for respiratory disease pooled from 11 March to 9 May in 2009, 2010 and 2011. AE-COPD, acute exacerbation of chronic obstructive pulmonary disease.

76.0±8.7 vs 69.5±15.9 years old; p=0.03). Significantly more males had AE-COPD (81.1% vs 50.0%; p=0.01), but significantly fewer had asthma attacks in 2011 compared with 2010 and 2009 (18.5% vs 54.6%; p=0.03).

The numbers of admissions for the main respiratory diseases for each 10-day bin during the study period are shown in figure 3. Pneumonia peaked during the second 10-day bin, AE-COPD and asthma attacks peaked during the third 10-day bin and progression of lung cancer peaked in the fifth 10-day bin.

Next, we investigated ADL status at hospitalisation and before the disaster among patients admitted during the 2011 study period. Because of the confused situation after the disaster, ADL status was not recorded in 11 patients. At hospitalisation, 195 patients (60.5%) were 'dependent' and 54 patients (16.7%) were 'partially dependent'. However, before the earthquake, only 86 patients (26.7%) were 'dependent' and 51 patients (15.8%) were 'partially dependent'. To investigate the impact of ADL status and its deterioration on time of admission for pulmonary disease after the disaster, we counted the number of patients who were 'originally dependent', 'newly dependent' or 'independent throughout' in each of the 10-day bins (figure 4). Throughout the study period, the majority of patients were dependent or partially dependent. In the first 20 days, the majority of admissions were for 'originally dependent' patients. After 3 weeks, there was a sharp increase in 'newly dependent' patients, as assessed by ADL status. Independent patients were mainly hospitalised during the first 20 days.

Table 1 shows the relationship between ADL category ('independent throughout', 'newly dependent' and 'originally dependent') and patient age, sex and diagnosis. The ratio of each disease was calculated for each category. Eleven patients whose ADL status was not completely recorded were excluded from the analysis. Young and male patients were more frequent in the order 'independent', 'newly dependent' and 'originally dependent'. In regard to patient diagnosis, proportion of pneumonia and progression of lung cancer increased in the same order, while the proportion of AE-COPD and asthma decreased.

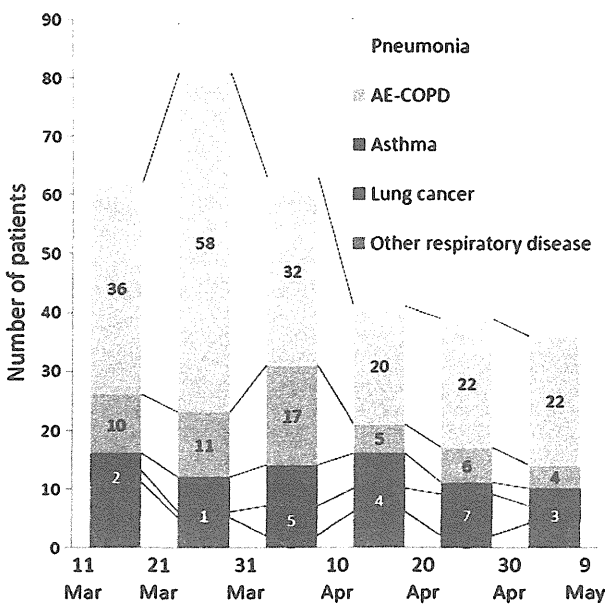

Figure 3 Distribution of patients hospitalised for respiratory disease after the Great East Japan Earthquake from 11 March to 9 May in 2011, presented in 10-day bins. AE-COPD, acute exacerbation of chronic obstructive pulmonary disease.

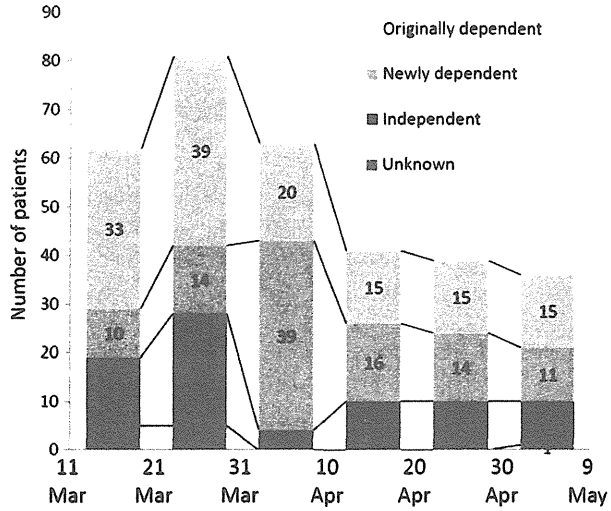

Figure 4 Influence of the disaster on activities of daily living status and its deterioration in patients hospitalised for respiratory disease from 11 March to 9 May in 2011, presented in 10-day bins.

DISCUSSION

Summary

In this retrospective descriptive and cross-sectional study, we found a substantial increase in the proportion of elderly patients hospitalised for respiratory disease after the earthquake and tsunami. Pneumonia, AE-COPD and

Table 1 Relationship between activities of daily living (ADL) and patient characteristics and respiratory disease

	Independent (n=70)	Newly dependent (n=104)	Originally dependent (n=137)
Age (years)	69.9±15.1	73.1±11.2	80.3±10.5
Male	49 (70.0)	63 (60.6)	69 (50.4)
Diagnosis			
Pneumonia	31 (44.3)	59 (56.7)	94 (68.6)
AE-COPD	17 (24.3)	17 (16.4)	15 (11.0)
Asthma	11 (15.7)	11 (10.6)	5 (3.7)
Lung cancer	3 (4.3)	6 (5.8)	12 (8.8)
Others	8 (11.4)	11 (8.0)	11 (8.0)

AE-COPD, acute exacerbation of chronic obstructive pulmonary disease.
Data are mean±SD for numerical variables and number (%) for categorical variables.