	100.0	72.1	16.8	3.7	7.4

(N, %)
東日本大震災・高齢被災者健康調査

【１８】握力（回収する担当者が測らせていただきます）
＜利き手＞

	総数	右手	左手	無回答
＊＊【総数】＊＊	1576	1067	33	476
	100.0	67.7	2.1	30.2

(N, %)
東日本大震災・高齢被災者健康調査

＜握力：右一回目＞

	総数	15kg未満	15kg以上 20kg未満	20kg以上 25kg未満	25kg以上 30kg未満	30kg以上 40kg未満	40kg以上 50kg未満	50kg以上	無回答	平均 (kg)
＊＊【総数】＊＊	1576	205	308	324	185	228	42	3	281	29782
	100.0	13.0	19.5	20.6	11.7	14.5	2.7	0.2	17.8	23.00

(N, %)
東日本大震災・高齢被災者健康調査

＜握力：右二回目＞

	総数	15kg未満	15kg以上 20kg未満	20kg以上 25kg未満	25kg以上 30kg未満	30kg以上 40kg未満	40kg以上 50kg未満	50kg以上	無回答	平均 (kg)
＊＊【総数】＊＊	1576	191	299	307	188	233	57	－	301	29921
	100.0	12.1	19.0	19.5	11.9	14.8	3.6	－	19.1	23.47

(N, %)
東日本大震災・高齢被災者健康調査

＜握力：左一回目＞

	総数	15kg未満	15kg以上 20kg未満	20kg以上 25kg未満	25kg以上 30kg未満	30kg以上 40kg未満	40kg以上 50kg未満	50kg以上	無回答	平均 (kg)
＊＊【総数】＊＊	1576	235	333	288	171	221	31	2	295	28555

	100.0	14.9	21.1	18.3	10.9	14.0	2.0	0.1	18.7	22.29

(N, %)

東日本大震災・高齢被災者健康調査

＜握力：左二回目＞

	総数	15kg未満	15kg以上 20kg未満	20kg以上 25kg未満	25kg以上 30kg未満	30kg以上 40kg未満	40kg以上 50kg未満	50kg以上	無回答	平均 (kg)
＊＊【総数】＊＊	1576 100.0	231 14.7	333 21.1	282 17.9	160 10.2	216 13.7	38 2.4	1 0.1	315 20.0	28207 22.37

Ⅱ．研究成果の刊行に関する一覧表

別紙4

研究成果の刊行に関する一覧表

雑誌

発表者氏名	論文タイトル名	発表誌名	巻号	ページ	出版年
Furukawa K, Arai H.	Earthquake in Japan	Lancet	377	1652	2011
冲永壯治	1．被災地からの報告 1)広域災害で生命線を失った高齢者が直面したこと	日本老年医学会雑誌	48	485-488	2011
Tomita N, Une K, Ohrui T, Ebihara T, Kosaka Y, Okinaga S, Furukawa K, Arai H.	Functional decline after an emergency shelter stay Misleading evidence.	JAGS	60	2380-2082	2012
Furukawa K, Ootsuki M, Kodama M, Arai H.	Exacerbation of dementia after the earthquake and tsunami in Japan	J Neurol	259	1243	2012
Daito H, Suzuki M, Shiihara J, Kilgore P.E, Ohtomo H, Morimoto K, Ishida M, Kamigaki T, Oshitani H, Hashizume M, Endo W, Hagiwara K, Ariyoshi K, Okinaga S.	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. Journal	39	1047-1048	2013
Kobayashi S, Hanagama M, Yamanda S, Satoh H, Tokuda S, Kobayashi M, Ueda S, Suzuki S, Yanai M.	The impact of a large-scale natural disaster on patients with chronic obstructive pulmonary disease: The aftermath of the 2011 Great East Japan Earthquake .	Respiratory Investigation	51	17-23	2013
Yamanda S, Hanagama M, Kobayashi S, Satou H, Tokuda S, Niu K, Yanai M.	The impact of the 2011 Great East Japan Earthquake on hospitalization for respiratory disease in an rapidly aging society: a retrospective descriptive and cross-sectional study at the disaster base hospital in Ishinomaki.	BMJ	3	1-7	2013

Ⅲ. 研究成果の刊行物・別刷

We agree with L H Opie that, in individuals without previous vascular events, both the relative and absolute reductions in risk of death due to cancer on aspirin versus control are larger than the equivalent reductions in risk of fatal vascular events, and that effects on cancer outcomes will dominate the overall risk/benefit equation, particularly when the delayed effects on cancer death beyond the end of the trials is also factored in.

I have received honoraria for talks, advisory boards, and clinical trial committees from several pharmaceutical companies with an interest in antiplatelet agents, including AstraZeneca, Bayer, Boehringer Ingelheim, Sanofi-Aventis/Bristol-Myers Squibb, and Servier.

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1 Medical Research Council's General Practice Research Framework. Thrombosis prevention trial: randomised trial of low-intensity oral anticoagulation with warfarin and low-dose aspirin in the primary prevention of ischaemic heart disease in men at increased risk. *Lancet* 1998; **351:** 233–41.
2 Peto R, Gray R, Collins R, et al. Randomised trial of prophylactic daily aspirin in British male doctors. *BMJ* 1988; **296:** 313–31.
3 Antithrombotic Trialists' (ATT) Collaboration. Aspirin in the primary and secondary prevention of vascular disease: collaborative meta-analysis of individual participant data from randomised trials. *Lancet* 2009; **373:** 1849–60.


Reuters

Earthquake in Japan

At 1446 h on Friday, March 11, a magnitude 9·0 earthquake hit the northeastern part of Japan, followed by enormous tsunamis, which destroyed many of the coastal cities. Uncountable aftershocks continued even as late as April 27, and more than 10 000 people are still missing.

Japan experienced another strong earthquake in 1995, which caused serious damage in the Kobe area; however, the recent one is distinct from that. The area around Kobe is more clustered and has a denser population than the northeast coastal area, but the number of casualties this time is reported to be much larger than that of Kobe. This discrepancy is because Kobe's earthquake happened directly above its epicenter, but the recent one's epicenter was located beneath the sea and caused huge tsunamis. Most of the casualties were killed by the tsunamis this time, but the victims of Kobe's quake were due to collapses and fires.

Of course emergency medicine for the victims took first priority; the management of chronic illness and mental problems, however, is also a big issue now. Many, even those who did not have a major acute injury or illness, could not source enough medicine for their chronic illnesses such as hypertension, diabetes, thrombosis, Parkinson's disease, etc. In addition to physical problems, the number of people who need psychological support is not small. We saw a woman who was afraid emergency helicopters would fall on her, a teenage girl with hyperventilation syndrome and terrible anxiety and shivering, and a Parkinson's disease patient who could not move at all because he ran out of medicine.

The initial chaos has now abated somewhat, but medical needs are still high in Japan. Your support and help is welcome.

We declare that we have no conflicts of interest.

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Since the massive earthquake and consequent tsunami in eastern Japan on March 11, 2011, the resulting catastrophic damage has been apparent to the world. The secondary disaster is just in its infancy—that is, how to supply and manage stable medical resources for patients with chronic diseases.

Our patients on continuous-infusion prostacyclin for pulmonary hypertension were a particular concern. Forming a supply chain for such drugs in the earliest stages of the disaster was difficult; however, we found that social networking services could have a useful role. In the aftermath of the earthquake, telephone networks were unreliable even in the metropolitan areas. However, the internet was comparatively stable and thus enabled communication by email, Skype, and Twitter.

Twitter has an excellent system for disseminating information to other participants via the "re-tweet" facility. This system facilitates rapid sharing of other participants' messages with all of one's followers, resulting in an exponential proliferation of information dispersal. We were able to notify displaced patients via Twitter on where to acquire medications. These "tweets" immediately spread through patients' networks, and consequently most could attend to their essential treatments.

Obviously, direct human assistance available in parallel with the social media was also important for patients' care. Health-care providers and medical service staff went the extra mile to collaborate and deliver oxygen and drugs. We delivered prostacyclin to one patient by helicopter. Together, these efforts ensured that all patients on prostacyclin treatment received their required medication.

Our experience has shown that social networking services, run concurrently with physical support, were significant in triumphing over many difficulties in the recent catastrophe.

We declare that we have no conflicts of interest.

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A magnitude 9·0 earthquake struck the northeast mainland of Japan on March 11. In the affected areas, essential services such as water and electricity supplies were largely destroyed.

In such circumstances, haemodialysis therapy is extremely difficult. However, dialysis patients cannot survive without receiving regular dialysis. Thus, about 600 dialysis patients left Iwaki, a city located only 40 km south

第53回日本老年医学会学術集会記録
〈パネルディスカッション4：高齢者災害時医療～避難所からいかに高齢者を守るか～〉

1. 被災地からの報告
1）広域災害で生命線を失った高齢者が直面したこと

冲永　壮治

Key words：東日本大震災，津波，避難所，肺炎，高齢者

（日老医誌　2011；48：485-488）

はじめに

東日本大震災における死因の90％は溺死であることが判明し，犠牲者が多い割には受傷者が少ないという結果となった．阪神・淡路大震災では死因の80％が建物の倒壊による圧死であり，また多くの受傷者が出たことと対照的であった[1]．津波災害の急性期が過ぎた後，気仙沼市立病院では肺炎患者の入院が急増していった．近隣の基幹病院でも同様な現象が起きていた．肺炎の発症は4月においてさらに増加し，5月に入っても衰えを知らなかった．この現象はこのたびの津波災害を特徴づけるものであり，今後の災害医療の在り方に重要なヒントを与えるものと考えられる．

本当に肺炎は増えたのか

2004年のインド洋津波では感染症の流行が懸念されたが，実際には小規模に留まった[2]．東北大学病院における震災関連入院症例の分析では，震災発生後1週間は外傷が多いが，2・3週目では感染症が優勢となり，その7割近くが肺炎であった（東北大学大学院医学系研究科　感染制御・検査診断学分野　賀来満夫，私信）．津波後に気仙沼市立病院の肺炎入院は増加したが，例えば市内の他病院・診療所が機能を失って当院が全ての肺炎患者を受け入れた結果かもしれない．この問題に関しては現在検証中であるが，①気仙沼市立病院における肺炎入院が去年の同時期に比べあまりに多いこと（3月期の中下旬では約4.5倍），②後述のような特異な発症形式であること，③津波によって海岸線の主要道路が寸断し，他所からの気仙沼市への患者流入が少ないことなどから，肺炎発症は津波後に増加していったと推測される．一方インフルエンザはいくつかの避難所で発生したものの，東北大学をはじめとした感染制御科の介入によって流行は回避できた．

津波後肺炎の特徴

大東久佳（気仙沼市立病院　呼吸器科），鈴木基（長崎大学熱帯医学研究所　臨床研究分野）らが，3月11日から31日までの3週間に当院に入院した肺炎患者55人について検討した．肺炎の診断は，胸部単純レントゲンあるいは胸部CTスキャンの所見を第一条件とし，補助診断として理学的所見，血算・生化学，喀痰培養等を用いた．肺炎患者の年齢層に関しては，80歳以上は55％，70歳以上は85％であり，高齢者がほとんどを占めた（図1）．また入院経路としては，避難所からの入院が45％で，自宅からは18％，施設からは20％であった（図2）．3月末日の時点で，気仙沼市の避難所にいる人数は全人口の約1/6なので，いかに避難所発症の肺炎が多いかがわかる．これは大きな意味を持ち，津波を免れて避難所にたどり着いた高齢者が肺炎というさらなる試練に直面し，避難所が受難所と化していたのである．この現象は，多くの避難所で電気や暖房がなく，上下水道の途絶によって衛生環境が悪化したためと考えられる．加えて栄養状態の悪化（バランスの悪い低栄養食や褥瘡の発症・増悪），震災ストレス，生活不活発病などが後押しをした．肺炎患者の予後に関しては，施設から入院した群で不良であった．施設からの入院11人のうち6人が死亡の転帰となった．これは施設が直接津波罹災したことも一因である．一般に称される「津波肺」とは，津波にのまれて，汚濁した海水を吸引することによる．その結果，肺化膿症や膿胸などを発症する．しかし今回の震災では，

Major medical issues in the disastered elderly by M-9 earthquake on March 11, 2011

Shoji　Okinaga：気仙沼市立病院呼吸器科，東北大学病院老年科

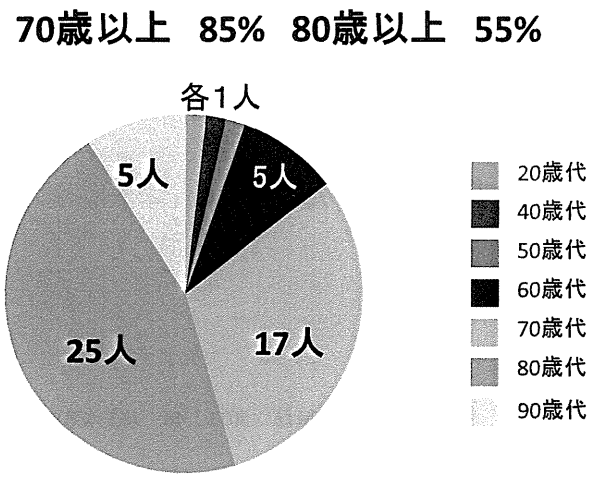

図1　肺炎患者の年齢構成
2011年3月11日～31日に入院　計55人

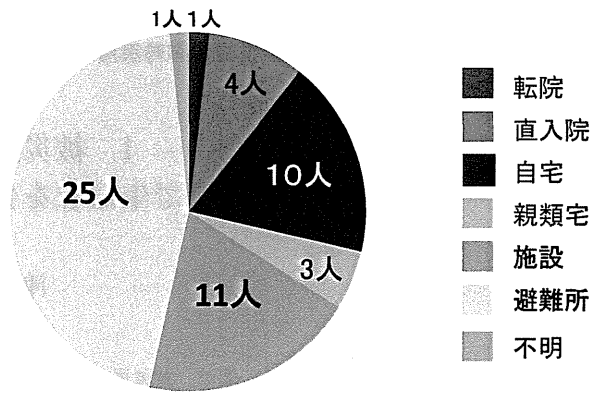

図2　肺炎患者の入院経路
2011年3月11日～31日に入院　計55人

いわゆる津波肺は少数であった．津波後の肺炎，特に避難所発症の肺炎は，概ね通常みられるCAP（市中肺炎）やNHCAP（医療・介護関連肺炎）と大差はなく，肺炎リスクを抱えた人の多くが津波の後に肺炎となったという具合である．治療も，CAP等のガイドラインで推奨される治療法で対応が十分でき，懸念されたレジオネラ等の特殊な肺炎の多発も無かった．

高齢者肺炎治癒後の問題

津波関連の肺炎に罹患した高齢者が軽快した後，平常時とは異なった問題が生じた．①ADLが低下して介護度がアップしてしまうケース．避難所に入った高齢者が不活発になって，床につく時間が増加する傾向がある．家では何らかの役割を持っていた高齢者が日課を失ったこと，自分が生きてきた証である家が流された喪失感，何もしないでも食事や医療が提供される依存度の高い生活，このような状況が自然と高齢者を動かなくさせ，誤嚥性肺炎のリスクを高める．そして肺炎となってベッド上での日々が続くと，肺炎が治癒した後，さらにADLが低下してしまう．震災前は歩いて自立していた高齢者が退院時にはすっかり寝たきりになってしまった，経管栄養になってしまったという症例もあった．こういった悪循環，すなわち“Geriatric Triangle”[3]が津波災害によって顕在化することになった．②治癒した後，どこに退院すればよいかという問題．避難所や施設での居住環境はまだ改善してない，多くのケースで親類宅も津波で流されているために一時期的に身を寄せるところもない，自宅に帰る場合でも家族ががれき処理等で日中は家にいないために孤立してしまう等，介護を要する高齢者の行き場が問題となった．③地域の病院・診療所も被災していて，地域連携室が機能しにくい．そのため退院後のfollow-upがスムースに行かない．④精神的に不安定で，不穏が強くなったり，うつ傾向が出現した症例があった．こういった問題に対しては，肺炎患者の早期リハビリテーションの実施，避難所に退院する場合は医療支援チームに患者情報を提供，家に退院する場合は訪問看護の実施（医師・看護師による「気仙沼医療支援隊」が組織された），市外や県外の支援病院へ転院，「心のケアチーム」へfollow-upの依頼などにより解決を試みた．

避難所関連肺炎ガイドラインの策定

肺炎の多発は，それまで高齢者を支えていたものが津波によって一気に失われた結果である．それはすぐには解決できないが，医療の介入でなんとか抑止できないかと考えた．幸い，多くの医療支援チームが避難所で医療活動を献身的に展開していた．医療支援チームに肺炎防止の協力を要請し，肺炎防止を目指したガイドラインを作成して配布した．医療支援チームは過密なスケジュールで行動していたため，ガイドラインはA4サイズ1枚裏表のみのコンパクトなものにした．内容としては，第一に肺炎患者を抽出してもらうこと，第二に重症度を判断してもらうことを記した（図3a）．その判断基準は，Diehrの肺炎予測ルールや，A-DROP，CURB-65等の重症度分類を参考にして示したが，敢えてスコアリングはしなかった．それは，検査手段が限られている（聴診器，体温計，パルスオキシメーター）ことと，面倒なスコア化より診察医の判断を重視し，当院への搬送をためらうことのないように配慮したからである．避難所では保健師やボランティアも活動しており，ガイドラインに肺炎予防の項目を設けてその啓蒙・励行を依頼した．ガイド

成人　避難所関連肺炎 ガイドライン　ver.2 2011.4.4
Guidelines for Refuge-Associated Pneumonia（RAP）in Adults

1. 肺炎を疑う所見
   ①咳嗽と有色喀痰
   ② 37.8 度以上の発熱
   ③呼吸数 20 回/分以上
   ④ SpO_2≦94%
   ⑤息苦しさ・呼吸困難
   ⑥ crackle 聴取
   ⑦胸痛（胸膜炎）
2. 重症度の目安
   ①年齢：男 70 才以上，女 75 才以上
   ②基礎疾患：COPD，DM，CHF，肝・腎疾患，悪性疾患，免疫不全など
   ③施設入所，寝たきり
   ④脈拍＞125 回/分
   ⑤呼吸数＞30 回
   ⑥新たな精神症状・意識障害
   ⑦脱水：腋窩の乾燥，口腔粘膜の乾燥，ツルゴール陽性，乏尿
3. 市立病院への受診・搬送基準
   ①「重症度の目安」3 項目以上
   ②ショックを伴う　または　SpO_2≦90%
   ③結核疑い：既往歴，免疫低下など
   ④ empiric therapy 3 日後にも解熱しない
   ⑤診察医の判断
4. 肺炎の予防
   ①ウイルス感染の予防：マスク，手指衛生，咳エチケット
   ②口腔ケア：歯磨き等
   ③栄養の保持
   ④誤嚥防止
   ⑤脱水回避：夜間のトイレを嫌がらず，こまめに水分摂取
   ⑥避難所の衛生環境の改善，保持

図 3a

5. 肺炎疑い時の empiric therapy
   ①元来は健常人
   経口：メイアクト MS（100）6 T 3×　または　フロモックス（75）6 T 3×（以上は食後内服が守れる時）
   クラビット（500）1T　1×　または　レスピラトリーキノロン*
   点滴：ロセフィン　1～2 g　1 日 1 回点滴
   ②腎機能低下疑い・高齢者
   経口：メイアクト MS（100）6 T 3×　または　フロモックス（75）6 T 3×（以上は食後内服が守れる時）
   レスピラトリーキノロン　半量
   点滴：ロセフィン　1 g　1 日 1 回点滴
   ③非定型肺炎疑い：頑固な咳と少ない痰など
   経口：ジスロマック SR 2 g または　ジスロマック（250）2 T 1×3 日間
   ミノマイシン（100）2 T　2×朝・夕
   ④慢性呼吸器疾患あり
   経口：レスピラトリーキノロン
   点滴：ロセフィン　1 回 1～2 g　1 日 1 回点滴
   チエナム　1 回 0.5～1 g，1 日 2 回点滴

*レスピラトリーキノロン：オゼックス，スパラ，アベロックス，ジェニナック，グレースビットなど．
クラビット高用量も可．
**抗菌薬の投与期間は原則 5～7 日として，適宜調節してください．
***上記の薬剤は“望ましい”選択です．近似抗菌薬で代用することは可能です．もし上記薬剤が無い場合は市立病院に請求できます．冲永までご連絡下さい．

図 3b

ライン裏面には肺炎の empiric therapy について記述した（図 3b）．当時，抗菌薬は比較的潤沢で，かつ無料なので，保険適応を考えずに推奨される使用法が可能であり，また 1 日 1 回の点滴は実行できる状況であった．

本ガイドラインの問題点

肺炎を疑う患者の背景別に抗菌薬使用例を記したが，この中に誤嚥性肺炎という項目を入れることができなかった．誤嚥性肺炎は災害による環境の悪化が主要因であり，同じ所で治療するよりは入院して治療するべきと考えたからである．誤嚥性肺炎は肺炎入院のなかでも多数を占めているにもかかわらず，避難所では予防がむずかしく，また治療も容易ではないため，ガイドラインを通じて有効な手立てを講じることが困難であった．誤嚥性肺炎にまつわる問題の深さは広域災害時においてさらに深刻さを増した．「ガイドライン」と敢えて称したのは，医療支援チームに意識されることを目的としたからである．本来ガイドラインはエビデンスに基づいて作られるが，このガイドラインに厳密な意味でのエビデンスは無い．日本という特殊な社会（超高齢者，高度医療，皆保険など）で，寒冷地の寒冷期に起こった大規模津波災害に関する肺炎のエビデンスは存在しない．いち早く Cochrane で津波後の感染症に対する Evidence Aid が web 上に公開されたが，これはインド洋津波を参考にして作られたものであった．一方国内の感染症に係る医療関係者が web で発信しており，それらを参考にし，また支援チームとして来院していた東北大学呼吸器内科医師との discussion によってガイドラインを作成した．窮余の一策ではあることは否めないが，現場で使われることを最優先とした．その効果を今後検証していく予定である．

おわりに

津波のような大規模災害ではしばしば harvesting effect（弱者刈り取り現象）が生じる．津波から逃げる力のすぐれた者が助かり，そうではない者が命を落とすという意味合いであるが，このたびの津波では，逃げるという発想を持った者が助かったようである．しかし今回，harvesting effect が津波の引いた後にもやってきた感が

ある．避難所での肺炎のみならず，腸炎，褥瘡，DVT，PTSD などが高齢者の命を脅かすことになった．今後起こるであろう大規模災害では，阪神・淡路や中越，東日本などで経験した震災とはまた異なった人的被害も想定される．しかしすべての広域災害で共通なことは，多くの高齢者が犠牲になることである．その対策の中で重要なことは，この第二の harvesting effect を最小にすることである．“その時”に老年医学がどのように initiative をとっていくかを今回の震災が教えてくれている．広域災害の老年医学という新しい分野が，今後大いに発展していくことに期待したい．

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Four months before presentation, he had undergone a prostate biopsy to evaluate a prostate-specific antigen level of 60 ng/mL. Pathology revealed a Gleason 7, Stage IIB tumor; follow-up bone scan to exclude metastases was equivocal. Hormonal therapy with a gonadotropin-releasing hormone analogue was started 1 month later. Thereafter, he was considered for radiation therapy (RT) that had begun 1 week before presentation. An administrative decision was made to continue RT after he was stabilized. One month later, he was readmitted with subdural and subconjunctival hemorrhage and facial fractures resulting from another fall. During this admission, even as he was being considered for a percutaneous endoscopic gastrostomy tube, the geriatrics team strongly advised against any artificial nutrition or further RT. Finally, RT was stopped in light of the patient's "poor prognosis." He lived at the nursing home for another 6 months.

DISCUSSION

The American Urological Association recommends definitive therapy rather than active surveillance for localized high-risk cancer (Grade 2C),[1] but observational data comparing the different therapeutic modalities are limited, particularly in older adults. For instance, the survival benefit of radical prostatectomy over watchful waiting in men with early-stage prostate cancer is confined to men younger than 65.[2] This results in a lack of clear guidelines regarding the standard of care for elderly men with prostate cancer. Also, dementia reduces survival, and elderly adults with cancer and dementia have higher mortality from cancer and noncancer causes.[3,4] Moreover, there is evidence that functional dependence is a predictor of poor outcome in older adults with cancer.[5]

This individual had neither capacity nor any documented directives. The conundrum is around making a decision to deliver curative therapy to a young-old adult with clinically localized high-risk prostate cancer but who has considerable cognitive and functional deficits that may limit not only the success of therapy, but also the enjoyment of any prolonged life as a result of that therapy.

Individual preference is an important aspect of evidence-based medicine that incorporates best available evidence with clinical experience.[6] In the absence of decision-making capacity in critically ill individuals, physicians generally resort to the surrogate decision-making process to assist in directing care, especially at the end of life. This begins with review of advance directives if any and discussion with family members and healthcare proxies. In the absence of these directives, the Substituted Judgment standard is used, wherein the decision-maker must have a clear and detailed understanding of the individual's values, preferences, and thoughts regarding health care and end of life.[7] When even this is not possible, the Best Interests standard is considered appropriate and legal. This involves the application of the principle of beneficence and attempts to weigh the potential burdens and benefits of treatment for this individual in this particular situation.[8] The President's Council on Bioethics professes that incapacitated adults should receive best available care yet clarifies this may not always extend biological life and advocates careful attention to comfort care and pain management.

In conclusion, this case highlights the clinical and ethical dilemma for physicians treating elderly adults without decision-making capacity. Greater participation of older adults in clinical trials to improve the quality of evidence and greater understanding of ethical principles by physicians treating older adults are vital.

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ACKNOWLEDGMENTS

Conflict of Interest: None.

Author Contributions: R. Ramaswamy is solely responsible for concept and design, analysis and interpretation, and preparation of the manuscript.

Sponsor's Role: There was no sponsor for this letter.

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FUNCTIONAL DECLINE AFTER AN EMERGENCY SHELTER STAY: MISLEADING EVIDENCE

To the Editor: Differentiation of delirium from dementia requires the utmost care, especially when the symptoms lack some core features.[1] Detection becomes even more difficult with the absence of suggestive medical history or laboratory findings, which occurs in nonalcoholic steatohepatitis (NASH).[2] We report the case of an elderly woman who developed delirium after an emergency shelter stay. She was originally misdiagnosed with dementia with disuse syndrome.

CASE REPORT

In June 2011, an 87-year-old woman's son admitted her, claiming that she had become "senile" after a month-long emergency shelter stay due to damage caused by the March

2011 earthquake and tsunami. Because of the destruction, water was unavailable for flushing toilets. Therefore, most of the evacuees limited food and liquid intake to minimize stool and urine production. After returning home, the woman manifested functional decline; she often mistook the time and forgot to take her medication, her gait became somewhat unstable, and slight edema developed in both legs. She had consulted doctors at several hospitals, where access to detailed tests were limited because of the destruction. Because her brain computed tomography (CT) scan and blood screening tests were normal, she was repeatedly diagnosed with dementia, reinforced by the effect of the disaster and lack of exercise.[3] One day, her hands were noted to be shaking briefly. Although this symptom appeared only once, her son decided to admit her to the hospital.

The woman's only significant medical history was hypertension, controlled with daily candesartan and nilvadipine (8 mg each); she had no significant family history of disease. No abnormalities, except obesity (body mass index (BMI) 29.4 kg/m^2), had been noted over several years of regular examinations. Her edema, which expanded to her upper and lower extremities, was classified as pitting and fast, indicating hypoalbuminemia as the major cause.[4] Pyramidal and extra-pyramidal signs and ataxia were not manifested; her muscle strength was well preserved. Mini-Mental State Examination revealed immediate recall failure. The forward and backward digit span test showed lower score, suggesting that her forgetfulness was inattention rather than memory impairment.[5] She spoke slowly and showed careless behavior, such as leaving the toilet without flushing after excretion. Because most of her symptoms seemed to be related to inattention, it was speculated that she had delirium rather than dementia, although fluctuation of symptoms or hyperactivity was unapparent.

The concomitance of "subsyndromal delirium"[1] and edema caused by hypoalbuminemia with mild thrombocytopenia (Figure 1A) suggested hepatic encephalopathy (HE),[6] which a blood ammonia level of 194 pg/mL and electroencephalographic findings confirmed. Abdominal ultrasonography showed cirrhosis without fluid retention (Child Class B). CT showed that her liver and spleen were of almost the same density (Figure 1B). Autoantibodies were negative. Her history and CT findings strongly indicated that cirrhosis occurred due to NASH, which often occurs in people with obesity or diabetes mellitus.[5] Insulin resistance was detected later; it had been missed in her annual examinations.[7] Her transaminase levels were normal in her regular examinations, suggesting that she had developed compensated cirrhosis several years earlier. Her nutrition had already improved by the time she developed HE, but sanitary water remained unavailable. These facts suggested that constipation, rather than malnutrition, was the likely cause of her encephalopathy. After 20 days of lactulose (19.5 g/d) and branched-chain amino acid (12 g/d) administration, her behavior and her performance on neuropsychological tests improved markedly (Figure 1A).

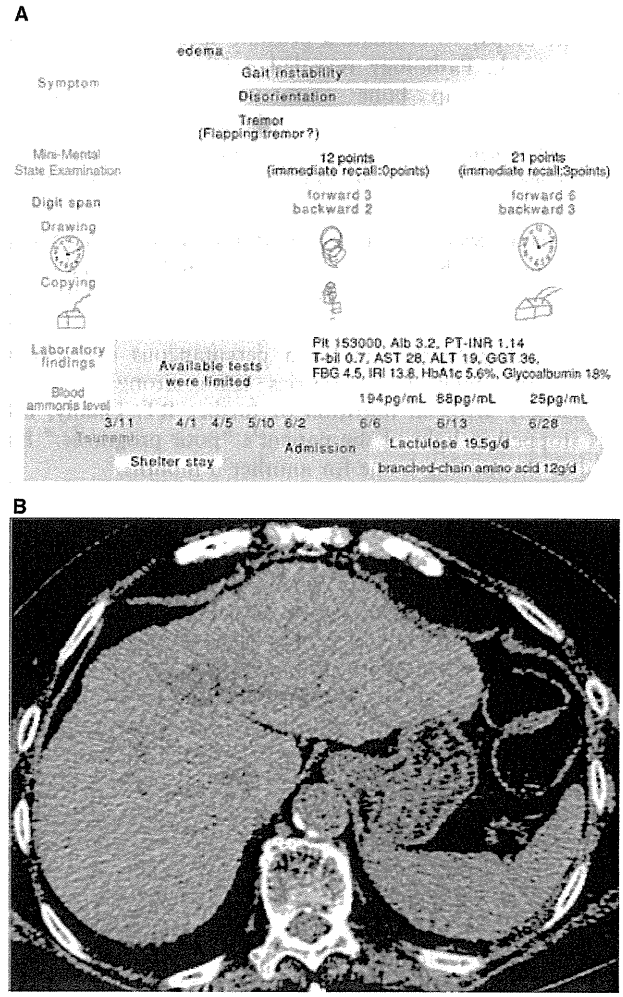

Figure 1. Clinical course and abdominal computed tomography of the patient. (A) Homeostasis model of assessment—insulin resistance (HOMA-IR) was calculated as 2.76, indicating high insulin resistance. Discrepancy between glycohemoglobin and glycoalbumin was observed. (B) Liver density was higher than fat density, indicating that fibrosis had already progressed. Splenomegaly, ascites, bile duct abnormalities, and collateral circulation were absent. Liver dysfunction caused by metal deposition was excluded, because the liver density was equivalent to that of the spleen; platelets 153,000/μL, albumin 3.2 g/dL, prothrombin time international normalized ratio 1.14, total bilirubin 0.7 mg/dL; aspartate aminotransferase 28 IU/L, alanine transaminase 19 IU/L, gamma-glutamyltranspeptidase 36 IU/L, fasting blood glucose 4,5 mmol/L, insulin resistance index 13.8 μU/mL; glycosylated hemoglobin 5.6%.

DISCUSSION

Comprehensive evaluation of edema, cognition, and behavior played a major role in diagnosis. Even without full access to detailed examinations, detection of subsyndromal delirium and speculation regarding its etiology were achieved through comprehensive assessment.

The major cause of misdiagnosis was NASH, which tends to be missed in the absence of suggestive history (e.g., excessive alcohol intake or hepatitis infection) and normal transaminase levels. Furthermore, if NASH has developed into cirrhosis, diabetes mellitus and insulin resistance (both causes of NASH) might be obscured. Its diagnosis should not depend heavily on laboratory findings or medical history alone.

Another cause of misdiagnosis was the subacute progression and lack of fluctuation of symptoms, which resulted from a variation in clinical progression of HE and difficulties in detecting fluctuation within low-stage HE.[6] Acute onset and fluctuation of symptoms are considered essential features of delirium,[8] but the possibility of delirium should not be excluded if any one of the core features exists.

The present case also indicates that maintaining appropriate lavatory conditions at emergency shelters is important not only for preventing infections,[9] but also for maintaining good excretory habits.

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ACKNOWLEDGMENTS

Conflict of Interest: None.

Author Contributions: Naoki Tomita: patient diagnosis and care and manuscript preparation. Kaori Une and Takashi Ohrui: patient diagnosis and advice on the manuscript. Takae Ebihara, Youichi Kosaka, Shoji Okinaga, Katsutoshi Furukawa, Hiroyuki Arai: patient diagnosis. All of the authors read the final version of the manuscript.

Sponsor's Role: None.

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COMMENTS/RESPONSES

POOR DENTAL HEALTH AND DEMENTIA

To the Editor: The authors of the paper entitled "Dentition, Dental Health Habits, and Dementia: The Leisure World Cohort Study"[1] conducted a longitudinal cohort study using the responses to a mailed survey to demonstrate that men with inadequate masticatory function who did not wear dentures and dentate individuals who did not brush their teeth daily had a greater risk of dementia. The authors described a number of potential mechanisms that might be responsible for this association, including periodontal infection, the associated inflammatory response, and its effects on brain vascularity.

To bolster their contention, they cite the Nun Study, which followed 101 participants "without dementia" and found that a low number of teeth increased the risk of dementia (hazard ratio = 2.2, 95% confidence interval = 1.1–4.5 for participants with 0–9 teeth vs those with 10–28 teeth) during the subsequent 12 years of observation.[2]

I would posit that the authors have truly identified the problem when they state that "it is plausible that an individual's poor oral health behaviors may be early signs of dementia." To bolster this argument, a closer look at the participants in the Nun Study reveals that many of these older nuns had evidence at a mean age of 22 of a premorbid low level of "idea density" (average number of ideas expressed per 10 words) in their hand-written autobiographies.[3] This low level of idea density at age 22 was significantly associated with poorer cognitive function measured approximately 58 years later at their last examination and also at their death when a neuropathological examination confirmed the diagnosis of Alzheimer's disease (AD). Another group of neuroscientists, who demonstrated, using similar methodology (propositional density), that specific elements (number of interrelated ideas, complexity of written language) in early adulthood writing samples (medical school admission essays) can be used to predict the development of AD in later life in men and women, recently confirmed this construct.[4]

Thus, I concur with the authors parenthetical statement that it is just as plausible to suggest that some components of neurodegenerative disease, which takes decades to fully develop, may have precipitated the dental disease (rather than the other way around) by hampering afflicted individuals from following routine oral hygiene procedures over a significant portion of their lifetime.[5,6]

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J Neurol (2012) 259:1243
DOI 10.1007/s00415-011-6329-x

LETTER TO THE EDITORS

Exacerbation of dementia after the earthquake and tsunami in Japan

Katsutoshi Furukawa · Mari Ootsuki · Manabu Kodama · Hiroyuki Arai

Received: 16 August 2011 / Accepted: 13 November 2011 / Published online: 30 November 2011

Dear Sir,

On Friday, March 11, 2011, a magnitude 9.0 earthquake hit Japan, which was followed by enormous tsunamis that caused numerous casualties and serious damage in the coastal cities [1]. After the disaster, many elderly people including patients with dementia were evacuated to asylums such as gymnasiums and halls because their houses were destroyed. Many of the patients visited our clinic after evacuation, and most of them got significantly worse with their dementia symptoms including behavioral and psychological symptoms of dementia (BPSD). We here examined changes in cognitive functions and BPSD with minimental state examination (MMSE) and neuropsychiatric inventory-questionnaire (NPI-Q), respectively, in patients with Alzheimer's disease after the earthquake.

We analyzed three groups including subjects who did not suffer from the disaster (group 1, M/F = 9/11, age 74.3 ± 8.3), subjects who had experienced the disaster but did not stay at an evacuation site (group 2, M/F = 9/9, age 75.6 ± 7.8), and subjects who were forced to stay at an evacuation site (group 3, M/F = 8/9, age 77.8 ± 8.5). We compared the altered values (after-before) of each test in the three groups. Both groups 2 and 3 showed a decline in MMSE compared to group 1 although a significant difference was observed only between "group 1 and 2" and "group 1 and 3". Concerning the NPI-Q both group 2 and 3 exhibited exacerbation of BPSD and the significant difference was observed between "group 1 and 2", "group 1 and 3" and "group 2 and 3" (Fig. 1).

Disasters such as earthquakes, tsunamis, hurricanes, and tornados must be extremely stressful to elderly people. On the other hand, to change their circumstances to inferior conditions such as evacuation sites should affect their mental and cognitive condition more severely [2]. Nobody likes to live together with many other people in a big hall with people having poor hygiene. Not only physical but also mental care to the elderly who suffered from the disaster is now needed.

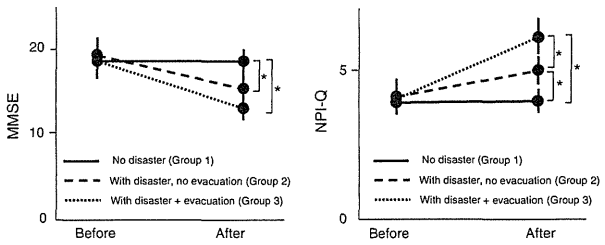

Fig. 1 Alterations of MMSE and NPI-Q after the earthquake and tsunami in patients with Alzheimer's disease. Changed values of each test between before and after the disaster were statistically analyzed. Values indicate mean ± SE. $*p < 0.05$

Conflict of interest The authors have no conflicts of interest to declare.

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ORIGINAL ARTICLE

Impact of the Tohoku earthquake and tsunami on pneumonia hospitalisations and mortality among adults in northern Miyagi, Japan: a multicentre observational study

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▶ Additional material is published online only. To view please visit the journal online (http://dx.doi.org/10.1136/thoraxjnl-2012-202658).

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Received 30 August 2012
Revised 25 January 2013
Accepted 29 January 2013
Published Online First 19 February 2013

To cite: Daito H, Suzuki M, Shiihara J, *et al*. *Thorax* 2013;**68**:544–550.

ABSTRACT

Background On 11 March 2011, the Tohoku earthquake and tsunami struck off the coast of northeastern Japan. Within 3 weeks, an increased number of pneumonia admissions and deaths occurred in local hospitals.

Methods A multicentre survey was conducted at three hospitals in Kesennuma City (population 74 000), northern Miyagi Prefecture. All adults aged ≥18 years hospitalised between March 2010 and June 2011 with community-acquired pneumonia were identified using hospital databases and medical records. Segmented regression analyses were used to quantify changes in the incidence of pneumonia.

Results A total of 550 pneumonia hospitalisations were identified, including 325 during the pre-disaster period and 225 cases during the post-disaster period. The majority (90%) of the post-disaster pneumonia patients were aged ≥65 years, and only eight cases (3.6%) were associated with near-drowning in the tsunami waters. The clinical pattern and causative pathogens were almost identical among the pre-disaster and post-disaster pneumonia patients. A marked increase in the incidence of pneumonia was observed during the 3-month period following the disaster; the weekly incidence rates of pneumonia hospitalisations and pneumonia-associated deaths increased by 5.7 times (95% CI 3.9 to 8.4) and 8.9 times (95% CI 4.4 to 17.8), respectively. The increases were largest among residents in nursing homes followed by those in evacuation shelters.

Conclusions A substantial increase in the pneumonia burden was observed among adults after the Tohoku earthquake and tsunami. Although the exact cause remains unresolved, multiple factors including population aging and stressful living conditions likely contributed to this pneumonia outbreak.

Key messages

What is the key question?

▶ Did the pneumonia incidence increase among the adult population after the Tohoku earthquake/tsunami, what were the characteristics of the disaster-associated pneumonia?

What is the bottom line?

▶ Our survey in a well defined population of northern Miyagi Prefecture revealed that a marked increase in the incidence of pneumonia hospitalisations and pneumonia-associated deaths was observed during the 3-month period following the disaster, the vast majority of the victims were older people, only 3.6% were associated with near-drowning in the tsunami waters, and the clinical and microbiological characteristics of the post-disaster patients were similar to those of the pre-disaster patients.

Why read on?

▶ Because this disaster affected a notably aging population with the highest baseline pneumonia incidence rate, the disaster caused a drastic increase in the number of admissions and placed a heavy burden on local hospitals. In addition to using the pneumococcal vaccine for disaster-affected populations, the provision of optimal living conditions, medical check-ups and oral hygiene care must be a priority for older people after natural disasters.

INTRODUCTION

On 11 March 2011, a magnitude 9.0 earthquake struck off the northeastern coast of Japan. Within an hour of the earthquake, devastating tsunamis swept over the east coast of the Tohoku Region, resulting in approximately 20 000 deaths and catastrophic damage to the local infrastructure and environment.[1 2] As a result of the extensive destruction of homes, more than 400 000 displaced people were moved to emergency evacuation shelters that were not supplied with electricity, gas, water or food, despite sub-freezing winter temperatures.[3 4]

Previous studies showed that acute respiratory infections were frequently observed among people displaced by the 2001 earthquake in El Salvador,[5] among those affected by the 2003 Bam earthquake

in Iran[6] and among people in Aceh Province affected by the 2004 Indian Ocean earthquake and tsunami.[7] Furthermore, severe pneumonia associated with the aspiration of seawater, known as 'tsunami lung', was reported in areas affected by the Indian Ocean tsunami.[8–10] However, these studies were conducted in resource-limited settings without reliable baseline data and lacked a standardised case definition. The impact of natural disasters, including tsunamis, on the risk of pneumonia remains largely unknown.

Within 3 weeks of the earthquake and tsunami on 11 March, a rapid increase in pneumonia hospitalisations and related deaths in northern Miyagi Prefecture was reported by mass media outlets.[11] We undertook an investigation to elucidate the impact of the Tohoku earthquake/tsunami on the incidence of pneumonia-related hospitalisations and mortality among adults aged ≥18 years in Kesennuma. We also sought to describe the clinical characteristics of disaster-related pneumonia and investigate the potential causes of increased rates of pneumonia in the affected population.

METHODS

Setting

Kesennuma is located on the northeastern coast of Miyagi Prefecture (figure 1). The city has a long, saw-toothed coastline with narrow, flat land facing the Pacific Ocean. The total population in February 2011 was 74 257 (source: Department of

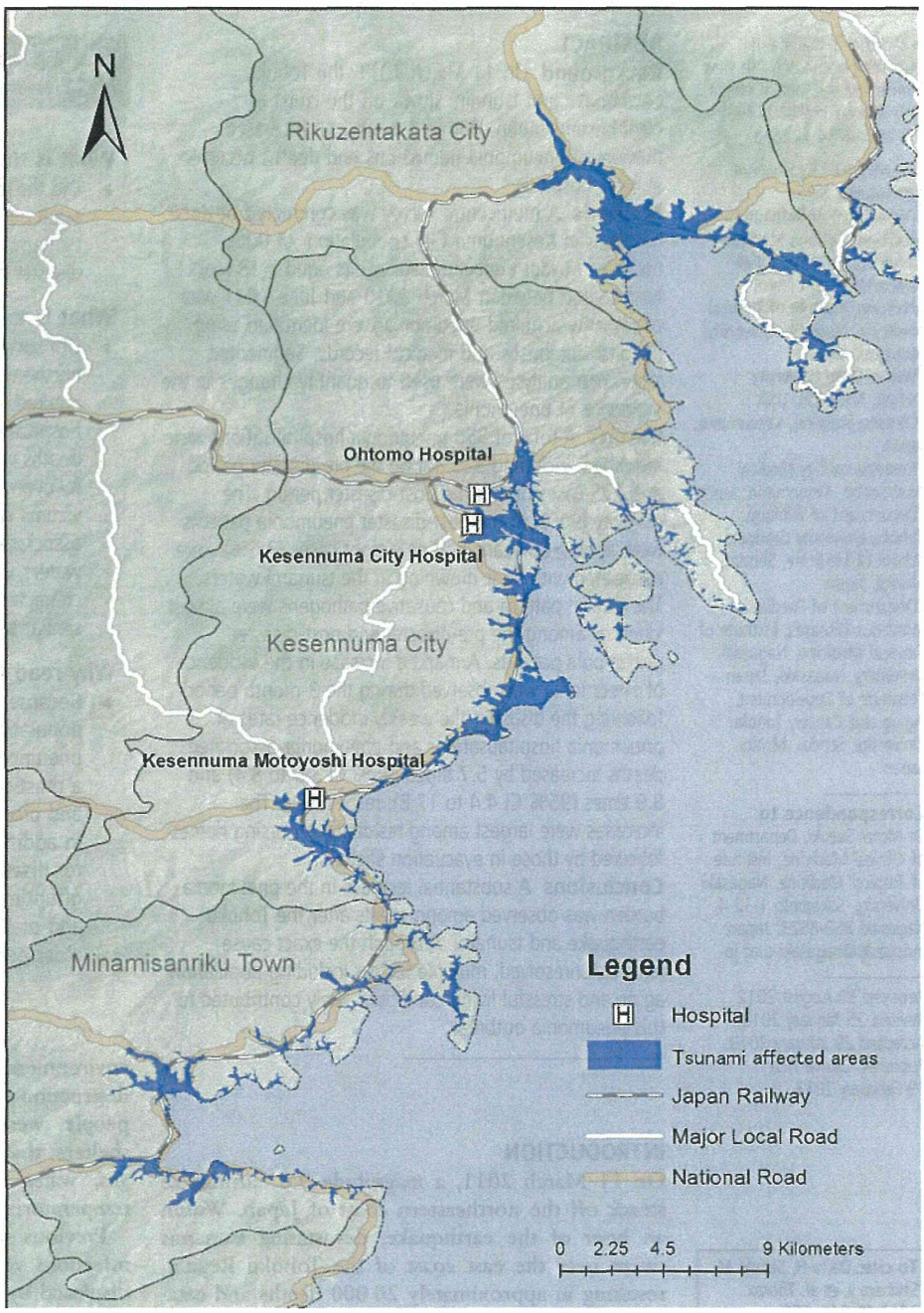

Figure 1 Area affected by the Tohoku earthquake and tsunami, Kesennuma City, Miyagi Prefecture. The disaster area data were obtained from the overview map of tsunami-affected areas released by the Geospatial Information Authority of Japan (http://www.gsi.go.jp/BOUSAI/h23_tohoku.html).

Vital Statistics, Kesennuma City). The city inhabitants included a substantial number of older adults: 30.2% (n=22 421) were aged ≥65 years and 8.9% (n=6618) were aged ≥80 years. These percentages were higher than the national averages (23% and 6.4%, respectively). At the time of the disaster, no national programme for the administration of the 23 valent polysaccharide pneumococcal vaccine (PPV23) existed in Japan, and its coverage among Kesennuma residents aged ≥65 years was <5%.

At 14 : 46 local time on 11 March 2011, the earthquake shook Kesennuma. The first large tsunami wave hit Kesennuma within a half hour of the earthquake, resulting in the deaths of 1032 residents; an additional 324 residents were listed as missing. The majority (>90%) of the victims died from drowning.[2]

The tsunamis devastated buildings, cars, ships and all other structures. Major oil tanks in the port were damaged and leaked petroleum, leading to massive conflagrations in the city. The main road was demolished to the north and the south, and the city was isolated (figure 1). In the aftermath, residents fled to evacuation shelters, including schools and public halls, to relatives' houses located on higher ground. The number of evacuees reached a peak on 17 March 2011 (20 105 individuals at 99 sites), while many other residents remained in their partially damaged houses.

In early April 2011, a considerable increase in pneumonia hospitalisations was reported from hospitals in northern Miyagi Prefecture. Media outlets reported that the outbreak may have been related to exposure to dried oil mist (ie, oil leaked from damaged storage tanks) or contaminated tsunami water.

Study design

In response to this outbreak, the Kesennuma City Hospital (KCH), the Kesennuma City Medical Association and Nagasaki University established an investigation team and initiated a multicentre survey on 12 May. The team identified three hospitals in Kesennuma that were providing inpatient care for patients with pneumonia before the disaster (KCH, 451 beds; Kesennuma Motoyoshi Hospital (KMH), 38 beds; and Ohtomo Hospital (OH), 78 beds). The team also identified an orthopaedic hospital and some clinics that had a small number of pneumonia admissions before the disaster (approximately 10 cases per year in total); however, their buildings were completely demolished, and their patients' records were unavailable. Therefore, we did not include those cases.

Case ascertainment

For the study period (defined as 1 March 2010 to 30 June 2011), all patients who were hospitalised with a diagnosis of pneumonia were enumerated from existing hospitalisation databases. Working as a panel, three qualified pulmonologists reviewed medical charts and chest radiographs (CXRs) in September 2011 using a standardised case definition based on the British Thoracic Society guidelines.[12] After reviewing the medical charts and CXRs, the panel's consensus CXR interpretations were recorded. Patients were classified as having any pneumonia if they showed pulmonary consolidation on CXR and any respiratory symptoms consistent with pneumonia. If a patient developed the disease 48 h after admission, the patient was classified as having hospital-acquired pneumonia and was excluded from further analysis. Repeated episodes of pneumonia in the same patient within a 2-week period were regarded as a single episode.

While inspecting hospitalisation records and CXRs, we realised that a considerable proportion of paper-based medical charts and CXRs in KMH were lost or damaged by the tsunami, and only discharge summaries were available. Therefore for analysis, the patients were classified into one of two pneumonia case categories: (1) *confirmed pneumonia* (full medical records were available and the presence of consolidation was confirmed by pulmonologists) and (2) *probable pneumonia* (detailed data and CXRs were not available, but the history described in the summary records was compatible with pneumonia). We defined pneumonia episodes as near-drowning related if patients were engulfed by the tsunami water on 11 March 2011, and their disease onset occurred within 4 weeks of the disaster.

Data collection

Demographic, clinical, radiographic, microbiological and evacuation site information was collected from the medical charts using a standardised abstraction form. The patients' addresses before the disaster were extracted from the hospital database and converted to geographical coordinates. Patients with pneumonia who died in any of the three study hospitals were categorised as fatal cases. The severity of pneumonia was assessed using the CURB65 scoring system.[13] Microbiological tests were routinely performed for clinically suspected cases throughout the study period at KCH, but they were not available at the other hospitals.

Data analysis

The demographic and clinical characteristics of the study patients were compared between the pre-disaster and post-disaster periods using χ^2 and Fisher's exact tests. The near-drowning-related cases were excluded from this comparison because the cause of disease was clear. The factors associated with death were assessed using Poisson regression models with robust SEs.[14] Pneumonia incidence and mortality rate calculations were limited to patients living in Kesennuma. The effects of the disaster, defined as a change in the weekly incidence of hospitalisations and associated deaths after the disaster (ie, the incidence rate ratios), were separately assessed using segmented generalised linear Poisson regression models allowing for overdispersion.[15] The regression models included terms for the disaster and time trends before and after the disaster. The change in the population size due to the disaster was taken into account using the offset function. Partial correlograms were used to assess serial autocorrelation of the residuals and, since there was no detectable autocorrelation, the data were modelled assuming independence.

Ethics

This study was approved by the Institutional Review Board of KCH.

RESULTS

Patients

Over the course of the study period (1 March 2010 to 30 June 2011), a total of 550 pneumonia cases were identified from hospital and facility records. According to the patients' disease onset, 225 confirmed cases and 100 probable cases occurred before 11 March and 225 confirmed cases occurred after 11 March (see online supplementary appendix figure 1). There was a sharp rise in the weekly number of pneumonia hospitalisations shortly after the disaster (figure 2A). A majority of the patients (95%) were city residents and their geographical distribution was similar across the study periods (see online supplementary appendix figure 2). When only city residents were included in the analysis, the highest incidence rate occurred during the first 2 weeks after the disaster, and the

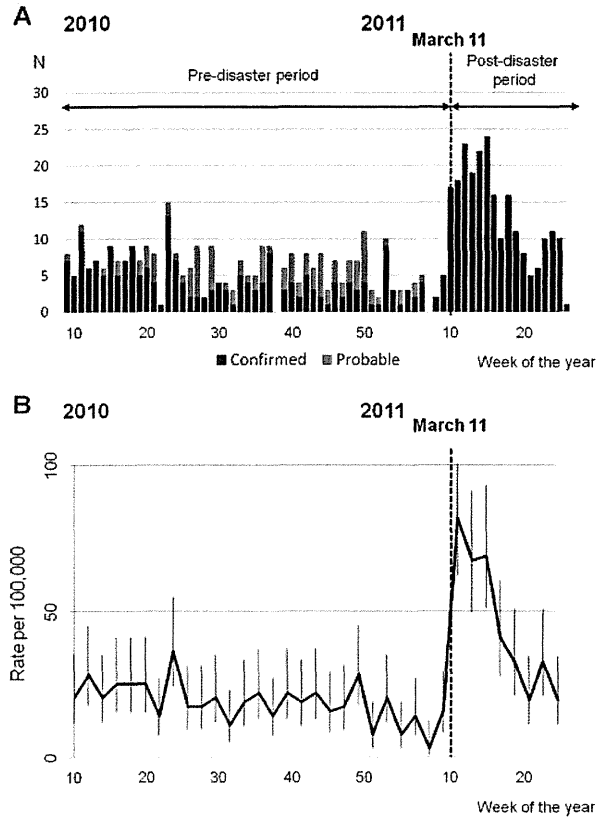

Figure 2 Trend of pneumonia hospitalisations in Kesennuma City, March 2010 to June 2011. (A) Weekly number of confirmed and probable cases according to the date of onset. (B) Biweekly incidence rates (per 100 000 people) calculated according to the date of onset. Cases were limited to the residents of Kesennuma City. The vertical lines indicate 95% CI.

incidence declined to the baseline level by mid-June 2011 (figure 2B).

To understand changes in the incidence of pneumonia, we compared the periods before (1 March 2010–10 March 2011) and after (11 March–30 June 2011) the disaster (table 1). The demographic and clinical pictures of disaster-related pneumonia were similar to those of pre-disaster cases, except that a substantial proportion (27.7%) of post-disaster patients were living in evacuation shelters. Nearly 90% of patients were older adults aged ≥65 years. The patients who were identified from evacuation shelters were younger (average age 76.7 years vs 80 years, p=0.047), less likely to have underlying medical conditions (45% vs 59.9%, p=0.049) and less likely to have fatal pneumonia (10% vs 29.3%, p=0.003) than patients with pneumonia identified from residences and nursing homes.

The patients identified from nursing homes were predominantly women, older and more likely to have had underlying conditions than were patients from homes and evacuation shelters. The proportion of patients with severe pneumonia with CURB65 ≥3 was high among patients from nursing homes, and those patients were more likely to die in the post-disaster period than in the pre-disaster period.

Incidence rates

During the three and a half months following 11 March, the weekly incidence of pneumonia hospitalisations increased by 5.7 times (95% CI 3.9 to 8.4) from the baseline level (table 2). The age group specific ratios were similar across all generations, whereas the absolute increase in the incidence was substantially greater among older people, especially those aged ≥80 years (the rate difference, 156.3 (95% CI 90.8 to 221.9) per 100 000 per population-week). The admission rate ratio was highest among nursing home residents followed by the residents of evacuation shelters. For pneumonia-related deaths, the rate increased by 8.9 times (95% CI 4.4 to 17.8) from the baseline level, and the mortality rate ratio was highest among nursing home residents.

Pneumonia aetiologies

Streptococcus pneumoniae, *Haemophilus influenzae* and *Klebsiella pneumoniae* were the leading causative pathogens identified in pre-disaster and post-disaster pneumonia cases. The positivity of *H influenzae* increased by fourfold after 11 March, especially among patients from evacuation shelters. *Staphylococcus aureus* was also found in patients throughout the study period, but its causative role was unclear (see online supplementary appendix table 1). None of the patients in this study were reported to have had positive rapid tests for influenza (the percentages tested before and after the disaster were 11.4% and 17.9%, respectively) or *Legionella pneumophila* serogroup 1 (28.4% and 35.5%, respectively).

Risk factors for death

Both before and after 11 March, a higher CURB65 score was significantly associated with an increased risk of death; the mortality also increased by age group, but the statistical evidence of this increase was weak. After the disaster, male gender and pre-hospital antibiotics use were associated with a higher risk of death after adjusting for other factors, and staying at an evacuation shelter was associated with a lower risk of death, although the significance was only marginal after adjustment. However, their effects on death were similar to the baseline figures (see online supplementary appendix table 2).

Near-drowning-related pneumonia

A history of exposure to tsunami water on 11 March was recorded in 10 patients. Among them, eight (3.6% of the disaster-related cases) were near-drowning-related pneumonia; seven were women, three were inside a car when engulfed by the tsunami, and one died from the disease. The median age was younger than that of other disaster-related pneumonia patients (62 years vs 79 years, p<0.001).

DISCUSSION

In this report, we documented a substantial increase in the rate of pneumonia-related hospital admissions and deaths in Kesennuma among adults of all age groups soon after the Tohoku earthquake and tsunami. The clinical and microbiological characteristics of the post-disaster patients were similar to those of the pre-disaster patients. The vast majority of the victims were older people. Because this disaster affected a notably aging population with the highest baseline pneumonia incidence rate, the disaster caused a drastic increase in the number of admissions and placed a heavy burden on local hospitals.

Although the causal mechanism was not fully established, our findings suggested that multiple factors have contributed to this outbreak. The largest increase in the pneumonia burden was observed in nursing home residents, the majority of which were older people with physical and mental limitations and needed assistance with daily activities. A sudden change in their living

Table 1 Characteristics of confirmed pneumonia cases by residence, before and after the 2011 Tohoku earthquake and tsunami, Kesennuma City, Miyagi, Japan

Characteristics	Pre-disaster period (1 March 2010–10 March 2011)†			Post-disaster period (11 March–30 June 2011)†				
	Residential category*			Residential category**				
	Total (n=225)	Home (n=193)	Nursing home (n=32)	Total (n=217)	Home (n=117)	Nursing home (n=40)	Evacuation shelter (n=60)	Pre-disaster vs post-disaster period p Value‡
Female sex (%)	98 (43.6)	77 (39.9)	21 (65.6)	93 (42.9)	46 (39.3)	26 (65)	21 (35)	0.882
Age category (%)								
18–49 years	13 (5.8)	12 (6.2)	1 (3.1)	4 (1.8)	3 (2.6)	0 (0)	1 (1.7)	0.161§
50–64 years	21 (9.3)	20 (10.4)	1 (3.1)	18 (8.3)	10 (8.6)	3 (7.5)	5 (8.3)	
65–79 years	61 (27.1)	56 (29)	5 (15.6)	67 (30.9)	32 (27.4)	6 (15)	29 (48.3)	
≥80 years	130 (57.8)	105 (54.4)	25 (78.1)	128 (59)	72 (61.5)	31 (77.5)	25 (41.7)	
Duration of symptoms before admission (%)								
≤2 days	109 (48.4)	91 (47.2)	18 (56.3)	114 (52.5)	59 (50.4)	25 (62.5)	30 (50)	0.434
3 days or more	109 (48.4)	96 (49.7)	13 (40.6)	98 (45.2)	54 (46.2)	14 (35)	30 (50)	
Antibiotics prescribed before admission (%)	32 (14.2)	23 (11.9)	9 (28.1)	29 (13.4)	7 (6)	10 (25)	12 (20)	0.794
With underlying conditions (%)	129 (57.3)	107 (55.4)	22 (68.7)	121 (55.8)	64 (54.7)	30 (75)	27 (45)	0.739
CURB65 score (%)								
3–5 (severe)	26 (11.6)	23 (11.9)	3 (9.4)	27 (12.4)	10 (8.6)	13 (32.5)	4 (6.7)	0.916
0–2 (less severe)	186 (82.7)	159 (82.4)	27 (84.4)	179 (82.5)	97 (82.9)	26 (65)	56 (93.3)	
Deceased (%)	39 (17.3)	31 (16.1)	8 (25)	52 (24)	28 (23.9)	18 (45)	6 (10)	0.085
Microbiological tests performed	145 (64.4)	129 (66.8)	16 (50)	139 (64.1)	74 (63.3)	22 (55)	43 (71.7)	0.932
Positive for *Streptococcus pneumoniae*¶	15 (6.7)	13 (6.7)	2 (6.3)	22 (10.1)	9 (7.7)	4 (10)	9 (15)	0.402
Positive for *Haemophilus influenzae*	3 (1.3)	3 (1.5)	0 (0)	14 (6.5)	7 (6)	0 (0)	7 (11.7)	0.013§
Positive for *Klebsiella pneumoniae*	8 (3.6)	6 (3.1)	2 (6.2)	11 (5.1)	5 (4.3)	4 (10)	2 (3.3)	0.698

*The characteristics differed by residential categories for gender (p=0.007) and pre-hospital antibiotic treatment (p=0.015).
†The pre-disaster and pos-disaster cases were categorised according to the date of onset. The near-drowning-related cases were excluded.
‡Characteristics were compared between the pre-disaster and post-disaster cases. χ^2 tests were performed unless otherwise indicated.
§Fisher's exact test.
¶Either a bacterial culture was isolated or a rapid urinary antigen test was positive.
**The characteristics differed by residential categories for gender (p=0.006), age group (p=0.012), pre-hospital antibiotic treatment (p=0.002), presence of underlying conditions (p=0.012), clinical severity (p<0.001) and fatality (p<0.001).

environment after the disaster, such as a lack of appropriate nutrition, the loss of regular medicines and a shortage of caregivers, must have worsened their conditions.[16] It should be noted that many caregivers were also victims who lost their families, friends and homes. This may have been reflected by the fact that the highest mortality rate among patients from nursing homes occurred in the early post-disaster period (results not shown). A high incidence was also observed in the residents of evacuation shelters. Crowding is a risk factor for *S pneumoniae* and *H influenzae* infection,[17 18] and we found that these pathogens, particularly *H influenzae*, were isolated more frequently in patients from evacuation shelters.

The increased incidence observed in all residential places suggests that other factors which were shared by all survivors have also played an important role. First, hypothermia is known to increase the risk of subsequent infections, including pneumonia.[19 20] On 11 March, it was snowing in northern Miyagi. All survivors were suddenly left without running water, gas, electricity or oil in freezing weather (−3 to −5°C at night; see online supplementary appendix figure 3). The majority of the evacuation shelters were not sufficiently equipped with heating and blankets immediately after the disaster. Second, people experience stress reactions after the disaster. Psychological stress weakens the immune system and may increase the risk of respiratory infections.[21 22] Third, the medical supply systems have drastically changed. Soon after the disaster, more than a hundred relief teams arrived in Kesennuma and initiated care for survivors; this change may have increased the chance of identifying patients with pneumonia.

The abovementioned reasons also explain the decline in pneumonia cases after May; the temperature increase, improvements in living conditions (water, gas and electricity had been fully restored by the end of May), recovery of medical supplies, and the decline in the number of evacuees reduced the risks of pneumonia. However, in our study, it was impossible to know what factors have truly contributed to this outbreak.

Pneumonia outbreaks after natural disasters have never been documented in the past. In 2005, Nishikiori and colleagues conducted a cross-sectional survey (n=3533 individuals) in Sri Lanka after the Indian Ocean tsunami,[23] and no deaths were reported between one week and two and a half months after the tsunami. The different findings in Sri Lanka may be explained by the difference in population structures. If we projected our age group-specific estimates onto a population in Sri Lanka, where the proportions of people aged ≥65 years and ≥80 years in 2004 were 7% and <0.5%, respectively, the overall impact on pneumonia admission and mortality would decrease by almost 80%. Therefore, it is plausible that the impact of

Table 2 Incidence of pneumonia hospitalisations and pneumonia-associated mortality among people aged ≥18 years before and after the 2011 Tohoku earthquake and tsunami, Kesennuma City, Miyagi, Japan

	Pre-disaster period (1 March 2010–10 March 2011)*			Post-disaster period (11 March 2011–30 June 2011)*			
	Pop.†	N‡	Weekly incidence rate§ (95% CI)	Pop.†	N‡	Weekly incidence rate§ (95% CI)	Rate ratio (95% CI)¶
Pneumonia hospitalisations							
Total	63365	305	9.2 (8 to 10.4)	61104	208	38.3 (28.6 to 48)	5.7 (3.9 to 8.4)
Age category (years)							
18–49	23354	14	1 (0.4 to 1.5)	22291	6	3.6 (-0.4 to 7.7)	10 (1.9 to 54.3)
50–64	17590	24	2.5 (1.3 to 3.6)	17245	18	7.3 (0.6 to 14)	6.1 (1.5 to 24.7)
65–79	15803	85	10.6 (8.2 to 13.1)	15241	62	62.6 (37.5 to 87.7)	6.2 (3.3 to 11.5)
80+	6618	182	52.3 (43.8 to 60.8)	6327	122	193.3 (129.1 to 257.5)	5.2 (3.2 to 8.5)
Residence location							
Home	62239	262	8.1 (7 to 9.2)	54460	111	21 (12.9 to 29)	2.7 (1.7 to 4.4)
Nursing home	1126	43	57 (38.6 to 75.5)	796	38	882.8 (481.3 to 1284.3)	28.2 (11.7 to 68)
Evacuation shelter	–	–	–	5848	59	328.7 (190.8 to 466.7)	10.2 (6.2 to 16.9)
Pneumonia-associated deaths							
Total	63365	55	1.6 (1.2 to 2.1)	61104	49	12.8 (7.5 to 18.1)	8.9 (4.4 to 17.8)
Age category (years)							
18–79	56747	13	0.4 (0.2 to 0.7)	54777	12	8.7 (3 to 14.4)	18.6 (5.3 to 64.9)
80-	6618	42	12 (8.5 to 15.5)	6327	37	66.3 (32.8 to 99.8)	6.7 (3 to 14.8)
Residence location							
Home	62239	46	1.4 (1 to 1.8)	54460	27	7.1 (2.7 to 11.5)	4.8 (2 to 11.2)
Nursing home	1126	9	12.4 (4.5 to 20.3)	796	17	555.2 (216.6 to 893.7)	40.6 (9.1 to 180.8)
Evacuation shelter	–	–	–	5848	5	80.6 (0.2 to 160.9)	11.6 (3.7 to 36.2)

*The pre-disaster and post-disaster cases were categorised according to the date of onset. The near-drowning-related cases were excluded.
†Population in 28 February 2011 for the pre-disaster period and in 31 May 2011 for the post-disaster period. The population in each residential category reflects the period average. Data provided by Kesennuma City Hall.
‡Number of patients living in Kesennuma.
§Per 100 000 people. Weekly incidence rates were estimated using segmented generalised linear Poisson regression models allowing for time trends and the change in the population size.
¶Rate ratios were estimated using segmented generalised linear Poisson regression models. Rate ratios for evacuation shelter residents were estimated using the overall pre-disaster incidence as a reference.

disasters on pneumonia incidence was overlooked in developing countries with relatively young populations.

A comparable event may have been observed in Japan after the Hanshin-Awaji earthquake that occurred in Hyogo Prefecture (where 15% of the population were aged ≥65 years) in January 1995. Among 1948 patients admitted for illness during the first 15 days after the earthquake, 418 (21%) had pneumonia. Their average age was 66 years,[24] although population-based impact estimates were unavailable. In contrast, no pneumonia outbreak was documented after Hurricane Katrina, which occurred during the summer.[25 26] Freezing temperatures may be a critical factor in pneumonia outbreaks after a disaster.

In our study, eight cases of near-drowning-related pneumonia were identified. Pneumonia associated with the aspiration of tsunami water drew global attention after a series of melioidosis cases among the Indian Ocean tsunami survivors was reported.[8–10] This condition has been sometimes referred to as 'tsunami lung', which is defined as pneumonia caused by the aspiration of tsunami water containing soil, oil and sewage.[27 28] However, there is no evidence that this condition is distinct from seawater drownings unrelated to tsunami disasters. Furthermore, the clinical characteristics of victims of the Indian Ocean tsunami may not be comparable to those of patients in settings where *Burkholderia pseudomallei* is not endemic, as in our case. Natural disasters do not cause new diseases that are not endemic to the affected area.[29–31] The term 'tsunami lung' must be used with caution to avoid media sensationalism.

The limitations of our study arise from the nature of hospital-based data collection. In Japan, 70% of the medical costs for people aged <70 years and 80–90% of the medical costs for people aged ≥70 years are covered by insurance,[32] and all medical fees for the disaster-affected people were waived after 11 March.[33] The cost was not a barrier to hospitalisation throughout the study period. Non-pneumonia diseases, such as heart failure, might have been misdiagnosed as pneumonia during the post-disaster period especially among older patients. However, the cases in this study were confirmed by experts using a standardised case definition, and the microbiological confirmation rate was similar between the pre-disaster and post-disaster period. Thus, the impact of misclassification and potential changes in admission criteria on our incidence estimates must be minimal. However, due to the limited microbiological data, the aetiology of our cases was not fully established.

Pneumonia and pneumonia-related deaths among older people have been overlooked in emergency preparedness and humanitarian responses, most likely because both are common events in this population. The key findings of our study are: disaster-affected people, especially those exposed to stressful living conditions, are at high risk of developing pneumonia and pneumonia-related death during the emergency phase of a disaster; and the pneumonia burden becomes substantial in areas with an aging population. This situation may arise in low-income and middle-income countries, as their populations are rapidly aging.[34] In addition to using the PPV23 or pneumococcal conjugate vaccine for disaster-affected populations, the provision of optimal living conditions, medical check-ups and oral hygiene care must be a priority for older people after natural disasters.[35]