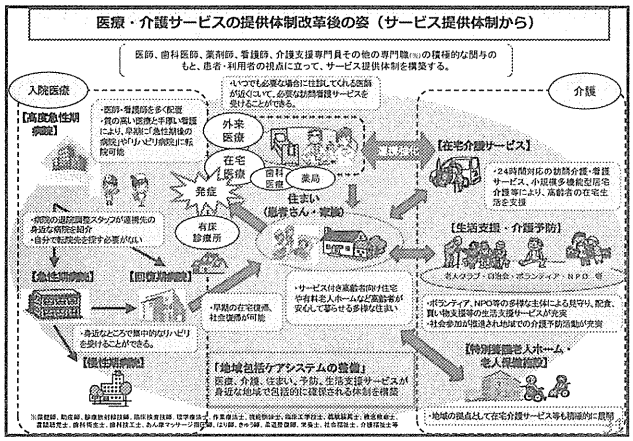

ご静聴ありがとうございました。

(資料 9)

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脳卒中急性期治療の課題—包括的脳卒中センターの整備に向けて—

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Issues in Acute Stroke Care Systems in Japan with a Special Emphasis on Implementation of Comprehensive Stroke Centers

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The J-ASPECT Study, a nationwide Japanese study was conducted regarding the acute stroke care capacities of professional training institutions and the prevalence of burnout and quality of life amongst board-certified neurosurgeons and neurologists in Japan. We found that significant disparities existed in the fulfillment of the recommended items for comprehensive stroke centers, and a high prevalence of burnout among those professionals who worked for stroke care. The study group also analyzed the risk of in-hospital mortality for 53,170 acute stroke cases using nationwide administrative data based on the Diagnosis Procedure Combination (DPC) payment system.

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Key words : stroke, stroke center, stroke unit, quality of care
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Table 1　一次脳卒中センターの推奨要件
米国における脳卒中センターの認定
(Primary Stroke Center：PSC)

Primary Stroke Center に求められる条件（米国ブレインアタック連合の勧告　Alberts et al. JAMA 2000）		
1	脳卒中チーム	脳卒中に精通した最低医師 1 人，看護師 1 人，24 時間体制，15 分以内に診療開始
2	ケアの手順書	特に t-PA 静注療法では必須
3	神経放射線	指示から撮影まで 25 分以内，20 分以内の撮影
4	検査室	24 時間体制で，一般血液検査と凝血学的検査，心電図
5	脳神経外科	必要時 2 時間以内に脳外科医のアクセスが可能
6	Stroke Unit	初期の救命治療以降の脳卒中に特化した治療・リハビリテーションを行うユニット
7	救急隊との連携	ホットラインをもって，遅滞なく受け入れる
8	教育プログラム	一般住民に脳卒中の予防，診断，救急治療の受け方を教育
9	医療の質	患者データベースをもち，常に治療と患者転帰の統計をモニターできる

・t-PA 静注療法の普及，整備を目的とした脳卒中センターの要件を策定
・JCAHO（Joint Commission on Accreditation of Healthcare Organizations）が認定
・AHA/ASA と合同で，2003 年から施設認証を開始
・2011 年 1 月　49 州で 800 施設以上を認定

はじめに

世界に例をみない速度で進む超高齢社会のわが国において，後遺障害や廃用症候群により寝たきりを招来する脳卒中の救急治療は喫緊の課題である．高齢者医療費の最大の原因である脳卒中の患者数は今後もさらに増加し，2020 年には 300 万人に達すると予想されている．

脳卒中の救急医療は，急性期脳梗塞に対する t-PA 静注療法の認可に引き続いて，血管内治療による再開通療法が認可され，急速な変貌を遂げつつある．本邦において，t-PA 静注療法の人口あたりの施行率に地域格差が存在することが報告されているものの[4]，血管内治療や複雑な脳血管病変に対する脳血管外科治療の施行体制に関する実態は明らかでない．米国では，t-PA 静注療法の適正使用を目的とした一次脳卒中センターの認証がすでに 800 施設以上で行われ，2012 年からはより高度の脳卒中医療を施行可能な，包括的脳卒中センターの整備が開始されつつある[1)2)]．本稿では，本邦の脳卒中急性期医療の問題について，概説した．

米国における一次脳卒中センター（Primary Stroke Center）の整備

1995 年，米国 National Institutes of Neurological Disorders and Stroke (NINDS) により実施された多施設無作為化比較試験 (randomized controlled trial：RCT) によって，発症 3 時間以内の急性期虚血性脳血管障害例における，アルテプラーゼ 0.9 mg/kg 静脈投与の有効性が証明され[6]，米国では 1996 年米国食品医薬品局により，t-PA 静注療法が認可された（t-PA）．それを受けて，米国では tPA 静注療法を適正に使用できる施設を認証することの重要性が認識され，t-PA 静注療法の普及・整備を目的とした，一次脳卒中センター（Primary Stroke Center）の要件を策定された[1]．この認証を実際に担っているのは，Joint Commission on Accreditation of Healthcare Organizations（JCAHO）である．2003 年からその施設の認証を開始して，2011 年 1 月の時点で 49 州 800 施設以上が認定されている．その認証要件を **Table 1** に示す．この要件は，適宜改訂されている．具体的には，多職種の脳卒中チーム（acute stroke team）とそのケアの手順書（t-PA protocol）など，特に t-PA の静注療法の適性使用に関する評価が必須とされている．

プロセス指標としては，神経放射線検査については，指示から撮影まで 25 分以内，20 分以内に撮影することとされ，検査室は 24 時間体制で，一般血液検査と凝固検査，心電図が実施できることが挙げられている．5 番目の要件として，必要時に 2 時間以内に脳神経外科医にアクセス可能であることが挙げられている．この点は，脳神経外科医が脳卒中急性期医療の最前線にいることが多い本邦と事情が異なる．たとえば，米国脳神経外科学会（AANS）の調査では，米国の脳神経外科医の中で，外傷以外の脳救急疾患の診療に携わるのは，7%にしか過ぎないとされている[8]．

Stroke unit にはさまざまな定義があり，初期の救命治療以降の脳卒中に特化した治療と急性期リハビリテーションが含まれているが，その整備は，脳卒中患者の予後に影響するエビデンスがあるため，推奨項目に入っている[10]．救急隊とのホットラインによる連携，教育プロ

Table 2　包括的脳卒中センターの推奨要件

包括的脳卒中センターの要件 (Comprehensive Stroke Center, Alberts et al. Stroke 2005)
・Primary Stroke Center の要件（t-PA 静注療法） ＋ ・脳卒中内科医，脳血管外科医などの専門家 ・高度な Neuroimaging，神経放射線科医 ・脳血管外科治療，急性期脳血管再開通療法 —年間 SAH 治療（クリッピング）＞20（10） —AVM など高度な外科治療 ・インフラ（集中治療室），レジストリー ・リハビリテーション，ストロークナース

グラム，それから患者データベース（ストローク・レジストリ）を持ち，定期的にピアレビューを行うこと，すなわち医療の質をモニターし，高める努力が推奨されている．

包括的脳卒中センター（Comprehensive Stroke Center）の概念

前述の一次脳卒中センター（Primary Stroke Center）は，急性期虚血性脳卒中例を対象とした，t-PA 静注療法の普及・整備を目的としたものである．脳卒中医療の現場では，虚血性脳卒中の中で，t-PA 静注療法の対象になる患者は，数％に過ぎず，また脳内出血やくも膜下出血などの出血性脳卒中も 3〜4 割を占めることから，急性期脳梗塞に対する再開通療法や出血性脳卒中に対する外科，血管内治療などの，より高度の脳卒中医療を常時提供することが可能な施設の整備が求められるようになってきた．これを受けて，Primary Stroke Center の推奨要件が公表された後，5 年遅れて 2005 年に *Stroke* 誌に，包括的脳卒中センター（Comprehensive Stroke Center）の要件が発表された[2]．JCAHO が中心となって，米国では昨年から施設の認証が始まっている．

包括的脳卒中センターの推奨要件を **Table 2** に示す．JCAHO のホームページでは，治療件数については，たとえば年間のくも膜下出血の治療が 20 件以上とか，そのうちクリッピングは 10 例，年間の動脈瘤塞栓術が破裂も未破裂も含めて 15 例以上，t-PA の静注療法，これは telemedicine も含んで 25 例以上などの推奨要件が出されている．これは一次脳卒中センター（Primary Stroke Center）の要件を満たしていることが前提であり，前述のインフラとか，レジストリとか，リハビリテーション，ストロークナースといった多職種から構成されるチーム（acute stroke team）があったうえで，より高度な治療を常時提供できるというのが，包括的脳卒中センター（Comprehensive Stroke Center）である．

日本の脳卒中医療の現状と J-ASPECT Study

では，日本の脳卒中医療の現状はどうであろうか？医療制度は，各国さまざまな違いがあり，1 つの国で成立する制度が，他の国でよい結果をもたらすか否かは十分検証する必要がある．脳卒中の救急医療は，t-PA 静注療法の認可により，脳卒中疑いの患者を適切な搬送先へ可及的早期に搬送することが求められているが，依然として厳然とした地域格差があるとされている[4]．いわゆる「包括的脳卒中センター」の適正な整備を行うためには，地理的条件の異なる二次医療圏について，脳卒中診療施設の包括的脳卒中センターの推奨要件（専門医などの人的要因，インフラ）の充足度を把握する必要がある．

このような見地からわれわれは，J-ASPECT Study Group を組織し，2010 年度から 3 年間の計画で，厚生労働科学研究費をいただいて，「包括的脳卒中センターの整備に向けた脳卒中の救急医療に関する研究」（研究代表者 飯原弘二）を開始した．この研究は，大きく 3 つの調査から成り立っており，1）脳卒中診療施設調査，2）脳卒中診療医の勤務状況と疲労度調査，3）脳卒中患者の退院調査を順次施行した．以下，その概要を述べる．

1 脳卒中診療施設調査

日本脳神経外科学会，日本神経学会および日本脳卒中学会教育訓練施設を対象に，1）米国ブレインアタック連合が推奨する脳卒中センターの推奨要件（専門医，診断機器，専門的治療，インフラ，教育研究）に関する施設調査を施行し，749 病院から回答を得た（**Table 3**）．この推奨要件は，5 つの大分類（専門的人員，診断機器，専門的治療，インフラ，教育研究），25 項目からなり，この 1 項目を満たすごとに，1 点を加算することで，施設ごとの推奨要件の充足の割合を，25 点満点で単純に合計したものを，total CSC score とした．自施設のスコアと全国の参加施設の分布は，当研究班ホームページで参照することができる．このスコアに関しては，たとえば，専門的人員の中の脳神経外科医，神経学会専門医の充足率は，それぞれ 92.7%，47.8%であり，欧米とまったく異なることが明らかとなった[3)7)]．また，診断機器については，MRI 拡散強調画像が，常時撮影できる施設が 86.4%と非常に整備が進んでいることが明らかとなった．一方，ストロークケアユニットの整備は，17.6%と

遅れていることが判明した．この total CSC score は，都市圏別に検討すると歴然とした地域格差が存在する（**Fig. 1**）．**Fig. 2** は，この total CSC score を四分位に分けて，スコアの低いものから，Q1〜4 に分類し，これを医療圏ごとに脳卒中センターの機能を表示したものである．パイの大きさは，当該医療圏の中に存在する，本診療施設調査に回答した病院数に相当する．今後，このスコアが臨床的あるいは医療政策的にどのような意義をもつのかを検証していく必要がある．

② 脳卒中診療医の勤務状況と疲労度調査

燃え尽き症候群は，Maslach ら[5]によると，シニシズムや離人症的症状あるいは極度の疲労を特徴とする病態で，たとえば米国外科学会の会員の 40%はバーンアウトしており，30%はうつ病のスクリーニング陽性，28%は low mental QOL を示すと報告されている（2009）[9]．バーンアウトと医療過誤との関連も指摘されている．しかし，脳卒中診療に関係する医師という専門的な集団のみを対象とした調査は，世界的にもこれまで行われておらず，特に緊急対応の要請が強い脳卒中診療という状況を考慮すると，第一線の診療に携わっている医師の勤務状況と疲労度の把握は喫緊の課題であると考えられる．

そこで本研究班では，分担研究者の国立循環器病研究センター研究所 西村邦宏博士が中心となって，脳卒中診療に携わる日本脳神経外科学会と日本神経学会の専門医を対象にアンケートを実施した．この調査を企画したのが，ちょうど東日本大震災の直後であったため，この震災の影響を考慮して，東北の 3 県居住のドクターを対象から除いた．年齢，性別，経験年数，労働時間，当直回数，オンコールの回数，収入などを説明変数として，QOL の測定は SF-8，このバーンアウトに関しては，Maslach の Burnout Inventory の日本語版を用いて測定した（**Table 4**）．

回答者の平均は，経験年数は 21 年，週 65.9 時間労働で，月に 3 回程度の当直と，週に 2 回程度のオンコール勤務を行っており，燃え尽き症候群の定義を，疲弊感またはシニシズムのどちらかを満たすこととした場合，48%の回答者が燃え尽き症候群の可能性があるということになった．特に睡眠時間と収入が少ないと，燃え尽き症候群の割合は大きくなるということがわかった．今後，何らかの介入をすることで燃え尽き症候群の頻度を低下させることが可能か否か検討中である．

③ 脳卒中患者の退院調査

2011 年度には DPC 参加病院 256 施設において 2010 年度に加療した脳卒中症例 65,165 例（予定入院を除く脳卒中症例 53,170 例）を登録し，本邦における単年度の調査としては過去最大規模の横断調査を施行し，死亡率に影響する施設要因，人的要因について解析を行っている（**Table 5, 6**）．この手法は，DPC 調査に用いる電子情報を用いた，独創的な脳卒中大規模データベースのあり方を示すものである．この一連の研究の中で，DPC 情報を用いた退院調査が，脳卒中の大規模データベースとして大きな可能性を持つこと，年度ごとのアウトカムを参加施設にフィードバックすることによって，ベンチマークとして大きな可能性を持つことを見出しており，後続研究で実証していきたいと考えている．また，病院ごとの脳卒中入院患者の死亡率は，当研究班ホームページにアクセスすることで，自施設に入院した急性期脳卒中患者の死亡率が日本全国の病院の中で，どこに位置しているかをフィードバックできるようにしている（**Fig. 3**）．

Table 3　J-ASPECT Study 脳卒中診療施設調査の概要

脳卒中診療施設調査（2011 年 2 月）
・目的：脳卒中センターの機能と脳卒中治療件数
・対象：日本脳神経外科学会，日本神経学会，日本脳卒中学会研修教育施設　1,369 施設
・調査項目：
・一次脳卒中センター（t-PA 静注療法の適正使用）の要件
—t-PA protocol の整備 etc
・包括的脳卒中センターの要件（CSC Score：0〜25）
—人的資源　(7)：専門医（脳神経外科，神経内科，血管内治療，救急）etc
—診断機器　(6)：CT, MRI-DWI, 血管撮影 etc 常時施行可能
—専門的治療　(5)：脳動脈瘤治療，脳内血腫除去，再開通療法 etc
—インフラ　(5)：SCU, ICU, 手術・血管内治療 常時施行可能
—教育　(2)：院内外多職種，地域住民　対象

謝辞

本研究は，平成 22〜24 年厚生労働科学研究費補助金事業「包括的脳卒中センターの整備に向けた脳卒中の救急医療に関する研究」（研究代表者 飯原弘二），および総務省消防庁防災科学研究推進制度による研究助成（研究代表者 飯原弘二）を一部受けて施行された．

J-ASPECT Study Group
研究代表者
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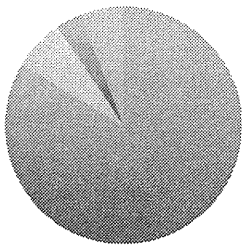
分担研究者
国立循環器病研究センター脳卒中統合イメージングセンター部長　中川原譲二

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）
「包括的脳卒中センターの整備に向けた脳卒中の救急医療に関する研究」（研究代表者　飯原弘二）

大都市・小都市
【調査対象施設の分布】

都市圏人口



▒大都市_中心 ▒大都市_郊外 ▒小都市_中心
▒小都市_郊外 ▒その他

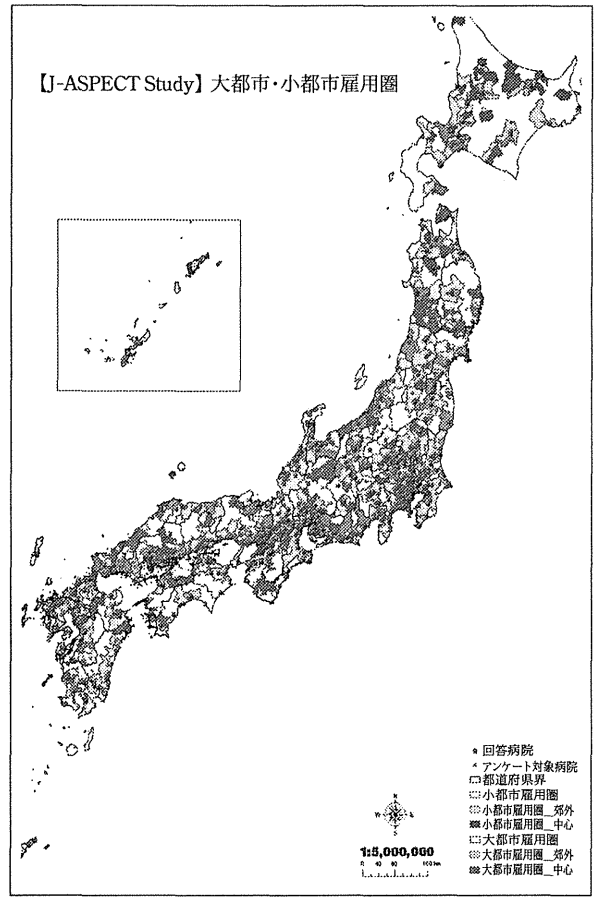


Fig. 1　J-ASPECT Study 脳卒中診療施設調査回答病院の概要

岩手医科大学脳神経外科教授　小笠原邦昭
杏林大学脳神経外科教授　塩川芳昭
千葉県循環器病センターセンター長　小野純一
昭和大学大学院救急医学講座教授　有賀　徹
名古屋大学大学院脳神経外科准教授　宮地　茂
長崎大学脳神経外科教授　永田　泉
産業医科大学公衆衛生学教授　松田晋哉
国立循環器病研究センター脳血管内科部長　豊田一則
国立循環器病研究センター EBM・リスク情報解析室室長　西村邦宏
国立循環器病研究センター先進医療・治験推進部　嘉田晃子

J-ASPECT Study　診療施設調査参加施設
Abashiri Neurosugical Rehabilitation Hospital, Ageo Central General Hospital, Aichi Medical University Hospital, Aidu Chuo Hospital, Aizawa Hospital, Akiba Hospital, Akiru Municipal Medical Center, Akita General Hospital, Akita Kumiai General Hospital, Akita Rosai Hospital, Akita University Hospital, Ako Central Hospital, Ako City Hospital, Almeida Memorial Hospital, Amakusa Medical Center, Anji Kosei Hospital, Aomori Kyoritsu Hospital, Aomori Municipal Hospital, Aomori Rosai Hospital, Aoyama Hospital, Araki Neurosurgical Hospital, Arao City Hospital, Arita Kyouritsu Hospital, Asahikawa Medical University Hospital, Asahikawa Red Cross Hospital, Asao General Hospital, Ashikaga Red Cross Hospital, Atsumi Hospital, Ayabe City Hospital, Azuma Neurosurgical Hospital, Azumi Medical Hospital, Azumino Red Cross Hospital, Baba Memorial Hospital, Bellland General Hospital, "Beppu Medical Center, National Hospital Organization", Bizen Municipal Hospital, Central Gunma Neurosurgical Hospital, Chiba Cardiovascular Center, Chiba Central Medical Center, Chiba Emergency Medical Center, Chiba Neurosurgical Clinic, Chiba University Hospital, Chichibu City Hospital, Chigasaki City Hospital, Chikamori Hospital, Chubu-Tokusyukai Hospital, Chugoku Rousai Hospital, Chuno Kosei Hospital, Daiichi Hospital, Daini Okamoto General Hospital, Daiwa Hospital, Dohtoh Neurosurgical Hospital, Dokkyo Medical University Hospital, Ehime Prefectural Central Hospital, Ehime Prefectural Imabari Hospital, Ehime University Hospital, Enshu Hospital, Fuchu Hospital, Fuji Brain Institute and Hospital, Fuji General Hospital, Fujii Neurosurgical Hospital, Fujimoto Hayasuzu Hospital, Fujisawa City Hospital, Fujisawa Neurosurgical Hospital, Fujita General Hospital, Fujita Health University Hospital, Fujiyoshida Municipal Medical Center, Fukaya Red Cross Hospital, Fukui Red Cross Hospital, Fukui General Hospital, Fukui Kosei Hospital, Fukui Social Insurance Hospital, Fukui University Hospital, Fukuoka City Hospital, Fukuoka Kieikai Hospital, Fukuoka Seishuukai Hospital, Fukuoka Shin Mizumaki Hospital, Fukuoka Tokushukai Medical Center, Fukuoka University Hospital, Fukuroi

CSC Score に基づいた脳卒中治療ネットワークの可視化

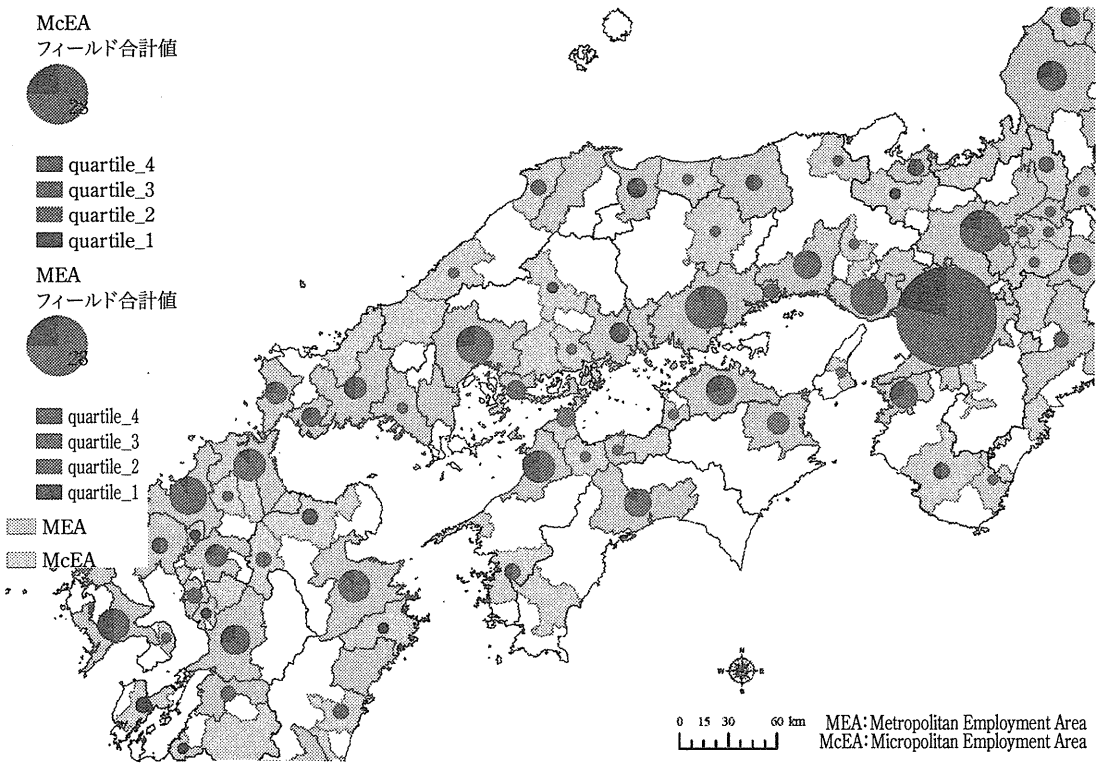


Fig. 2　J-ASPECT Study CSC スコアに基づいた脳卒中治療ネットワークの可視化

Table 4　J-ASPECT Study 脳卒中診療医の勤務状況と疲労度調査

脳卒中診療医の勤務状況疲労度調査 (2011 年 5 月)
・目的：脳卒中治療に携わる医師の Quality of Life (QOL)，燃え尽き症候群の頻度を測定
・対象：日本脳神経外科学会専門医，日本神経学会専門医　10,741 名（震災の影響を考慮し，東北 3 県を除く全国調査）
・方法：アンケート調査により，脳卒中治療に携わる医師の QOL，燃え尽き症候群の頻度を測定
・疲弊度の測定 —燃え尽き症候群：日本版 MBI-GS を使用 —QOL 測定：SF-8（SF-36 の短縮版）＋MHI-5
・背景因子 労働時間，睡眠時間，施設要因など合わせて評価

Table 5　J-ASPECT Study 脳卒中患者の退院調査の概要

脳卒中患者の退院調査 —DPC，電子レセプト情報の活用— (2011 年，2012 年)
・目的：脳卒中治療の大規模データベースの作成と，ベンチマーキングの可能性
・対象：日本脳神経外科学会，日本神経学会教育訓練施設の中で，脳卒中診療施設調査に参加した　749 病院
・方法：前年度に治療した脳卒中症例を，ICD 10 code で抽出
・臨床指標の測定 —アウトカム指標（入院死亡率），プロセス指標　など
・診療施設調査データ（CSC Score）とアウトカムとの関係
・背景因子 —年齢，性，重症度，病院など合わせて評価 —Hierarchical regression analysis

Municipal Hospital, Fukushima Medical University Hospital, Fukushima Prefectural Aizu General Hospital, Fukushima Red Cross Hospital, Fukushima Takanori Memorial Hospital, Furukawa Seiryo Hospital, Fussa Hospital, Gamagohri City Hospital, Geriatrics Research Institute and Hospital, Gifu Central Hospital, Gifu Municipal Hospital, Gifu Prefectural General Medical Center, Gifu Prefectural Tajimi Hospital, Gifu University Hospital, Goshi Hospital, Gunma University Hospital, Hachinohe Heiwa Hospital, Hachisuga Hospital, Hakodate Neurosurgical Hospital, Hakodate Shintoshi Hospital, Hakuai Hospital, Hakuo-kai Sumi Hospital, Hamamatsu Medical Center, "Hamamatsu University School of Medicine, University Hospital", Hamamatsu Rosai Hospital, Hamanomachi Hospital, Hanwa Memorial Hospital, Harada Hospital, Hashima City Hospital, Hata Kenmin Hospital, Hayashi Hospital, Health Insurance Amakusa Chuo General Hospital, Health

Insurance Nankai Hospital, Health Insurance Naruto Hospital, Heart Life Hopital, Heisei Memorial Hospital, Heisei Neurosurgical Hospital, Hibino Hospital, Hidaka General Hospital, Higashimatsuyama Medical Association Hospital, Higashiyamato Hospital, Hikone Municipal Hospital, Himeji Central Hospital, Himi Municipal Hospital, Hiratsuka City Hospital, Hirosaki University Hospital, Hiroshima City Asa Hospital, Hiroshima General Hospital, Hiroshima Prefectural Hospital, Hiroshima Red Cross Hospital & Atomic-bomb Survivors Hospital, Hiroshima University Hospital, Hokkaido Neurosurgical Memorial Hospital, Hokkaido University Hospital, Hokushin General Hospital Nagano Prefectural Fideration of Agricultural Cooperatives for Health and Welfare, Hokushinkai Megumino Hospital, Hokuto Hospital, Hoshigaoka Koseinenkin Hospital, Houetsu Hospital, Hekinan Municipal Hospital, Hyogo Brain and Heart Center, Hyogo Prefectural Amagasaki Hospital, Hyogo Prefectural Awaji Hospital, Hyogo Prefectural Nishinomiya Hospital, Ibaraki Prefectural Central Hospital, Ibaraki Seinan Medical Center Hospital, Ibi Kousei Hospital, Ichinomiya Neurosurgery Hospital, Ichinomiya West Hospital, Ichinose Hospital, Iida Municipal Hospital, Iizuka Hospital, Ikeda Neurosurgical Center Hospital, Ikuwakai Memorial Hospital, Imakiire General Hospital, Imamura Bun-in Hospital, Inagi Municipal Hospital, International University of Health and Welfare Atami Hospital, Inuyama Chuo Hospital, Iseikai Hospital, Iseikai Yahata Central Hospital, Isesaki Municipal Hospital, Ishikawa Prefectural Central Hospital, Ishinkai Yao General Hospital, Ishinomaki City Hospital, Ishioka Dai-Ichi Hospital, Isogo Central Hospital, Itami Kousei Neurosurgical Hospital, Itoigawa General Hospital, Itsukaichi Memorial Hospital, Iwaki Kyoritsu Hopital, Iwamizawa Municipal General Hospital, Iwata City Hospital, Iwate Medical University Hospital, Iwate Prefectural Iwai Hospital, Iwate Prefectural Ninohe Hospital, Iwate Prefecturel Isawa Hospital, Izumi General Medical Center, Izumino Hospital, Izumi Municipal Hospital, JA Kochi Hospital, JA Toride Medical Center, Japan Medical Alliance Higashi Saitama General Hospital, Japanese Red Cross Hadano Hospital, Japanese Red Cross Kitami Hospital, Japanese Red Cross Kobe Hospital, Japanese Red Cross Kochi Hospital, Japanese Red Cross Koga Hospital, Japanese Red Cross Kyoto Daini Hospital, Japanese Red Cross Medical Center, Japanese Red Cross Nagasaki Genbaku Hospital, Japanese Red Cross Ogawa Hospital, Japanese Red Cross Society Hachinohe Medical Center, Japanese Red Cross Society Himeji Hospital, Jiaikai Kajiura Hospital, Jichi Medical University Hospital, JR Tokyo General Hospital, Junshin Hospital, Juntendo University Hospital, Juntendo University Nerima Hospital, Juntendo University Urayasu Hospital, Junwakai Kinen Hospital, Juzenkai Hospital, Jyuzen General Hospital, Kaga City Hospital, Kagawa Prefectural Central Hospital, Kagawa Rosai Hospital, Kagawa University Hospital, Kagoshima City Hospital, Kagoshima Prefectural Oshima Hospital, Kagoshima Tokushukai Hospital, Kagoshima University Medical and Dental Hospital, Kainan Hospital, Kaiseikai Onishi Hospital, Kakegawa Municipal General Hospital, Kakizoe Hospital, Kakogawa City Hospital, Kameda Medical Center, Kameoka Shimizu Hospital, Kamiichi General Hospital, Kamitsuga General Hospital, Kanazawa Medical University Hospital, Kanazawa Municipal Hospital, Kanazawa Neurosurgical Hospital, Kanazawa University Hospital, Kanetsu Hospital, Kanoya Medical Center, Kansai Medical University Takii Hospital, Kanto Central Hospital for Public School Teachers, Kantoh Neurosurgical Hospital, Karatsu Red Cross Hospital, Kariya Toyota General Hospital, Kasai Cardiology Neurosurgery Hospital, Kasaoka Daiichi Hospital, Kashima Rosai Hospital, Kashiwaba Neurosurgical Hospital, Kashiwazaki General Hospital and Medical Center, Kasugai Municipal Hospital, Kasukabe Chuo General Hospital, Katagi Neurosurgical Hospital, Katano Hospital, Katsuta Hospital, Kawachi General Hospital, Kawakita General Hospital, Kawano Neurosurgical Hospital, Kawasaki Hospital, Kawasaki Medical School Hospital, Kawasaki Municipal Hospital, Kawasaki Municipal Tama Hospital, Kawasakisaiwai

Table 6　J-ASPECT Study 脳卒中患者の退院調査の速報

脳卒中患者の退院調査（速報） —DPC，電子レセプト情報の活用—
・65,165 例の脳卒中患者（2012 年 1 月現在）
・死亡退院：6,846 例（10.5%）
・入院後 24 時間以内の死亡：1,313 例（2%）
・入院後 7 日以内の死亡：3,673 例（5.6%）
・入院後 30 日以内の死亡：5,593 例（8.6%）
・救急車による緊急入院：30,447 例（46.7%）
・外科治療施行：7,350 例（11.3%）

研究協力施設への feed back
(http://jaspect.jp/index.html)

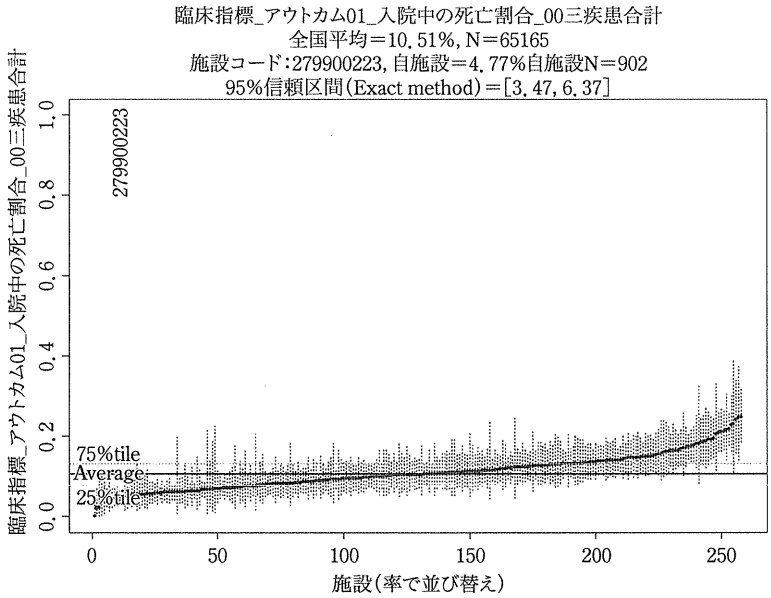


Fig. 3　J-ASPECT Study 脳卒中患者の退院調査結果のフィードバック

Hospital, Kazuno Kosei Hospital, Keijin Kai Kawasaki Hospital, Keiwakai Ebetsu Hospital, Kenwakai Otemachi Hospital, Kimitsu Chuo Hospital, Kinan Hospital, Kinki University Hospital, Kiryuu Kohsei General Hospital, Kishiwada Tokushukai Hospital, Kitakyushu Municipal Medical Center, Kitamurayama Hospital, Kitano Hospital, Kizawa Memorial Hospital, KKR Sapporo Medical Center, Kobari General Hospital, Kobe University Hospital, Kochi Health Sciences Center, Kochi Medical School Hospital, Kofu Jonan Hospital, Kofu Municipal Hospital, Kofu Neurosurgical Hospital, Kohka Public Hospital, Kohnan Hospital, Kokubu Neurosurgical Clinic, Kokura Memorial Hospital, Komaki City Hospital, Komatsu Municipal Hospital, Komono Kosei Hospital, Konan Kosei Hospital, Konan Tobu General Hospital, Kosei Hospital, Koshigaya Municipal Hospital, Koto Memorial Hospital, Kousei General Hospital, Kouseikai Takai Hospital, Kouseiren Murakami Hospital, Kugayama Hospital, Kumamoto City Hospital, Kumamoto Red Cross Hospital, Kumamoto Rousai Hospital, Kumamoto Takumadai Hospital, Kumamoto University Hospital, Kurashiki Central Hospital, Kurashiki Heisei Hospital, Kure Kyosai Hospital, Kurobe City Hospital, Kuroishi City Hospital, Kurosawa Hospital, Kurosu Hospital, Kurume University Hospital, Kusatsu General Hospital, Kushiro Kojinkai Memorial Hospital, Kushiro Rosai Hospital, Kuwana Hospital, Kuwana West Medical Center, Kyorin University Hospital, Kyoritsu General Hospital, Kyosai Tachikawa Hospital, Kyoto City Hospital, Kyoto Kujo Hospital, Kyoto Min-iren Chuo Hospital, Kyushu University Hospital, Machida Municipal Hospital, Maebashi Red Cross Hospital, Makita General Hospital, Masu Memorial Hospital, Matsudo City Hospital, Matsunami General Hospital, Matsushita Memorial Hospital, Matsuyama Red Cross Hospital, Matsuyama Shimin Hospital, Mattoh-Ishikawa Central Hospital, Mazda Hospital, Medical Corporation Kawamura Society Kubokawa Hospital, Meisei Hospital, Meitetsu Hospital, Midorigaoka Hospital, Mie Prefectural General Medical Center, Mie University Hospital, Mihara Memorial Hospital, Minamata City General Hospital and Medical Center, Minamisoma City General Hospital, Minase Hospital, Mine City Hospital, Minei Daiichi Hospital, Mino Municipal Hospital, Minoh City Hospital, Mishuku Hospital, Mito Medical Center, Mito Saiseikai General Hospital, Mitoyo General Hospital, Mitsugi General Hospital, Miyakonojo Regional Medical Center, Miyoshi Central Hospital, Mizushima Central Hospital, Morioka JRC Hospital, Moriya-daiichi General Hospital, Murakami Memorial Hospital Asahi University, Murata Hospital, Muroran City General Hospital, Musashino General Hospital, Nadogaya Hospital, Naga District Hospital, Nagahama City Hospital, Nagahama Red Cross Hospital, Nagano Municipal Hospital, Nagano Prefectural Kiso Hospital, Nagano Prefectural Suzaka Hospital, Nagano Red Cross Hospital, Nagaoka Chuo General Hospital, Nagaoka Red Cross Hospital, Nagareyama Central Hospital, Nagasaki Kawatana Medical Center, Nagasaki Municipal Hospital, Nagasaki Prefecture Shimabara Hospital, Nagasaki University Hospital, Nagatomi Neurosurgical Hospital, Nagoya Daini Red Cross Hospital, Nagoya Ekisaikai Hospital, Nagoya Medical Center, Nagoya Memorial Hospital, Nagoya University Hospital, Naha City Hospital, Nakamura Memorial Hospital, Nakamura Memorial South Hospital, Nakano General Hospital, Nakatsu Gastrointestinal Hospital, Namegata District General Hospital, Nanbu Tokushukai Hospital, Nantan General Hospital, Nara City Hospital, Nara Medical University Hospital, Nara Prefectural Hospital, Nara Prefectural Mimuro Hospital, Narita Red Cross Hospital, Nasu Neurosurgical Hospital, Nasu Red Cross Hospital, National Cancer Center Hospital, National Center for Child Health and Development, National Center for Global Health and Medicine, National Cerebral and Cardiovascular Center, National Disaster Medical Center, National Fukuoka-Higashi Medical Center, National Hospital Organization Chiba Medical Center, National Hospital Organization Hamada Medical Center, National Hospital Organization Himeji Medical Center, National Hospital Organization Kanazawa Medical Center, National Hospital Organization Kanmon Medical Center, National Hospital Organization Kobe Medical Center, National Hospital Organization Kumamoto Medical Center, National Hospital Organization Kure Medical Center, National Hospital Organization Maizuru Medical Center, National Hospital Organization Minami Wakayama Medical Center, National Hospital Organization Nagasaki Medical Center, National Hospital Organization Nara Medical Center, National Hospital Organization Okayama Medical Center, National Hospital Organization Osaka Minami Medical Center, National Hospital Organization Saitama National Hospital, National Hospital Organization Shizuoka Medical Center, National Hospital Organization Takasaki General Medical Center, National Hospital Organization Ureshino Medical Center, National Hospital Organization Utano Hospital, National Hospital Organization Yokohama Medical Center, National Kyushu Medical Center, Nayoro City General Hospital, Nihon University Itabashi Hospital, Niigata City General Hospital, Niigata Minami Hospital, Niigata Neurosurgical Hospital and Brain Research Center, Niigata Prefectural Cancer Center Hospital, Niigata Prefectural Central Hospital, Niigata Prefectural Shibata Hospital, Niigata Prefectural Tokamachi Hospital, Niigata Rosai Hospital, Niigata University Medical & Dental Hospital, Nippon Medical School Chiba Hokusoh Hospital, Nippon Medical School Hospital, Nippon Medical School Musashi Kosugi Hospital, Nippon Medical School Tama-Nagayama Hospital, Nipponbashi Hospital, Nishi-Agatsuma Welfare Hospital, Nishi-Kobe Medical Center, Nishinara Chuo Hospital, Nishinomiya Kyoritsu Neurosurgical Hospital, Nishio Municipal Hospital, Nishisaitama-chuo National Hospital, Nishiwaki Municipal Hospital, North Fukushima Medical Center, North Osaka Police Hospital, NTT Medical Center Tokyo, Obara Hospital, Obihiro-Kosei General Hospital, Odate Municipal General Hospital, Odawara Municipal Hospital, Oe Kyodou Hospital, Ofunato Hospital, Ogachi Central Hospital, Ogaki Municipal Hospital, Ogori Daiichi General Hospital, Ohda Municipal Hospital, Ohkawara Neurosurgical Hospital, Ohmiya Chuo General Hospital, Ohnishi Neurological Center, Ohta General Hospital, Oita Prefectural Hospital, Oita University Hospital, Oita-Oka-Hospital, Okayama City Hospital, Okayama East Neurosurgical Clinic, Okayama Kyokuto Hospital, Okayama Kyoritsu General Hospital, Okayama Rosai Hospital, Okayama University Hospital, Okazaki City Hospital, Okinawa Chubu Hospital, Okinawa Hokubu Hospital, Okinawa Kyodo Hospital, Okinawa Prefectural Miyako Hospital, Okinawa Prefectural Nanbu Medical Center and Children's Medical Center, Okinawa Prefectural Yaeyama Hospital, Okitama Public General Hospital, Okayama East Neurosurgical Clinic, Omihachiman Community Medical Center, Omori Red Cross Hospital, Omuta City Hospital, Ooi-Byouin, Ookuma Hospital, Oota Memorial Hospital, Osaka City General Hospital, Osaka City University Hospital, Osaka General Medical Center, Osaka Kosei-Nenkin Hospital, Osaka Medical Center, Osaka Medical College Hospital, Osaka Mishima Critical Care Medical Center, Osaka Neurological Institute, Osaka Neurosurgical Hospital, Osaka Police Hospital, Osaka Prefectural Senshu Critical Care Medical Center, Osaka Red Cross Hospital, Osaka Rosai Hospital, Osaka University Hospital, Otemae Hospital, Otsu Municipal Hospital, Research Institute for Brain and Blood Vessels Akita, Rumoi Central Clinic, Sadamoto Hospital, Saga Prefectural Hospital Koseikan, Saga Social Insurance Hospital, Sagamihara Kyodo Hospital, Sagamiharachuo Hospital, Saisei-kai Yokohama-shi Nanbu Hospital, Saiseikai Central Hospital, Saiseikai Fukuoka General Hospital, Saiseikai Gose Hospital, Saiseikai Hita Hospital, Saiseikai Hyuga Hospital, Saiseikai Imabari Hospital, Saiseikai Kumamoto Hosptal, Saiseikai Kurihashi Hospital, Saiseikai Kyoto Hospital, Saiseikai Matsusaka General Hospital, Saiseikai Matsuyama Hospital, Saiseikai Nagasaki Hospital, Saiseikai Nakatsu Hospital, Saiseikai Nara Hospital, Saiseikai Noe Hospital, Saiseikai Saijo Hospital, Saiseikai Shimonoseki General Hospital, Saiseikai Toyama Hospital, Saiseikai Utsunomiya Hospital, Saiseikai Yahata General Hospital, Saiseikai Yamaguchi Hospital, Saiseikai Yokohamashi Tobu Hospital, Saiseikai-Chuwa Hospital, Saitama Cancer Center Hospital, Saitama Cardiovascular and Respiratory Center, Saitama Medical Center, Saitama Medical Center Jichi Medical University, Saitama Medical University Hospital, Saitama Medical University International Medical Center, Saitama Municipal Hospital, Saito Memorial Hospital, Sakai City Hospital, Sakai Hospital Kinki University Faculty of Medicine, Sakaide Municipal General Hospital, Saku Central Hospital, Sakura General Hospital, Sakurakai Hospital, Sanda City Hospital, Sankoukai Miyazaki Hospital, Sannocho Hospital, Sano Kousei General Hospital, Sanyudo Hospital, Sapporo City General Hospital, Sapporo Higashi-Tokushukai Hospital, Sasebo Chuo Hospital, Sasebo City General Hospital, Sayama Hospital, Seguchi Neurosurgery Hospital, Seirei Hamamatsu General Hospital, Seirei Memorial Hospital, Seirei Mikatagahara General Hospital, Seirei Yokohama Hospital, Seiyu Memorial Hospital, Sendai City Hospital, Sendai Medical Association Hospital, Sendai Open Hospital, Senpo Tokyo Takanawa Hospital, Senseki Hospital, Shakaihoken Kobe Central Hospital, Shakaihoken Shimonoseki Kosei Hospital, Shiga Medical Center for Adults, Shiga University of Medical Science Hospital, Shimada City Hospital, Shimane Prefectural Central Hospital, Shimane University Hospital, Shimonoseki City Hospital, Shimotsuga General Hospital, Shin Koga Hospital, Shin Yukuhashi Hospital, Shin-Tokyo Hospital, Shingu Municipal Medical Center, Shinko Hospital, Shinoda General Hospital, Shinonoi General Hospital, Shinrakuen Hospital, Shinseikai Toyama Hospital, Shinshu Ueda Medical Center, Shinsuma Hospital, Shirahama Hamayu Hospital, Shirakawa Kosei General Hosptal, Shiroishi Neurosurgical Hospital, Shiroyama Hospital, Shiseikai Daini Hospital, Shizuoka Children's Hospital, Shizuoka City Hospital, Shizuoka General Hospirtal, Shobara Red Cross Hospital, Shonai Hospital, Shonan Kamakura General Hospital, Showa General Hospital, Showa Inan General Hospital, Showa University Fujigaoka Hospital, Showa University Hospital, Social Insurance Chukyo Hospital, Social Insurance Chuo General Hospital, Social Insurance Takahama Hospital, Soseikai General Hospital, South Miyagi Medical Center, Southern Tohoku General Hospital, St. Marianna University School of Medicine Toyoko Hospital, St. Francisco Hospital, St. Marianna University School of Medicine Hospital, Steel Memorial Hirohata Hospital, Steel Memorial Yawata Hospital, Suiseikai Kajikawa Hospital, Suita Municipal Hospital, Suwa Central Hospital, Suwakohan Hospital, Suzuka Kaisei Hospital, Tachikawa Medical Center, Takada Chuo Hospital, Takamatsu Municipal Hospital, Takamatsu Red Cross Hospital, Takarazuka City Hospital, Takarazuka Daii-

chi Hospital, Takashima Municipal Hospital, Takatsuki General Hospital, Takeda General Hospital, Takikawa Neurosurgery Hospital, Tama-Hokubu Medical Center, Tama-Nanbu Chiiki Hospital, Tamana Central Hospital, Tane General Hospital, Tano Hospital, Tanushimaru Central Hospital, Tatebayashi Kosei Hospital, Teikyo University Chiba Medical Center, "Teikyo University School of Medicine Hospital, Mizonokuchi", Takeda Hospital, Tenshindo Hetsugi Hospital, The Taiju-Kai Foundation Social Medical Corporation Kaisei General Hospital, Tochigi National Hospital, Toho University Ohashi Medical Center, Tohoku Koseinenkin Hospital, Tokai Central Hospital of the Mutual Aid Association of Public School Teachers, Tokai University Hachioji Hospital, Tokai University Hospital, Tokai University Oiso Hospital, Toki General Hospital, Tokuda Neurosurgical Hospital, Tokushima Prefectural Central Hospital, Tokushima Prefectural Kaifu Hospital, Tokushima University Hospital, Tokuyama Central Hospital, Tokyo Kyosai Hospital, Tokyo Medical and Dental University Hospital Faculity of Medicine, Tokyo Medical University Hospital, Tokyo Medical University Ibaraki Medical Center, Tokyo Metropalitan Hiroo Hospital, Tokyo Metropolitan Health and Medical Corporation Toshima Hospital, Tokyo Metropolitan Ohtsuka Hospital, Tokyo Metropolitan Police Hospital, Tokyo Women's Medical University Hospital, Tokyo Women's Medical University Yachiyo Medical Center, Tokyo Women's University Medical Center East, Tokyo-Teishin Hospital, Tokyo-west Tokushukai Hospital, Tokyo Medical University Hachioji Medical Center, Tomakomai Neurosurgical Hospital, Tomakomai Nissho Hospital, Tomei Atsugi Hospital, Tominaga Hospital, Tomioka General Hospital, Tonami General Hospital, Tone Central Hospital, Tosei General Hospital, Tottori Prefectural Kousei Hospital, Tottori Red Cross Hospital, Tottori Seikyo Hospital, Tottori University Hospital, Toyama City Hospital, Toyama Prefectural Central Hospital, Toyama Rosai Hospital, Toyohashi Medical Center, Toyokawa City Hospital, Toyooka Chuo Hospital, Toyooka Public Hospitals' Association Toyooka Hospital, Toyota Kosei Hospital, Tsuchiura Kyodo General Hospital, Tsukazaki Hospital, Tsukuba Medical Center Hospital, Tsushima City Hospital, Tsuyama Central Hospital, "Ube Industries, ltd. Central Hospital", Ueyama Hospital, Ugadake Hospital, University Hospital of the Ryukyus, University of Miyazaki Hospital, University of Tokyo Hospital, University of Tsukuba Hospital, University of Yamanashi Hospital, Urasoe General Hospital, Ushiku Aiwa General Hospital, Ushioda General Hospital, Uwajima City Hospital, Uwajima Tokushukai Hospital, Veritas Hospital, Wada Hospital, Wakakusa Dai-ichi Hospital, Wakayama Co-operative Hospital, Wakayama Medical University Hospital, Wakayama Medical University Kihoku Hospital, Wakayama Rosai Hospital, Wakayama Saiseikai Hospital, Yaentoge Neurosurgery Hospital, Yagi Neurosurgical Hospital, Yaizu City General Hospital, Yamachika Memorial Hospital, Yamada Kinen Hospital, Yamada Red Cross Hospital, Yamagata City Hospital Saiseikan, Yamagata Prefectural Kahoku Hospital, Yamagata Prefectural Shinjo Hospital, Yamagata University Hospital, Yamaguchi Grand Medical Center, Yamaguchi Red Cross Hospital, Yamaguchi Rousai Hospital, Yamaguchi University Hospital, Yamamoto Memorial Hospital, Yamanashi Kosei Hospital, Yamanashi Prefectural Central Hospital, Yamanashi Red Cross Hospital, Yamashiro Public Hospital, Yamato Municipal Hospital, Yao Tokushukai General Hospital, Yasugi Municipal Hospital, Yatsuo General Hospital, Yatsushiro Health Insurance General Hospital, Yawata Medical Center, Yayoigaoka Hospital, Yodogawa Christian Hospital, Yokkaichi Municipal Hospital, Yokohama Central Hospital, Yokohama City Minato Red Cross Hospital, Yokohama City University Hospital, Yokohama City University Medical Center, Yokohama General Hospital, Yokohama Rosai Hospital, Yokohama Sakae Kyosai Hospital, Yokohama Shin-midori General Hospital, Yokohama Stroke and Brain Center, Yokohamashintoshi Neurosurgical Hospital, Yokosuka General Hospital Uwamachi, Yomeikai Obase Hospital, Yonabaru Chuo Hospital, Yonago Medical Center, Yonezawa City Hospital, Yuaikai Hospital, Yukioka Hospital

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要　旨

脳卒中急性期治療の課題―包括的脳卒中センターの整備に向けて―

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塩川　芳昭　　有賀　　徹　　宮地　　茂　　豊田　一則　　松田　晋哉　　永田　　泉
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J-ASPECT Study Group

厚生労働科学研究費補助金事業「包括的脳卒中センターの整備に向けた脳卒中の救急医療に関する研究」（研究代表者 飯原弘二）の中で，日本脳神経外科学会，日本神経学会および日本脳卒中学会教育訓練施設を対象に，1）米国ブレインアタック連合が推奨する脳卒中センターの推奨要件（専門医，診断機器，専門的治療，インフラ，教育研究）に関する施設調査を施行し，749 病院から回答を得て，施設ごとの推奨要件の充足率に歴然とした格差が存在すること，2）脳卒中診療に従事する専門医の約半数が，疲労やストレスなどが原因で仕事への意欲が大幅に低下する「燃え尽き症候群」の恐れがあることを明らかとした．3）2011 年度には DPC 参加病院 256 施設において 2010 年度に加療した急性期脳卒中症例 53,170 例を登録し，本邦における単年度の調査としては過去最大規模の横断調査を施行し，死亡率に影響する施設要因，人的要因について解析を行っている．

脳外誌　22：678-687，2013

The Impact of Comprehensive Stroke Care Capacity on the Hospital Volume of Stroke Interventions: A Nationwide Study in Japan: J-ASPECT Study

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Background: The association between comprehensive stroke care capacity and hospital volume of stroke interventions remains uncertain. We performed a nationwide survey in Japan to examine the impact of comprehensive stroke care capacity on the hospital volume of stroke interventions. *Methods:* A questionnaire on hospital characteristics, having tissue plasminogen activator (t-PA) protocols, and 25 items regarding personnel, diagnostic, specific expertise, infrastructure, and educational components recommended for comprehensive stroke centers (CSCs) was sent to 1369 professional training institutions. We examined the effect of hospital characteristics, having a t-PA protocol, and the number of fulfilled CSC items (total CSC score) on the hospital volume of t-PA infusion, removal of intracerebral hemorrhage, and coiling and clipping of intracranial aneurysms performed in 2009. *Results:* Approximately 55% of hospitals responded to the survey. Facilities with t-PA protocols (85%) had a significantly higher likelihood of having 23 CSC items, for example, personnel (eg, neurosurgeons: 97.3% versus 66.1% and neurologists: 51.3% versus 27.7%), diagnostic (eg, digital cerebral angiography: 87.4% versus 43.2%), specific expertise (eg, clipping and coiling: 97.2% and 54% versus 58.9% and 14.3%, respectively), infrastructure (eg, intensive care unit: 63.9% versus 33.9%), and education (eg, professional education: 65.2% versus 20.7%). On multivariate analysis adjusted for hospital characteristics, total CSC score, but not having a t-PA protocol, was associated with the volume of all types of interventions with a clear increasing trend (P for trend $< .001$). *Conclusion:* We demonstrated a significant association between

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comprehensive stroke care capacity and the hospital volume of stroke interventions in Japan. **Key Words:** Stroke facilities—stroke units—ischemic stroke—intracerebral hemorrhage—subarachnoid hemorrhage—acute stroke therapy.

Introduction

Stroke is the third leading cause of death worldwide and a leading cause of long-term disability. In 2000, the Brain Attack Coalition discussed the concept of stroke centers and proposed 2 types of centers: primary[1] and comprehensive.[2] Most stroke patients can be treated appropriately at primary stroke centers (PSCs), and the Joint Commission has established programs for the certification of, and measurement of performance in, PSCs. The concept of a comprehensive stroke center (CSC) enables intensive care and the use of specialized techniques, which are not available at most PSCs.[2] A set of metrics and associated data elements that cover the major types of care that distinguish CSCs from PSCs have been published recently.[3] At present, when the certification of CSCs has been initiated worldwide, there are no nationwide reports on the associations between primary and comprehensive stroke care capacity and impact of comprehensive stroke care capacity on hospital volume of stroke interventions.

Aims

We performed a nationwide survey in Japan to determine the association between primary and comprehensive stroke care capacity and the impact of comprehensive stroke care capacity on the annual hospital volume of tissue plasminogen activator (t-PA) infusion, removal of intracerebral hemorrhage (ICH), and coiling and clipping of intracranial aneurysms (IAs).

Methods

Eligible Hospitals

The J-ASPECT study (Nationwide survey of Acute Stroke care capacity for Proper dEsignation of Comprehensive stroke cenTer in Japan) group developed a 49-question survey regarding hospital characteristics (eg, bed number, academic status, geographic location, and participation in the diagnosis procedure combination [DPC] payment system), primary and comprehensive stroke care capacity, and hospital volume of stroke interventions. The questionnaire was mailed on February 2011 to the 1369 certified training institutions of the Japan Neurosurgical Society, the Japanese Society of Neurology, and the Japan Stroke Society. In the case of nonresponders, a second mail was sent to the medical directors to ensure that the questionnaire was completed and returned.

Assessment of Comprehensive and Primary Stroke Care Capacities and Hospital Volume of Stroke Interventions

This survey included 25 items related to the 5 major components of CSCs (personnel, diagnostic programs, specific expertise, infrastructure, and educational components) and 5 items related to PSC certification (Tables 1 and 2).[2] Personnel were assessed according to 7 categories (eg, board-certified neurologists, board-certified neurosurgeons, and board-certified endovascular physicians). Because the original questions were highly specific, they were modified if necessary. Six advanced neuroimaging capabilities (eg, magnetic resonance imaging [MRI] with diffusion-weighted imaging [DWI] and digital cerebral angiography [DSA]) were investigated based on their availability 24 h/d, 7 d/wk (24/7). The availability of specific expertise for the stroke interventions was examined according to 5 categories (eg, carotid endarterectomy [CEA] and clipping and coiling of IAs). Regarding infrastructure, the availability of 5 items (eg, stroke unit and intensive care unit [ICU]) was surveyed.

Table 1. *Characteristics of the responding hospitals and items of primary stroke care capacity*

Variables	Category	*n*	%
Number of beds	<50	20	2.7
	50-99	30	4
	100-299	232	31
	300-499	260	34.7
	≥500	207	27.6
Academic hospital		90	12
DPC hospital		553	73.8
Geographic locations	MEA-central	381	50.9
	MEA-outlying	239	31.9
	McEA-central	90	12
	McEA-outlying	12	1.6
	Unclassified	27	3.6
PSC component	t-PA protocol	637	85
	t-PA physician*	688	92
	NIHSS*	529	70.7
	Acute stroke team*	198	26.5
	Direct phone with EMS*	435	58.5

Abbreviations: DPC, diagnosis procedure combination; EMS, emergency medical services; MEA, metropolitan employment area; McEA, micropolitan employment area; NIHSS, National Institutes of Health Stroke Scale; PSC, primary stroke center; t-PA, tissue plasminogen activator.

*Data missing: t-PA physician, 1; NIHSS, 1; acute stroke team, 1; direct phone with EMS, 5.

Table 2. *Number (percentage) of responding hospitals (n = 749) with the recommended items of comprehensive stroke care capacity*

Components	Items	*n*	%
Personnel	Neurologists	358	47.8
	Neurosurgeons	694	92.7
	Endovascular physicians	272	36.3
	Critical care medicine	162	21.6
	Physical medicine and rehabilitation	113	15.1
	Rehabilitation therapy	742	99.1
	Stroke rehabilitation nurses*	102	13.8
Diagnostic (24/7)	CT*	742	99.2
	MRI with diffusion	647	86.4
	Digital cerebral angiography*	602	80.8
	CT angiography*	627	84
	Carotid duplex ultrasound*	257	34.5
	TCD*	121	16.2
Specific expertise	Carotid endarterectomy*	603	80.6
	Clipping of IA	685	91.5
	Hematoma removal/ draining	689	91.9
	Coiling of IA	360	48.1
	Intra-arterial reperfusion therapy	498	66.5
Infrastructure	Stroke unit*	132	17.6
	Intensive care unit	445	59.4
	Operating room staffed 24/7*	451	60.4
	Interventional services coverage 24/7	279	37.3
	Stroke registry*	235	31.7
Education	Community education*	369	49.4
	Professional education*	436	58.6

Abbreviations: CT, computed tomography; IA, intracranial aneurysm; MRI, magnetic resonance imaging; TCD, transcranial Doppler.

*Data missing: stroke rehabilitation nurse, 9; CT, 1; digital cerebral angiography, 4; CT angiography, 3; carotid endarterectomy, 1; carotid duplex, 3; TCD, 3; stroke unit, 1; operating room staffed, 2; stroke registry, 7; community education, 2; professional education, 5.

Educational/research programs were assessed according to 2 items (community and professional education). Overall organizational and staffing levels of the hospitals in terms of CSC capacity were scored on the basis of the results of a questionnaire referring to 25 items originally recommended by the Brain Attack Coalition (total CSC score). A score of 1 was assigned for meeting each recommended item, and the maximum total CSC score was 25. Hospital volume of stroke interventions (eg, t-PA infusion, removal of ICH, and clipping and coiling of IAs) performed in 2009 was assessed.

Other Hospital Characteristics

Hospital characteristics pertaining to the number of beds, academic status (university/nonuniversity hospital), participation in the DPC-based payment system, and geographic location were described. The DPC database is a nationwide database in Japan comprising discharge abstract and administrative claim data.[4,5] In 2010, approximately 1388 acute care hospitals in Japan, representing approximately 18% and 50% of the number of hospitals and hospital beds, respectively, adopted the DPC-based payment system.[6] The geographic location of the hospitals was classified according to urban employment areas,[7] which are divided into Metropolitan Employment Areas (MEAs) and Micropolitan Employment Areas (McEAs). The MEAs and McEAs are further classified into central and outlying areas based on the commuting pattern of their inhabitants. These classifications are based on the 2005 population census.[8]

Selection Bias of the Responding Hospitals

To overcome selection bias, we compared the proportion of hospitals that adopted the Japanese DPC-based payment system (DPC hospital) between the responding and nonresponding hospitals. Among the eligible DPC hospitals, we compared the proportion of hospitals that treated more than 10 cases of ischemic stroke (IS), ICH, and subarachnoid hemorrhage between July and December 2008, by using the DPC data from the responding and nonresponding hospitals.

Statistical Analyses

We used Fisher's exact test to detect significant differences in the proportions of hospitals. Kruskal-Wallis and Wilcoxon tests were used to determine differences in categorical and total CSC scores. Multiple linear regression analysis was used to examine the impact of total CSC score and availability of t-PA protocol adjusted for other hospital characteristics on hospital volume of stroke interventions. We also calculated *P* values (2 tailed) for trend across total CSC score categorized into quartiles, and *P* less than .05 was considered significant. Percentages were calculated excluding missing data. SAS version 9.2 (SAS Institute, Inc., Cary, NC) and STATA version 12 (STATA Corp., College Station, TX) were used for all statistical analyses.

Ethics

This research was approved by the Institutional Review Board of the National Cerebral and Cardiovascular Center, which waived the requirement for individual informed consent.

Results

Response Rate and Responding-Hospital Characteristics

In total, 55% (749 hospitals) of the eligible institutions completed the questionnaire. The characteristics of the responding hospitals are shown in Table 1. DPC hospitals represented 65.3% of the eligible hospitals and 73.8% and 55% of the responding and nonresponding hospitals, respectively ($P < .0001$). The response rate of the DPC hospitals was significantly higher than that of the remaining hospitals (61.9% versus 41.3%, $P < .0001$). Among the DPC hospitals, a greater proportion of responding hospitals, rather than nonresponding hospitals, treated more than 10 cases of ICH (65.6% versus 49.9%, $P < .0001$) and subarachnoid hemorrhage (30.7% versus 17%, $P < .0001$) per 6 months but not of IS (79% versus 76.8%, $P = .454$).

Primary Stroke Care Capacity Recommended for PSCs

Written t-PA protocols were available in 85% of hospitals, and the National Institutes of Health Stroke Scale score was routinely documented in 70.7% of hospitals; however, an acute stroke team was available only in 26.5% of hospitals (Table 1).

Comprehensive Stroke Care Capacity Recommended for CSCs

Regarding the recommended personnel components of CSCs, 92.7% of hospitals had a neurosurgeon, 47.8% had a neurologist, and 36.3% had an endovascular physician (Table 2). The proportion of hospitals with critical care medicine physicians and physical medicine and stroke rehabilitation nurses was 21.6% and 15.1% and 13.8%, respectively. The availability of the personnel component ranged from 0 to 7 (median, 3; interquartile range [IQR], 2-4).

Computed tomography (CT), MRI with DWI, DSA, and CT angiography (CTA) were available 24/7 in 99.2%, 86.4%, 80.8%, and 84% of institutions, respectively, whereas carotid duplex ultrasonography and transcranial Doppler (TCD) were available only in 34.5% and 16.2% of hospitals, respectively. The availability of diagnostic components ranged from 0 to 6 (median, 4; IQR, 4-5).

CEA, clipping of IAs, and removal of ICH were available in 80.6%, 91.5%, and 91.9% of hospitals, respectively, whereas coiling of IAs and intra-arterial thrombolysis were available in 48.1% and 66.5% of hospitals, respectively. The availability of surgical and interventional components ranged from 0 to 5 (median, 4; IQR, 3-5).

A stroke unit and an ICU were available in 17.6% and 59.4% of hospitals, respectively. The availability of interventional service coverage on a 24-hour basis was observed in 37.3% of hospitals, whereas an operating room staffed 24/7 was available in 60.4% of hospitals. The availability of infrastructure components ranged from 0 to 5 (median, 2; IQR, 1-3).

Professional and community education were available in 58.6% and 49.4% of institutions, respectively (Table 2). The availability of the educational component ranged from 0 to 2 (median, 1; IQR, 0-2).

Geographical Disparity of Primary and Comprehensive Stroke Care Capacity

Among certified personnels, the proportion of neurologists, interventional physicians, and stroke nurses available at MEA-central institutes was significantly higher ($P < .001$, $P < .001$, and $P = .045$, respectively), whereas neurosurgeons, critical care medicine, and physical medicine were in place, irrespective of the location. Imaging techniques, such as MRI, diffusion-weighted MRI, CTA, digital subtraction angiography, and carotid duplex ultrasonography, were available on a 24-hour basis in similar proportions irrespective of the location, whereas TCD was available in a significantly higher proportion at MEA-central institutes except for TCD ($P = .003$). Specific surgical and interventional services for CEA ($P = .002$), coiling of IAs ($P < .001$), and intra-arterial reperfusion therapy ($P = .04$) were available in a significantly higher proportion at MEA-central institutes. The availability of stroke unit ($P < .001$), operating room staffed, and interventional services on a 24/7 basis ($P < .001$) was significantly more established at MEA-central institutes, whereas no significant differences were found with regard to the ICU. Community ($P = .011$) and professional education ($P = .003$) were more established at MEA-central institutes (Appendix Tables 2 and 3).

Associations between the Implementation of a t-PA Protocol and Comprehensive Stroke Care Capacity

Facilities with t-PA protocols had a higher likelihood of having a neurosurgeon (97.3% versus 66.1%, $P < .0001$), neurologist (51.3% versus 27.7%, $P < .0001$), endovascular physician (41.1% versus 8.9%, $P < .0001$), and physicians in critical care medicine (23.7% versus 9.8%, $P = .0007$) and physical medicine and rehabilitation (16.5% versus 7.1%, $P = .006$) (Table 3). There were no differences in the availability of personnel in rehabilitation therapy ($P = .355$) or of stroke rehabilitation nurses ($P = .695$). Facilities with t-PA protocols had a higher percentage of 24/7 availability of CT (99.5% versus 97.3%, $P = .042$), MRI with DWI (89.6% versus 67.9%, $P < .0001$), DSA (87.4% versus 43.2%, $P < .0001$), carotid duplex ultrasonography (37% versus 19.8%, $P = .0003$), and TCD (18.1% versus 5.4%, $P = .0002$). Moreover, hospitals with a t-PA protocol had greater availability of CEA (87.1% versus 43.8%, $P < .0001$), clipping of IAs (97.2% versus 58.9%, $P < .0001$), removal of ICH (97.5% versus 60.7%, $P < .0001$), coiling of IAs (54% versus 14.3%, $P < .0001$), and intra-arterial thrombolysis (73% versus 29.5%, $P < .0001$) and greater availability of a stroke unit (20.1% versus 3.6%, $P < .0001$), an ICU (63.9% versus

Table 3. *Characteristics of comprehensive stroke care capacity according to the presence or absence of a t-PA protocol*

Variables	t-PA protocol (+) *n*, %		t-PA protocol (−) *n*, %		OR	95% CI	*P* value
Personnel							
Neurologists	327	51.3	31	27.7	2.8	1.8-4.3	<.0001
Neurosurgeons	620	97.3	74	66.1	18.7	10.1-34.8	<.0001
Endovascular physicians	262	41.1	10	8.9	7.1	3.7-13.9	<.0001
Critical care medicine	151	23.7	11	9.8	2.9	1.5-5.5	.0007
Physical medicine and rehabilitation	105	16.5	8	7.1	2.3	1.2-5.4	.006
Rehabilitation therapy	632	99.2	110	98.2	1.14	0.4-12	.355
Stroke rehabilitation nurses	88	14	14	12.6	1.1	0.6-2.1	.695
Diagnostic							
CT*	634	99.5	108	97.3	5.9	1.2-29.5	.042
MRI with diffusion	571	89.6	76	67.9	4.1	2.6-6.6	<.0001
Digital cerebral angiography*	554	87.4	48	43.2	9.1	5.8-14.2	<.0001
CT angiography*	566	89.1	61	55	6.7	4.3-10.5	<.0001
Carotid duplex ultrasound*	235	37	22	19.8	2.4	1.5-3.9	.0003
TCD*	115	18.1	6	5.4	3.9	1.7-9.1	.0002
Specific expertise							
Carotid endarterectomy*	554	87.1	49	43.8	8.7	5.6-13.5	<.0001
Clipping of IA	619	97.2	66	58.9	24	13.1-43.7	<.0001
Hematoma removal/draining	621	97.5	68	60.7	25.1	13.4-46.9	<.0001
Coiling of IA	344	54	16	14.3	7	4.1-12.2	<.0001
Intra-arterial reperfusion therapy	465	73	33	29.5	6.5	4.2-10.1	<.0001
Infrastructure							
Stroke unit*	128	20.1	4	3.6	6.8	2.5-18.8	<.0001
Intensive care unit	407	63.9	38	33.9	3.4	2.3-5.3	<.0001
Operating room staffed 24/7	426	67.1	25	22.3	7.1	4.4-11.4	<.0001
Interventional services coverage 24/7	268	42.1	11	9.8	6.7	3.5-12.7	<.0001
Stroke registry*	229	36.3	6	5.4	10	4.3-23.1	<.0001
Education							
Community education*	348	54.8	21	18.8	5.3	3.2-8.7	<.0001
Professional education*	413	65.2	23	20.7	7.2	4.4-11.7	<.0001

Abbreviations: CI, confidence interval; CT, computed tomography; IA, intracranial aneurysm; MRI, magnetic resonance imaging; OR, odds ratio; TCD, transcranial Doppler.

*Data missing: CT, 1; digital cerebral angiography, 4; carotid U/S, 3; TCD, 3; carotid endarterectomy, 1; stroke unit, 1; stroke registry, 7; community education, 2; professional education, 5.

33.9%, $P < .0001$), an operating room staffed 24/7 (67.1% versus 22.3%, $P < .0001$), interventional service coverage 24/7 (42.1% versus 9.8%, $P < .0001$), and a stroke registry (36.3% versus 5.4%, $P < .0001$). Finally, hospitals with a t-PA protocol had greater availability of professional (65.2% versus 20.7%, $P < .0001$) and community (54.8% versus 18.8%, $P < .0001$) education (Table 3).

Impact of Total CSC Score on Hospital Volume of Stroke Interventions

The total CSC score, which ranged from 0 to 24 (median, 14; IQR, 11-18), was significantly higher in facilities with a t-PA protocol than in other facilities (median, IQR: 15, 12.5-18 versus 9, 5-11; $P < .0001$). On univariate analysis, the implementation of a t-PA protocol and total CSC score categorized into quartiles (Q1, 0-10; Q2, 11-13; Q3, 14-17; and Q4, 18-24) were each significantly associated with hospital volume of stroke interventions, as shown in Table 4. The impact of total CSC score (Q1-Q4) and the implementation of a tPA protocol on the annual case volume of stroke interventions in the participating hospitals was shown in Figure 1. On multiple linear regression analysis, the availability of a t-PA protocol and total CSC score each had a significant impact on the hospital volume of the stroke interventions after adjustment for other hospital characteristics (Appendix Tables 4-6). The inclusion of total CSC score, availability of a t-PA protocol, and other hospital characteristics in the model revealed that total CSC score, but not availability of a t-PA protocol, was significantly associated with the hospital volume of stroke interventions (Table 5).

Discussion

This study demonstrated a significant impact of comprehensive stroke care capacity represented by the total CSC score on the hospital volume of stroke interventions and unique aspects of comprehensive stroke care capacity in Japan.

Table 4. *Impact of the availability of a t-PA protocol and of total CSC score on hospital volume of stroke interventions performed in 2009: hospital volume of stroke interventions based on the availability of a t-PA protocol and on total CSC score (univariate analysis)*

	t-PA protocol			Total CSC score				
	(+)	(−)	*P* value	Q1	Q2	Q3	Q4	*P* value
t-PA infusion	5 (2-11)	0 (0-1)	<.0001	1 (0-3)	4 (1-7)	6 (4-10.5)	10 (5-16)	<.0001
Removal of ICH	7 (3-13)	0 (0-3)	<.0001	2 (0-4)	5 (3-9)	7.5 (3-15)	11.5 (6-18)	<.0001
Clipping of IA	17 (8-29)	0 (0-10)	<.0001	3 (0-11.5)	12 (6-21.25)	18 (10-30)	27 (18-43.75)	<.0001
Coiling of IA	4 (0-13)	0 (0-1)	<.0001	0 (0-1)	1 (0-4)	5.5 (1.25-13)	13 (5-22)	<.0001

Abbreviations: CSC, comprehensive stroke center; IA, intracranial aneurysm; ICH, intracerebral hemorrhage; t-PA, tissue plasminogen activator.

Unique Aspects of Comprehensive Stroke Care Capacity in Japan

This study illustrated several unique aspects of comprehensive stroke care capacity in Japan, for example, higher availability of neurosurgeons (92.7% versus 24%-54% in the United States)[9,10] and endovascular surgeons (36.3% versus 15%-22% in the United States),[9-11] which was in sharp contrast with the relative shortage of neurologists (47.8% versus 31%-73% in the United States) and other personnel.[9-11] In the United States, only 7% of neurosurgeons play an active role in nontraumatic cranial emergencies,[12] whereas in Japan, 59% of the board-certified neurosurgeons are engaged in stroke care. The proportion of Japanese hospitals offering MRI with DWI and CTA corresponded with the gradual increase in the availability of certain special diagnostic tests in the United States, whereas the availability of DSA (80.8%) was in contrast with the temporal decrease in the availability of catheter angiography observed in North Carolina (from 38% in 1998 to 30% in 2008) because of declines in the proportion of hospitals with neurointerventionalists.[11]

A stroke unit/stroke care unit as the critical infrastructure for acute stroke, which has been proven to reduce the number of deaths and long-term dependency,[13] was available in only 17.6% of hospitals in Japan; this was comparable with the proportion observed in hospitals in the United States (6.6%-28%).[9-11,14]

To determine the relationship between primary and comprehensive stroke care capacity, we used the implementation of a written t-PA protocol as a key item of primary stroke care capacity[1] as it is a key step in reducing t-PA–related complications.[15] The availability of a t-PA protocol (85%) recorded in the present study was comparable with that reported in 2 US statewide studies performed in Illinois in 2000 (72.8%)[9] and in North Carolina between 1998 (43%) and 2008 (69%).[11] Notably, facilities with a t-PA protocol in Japan had a higher availability of nearly all (92%) recommended items of comprehensive stroke care capacity, with the exception of personnel in rehabilitation therapy and stroke rehabilitation nurses. In a previous study performed in the United States,[9] however, no significant differences were noted in the availability of a larger number of critical items corresponding to the CSC items in this study (eg, endovascular physicians, CTA, conventional cerebral angiography, carotid duplex ultrasound, intra-arterial thrombolysis, stroke unit, and community stroke awareness program) according to the presence or absence of a t-PA protocol. Therefore, comprehensive stroke care capacity tended to coexist in hospitals with primary stroke care capacity in Japan than in the United States. A relatively larger commitment of neurosurgeons in acute stroke care (eg, t-PA infusion) in Japan may explain such a coexistence.

Table 5. *Impact of the availability of a t-PA protocol and of total CSC score on hospital volume of stroke interventions performed in 2009: multivariate linear regression analysis of the impact of total CSC score and availability of a t-PA protocol on hospital volume of stroke interventions*

	β	*P* value	95% CI	
tPA				
Total CSC score	.83	<.001	.67	.98
tPA protocol (+)	−1.31	.117	−2.95	.33
ICH				
Total CSC score	.97	<.001	.76	1.18
tPA protocol (+)	−1.17	.297	−3.36	1.03
Clipping				
Total CSC score	2.23	<.001	1.68	2.79
tPA protocol (+)	−4.33	.146	−10.17	1.51
Coiling				
Total CSC score	1.20	<.001	.92	1.48
tPA protocol (+)	−1.01	.496	−3.92	1.90

Abbreviations: CI, confidence interval; CSC, comprehensive stroke center; IA, intracranial aneurysm; ICH, intracerebral hemorrhage; t-PA, tissue plasminogen activator; Total CSC score, availability of a t-PA protocol, and other hospital characteristics were included in the model as independent variables.

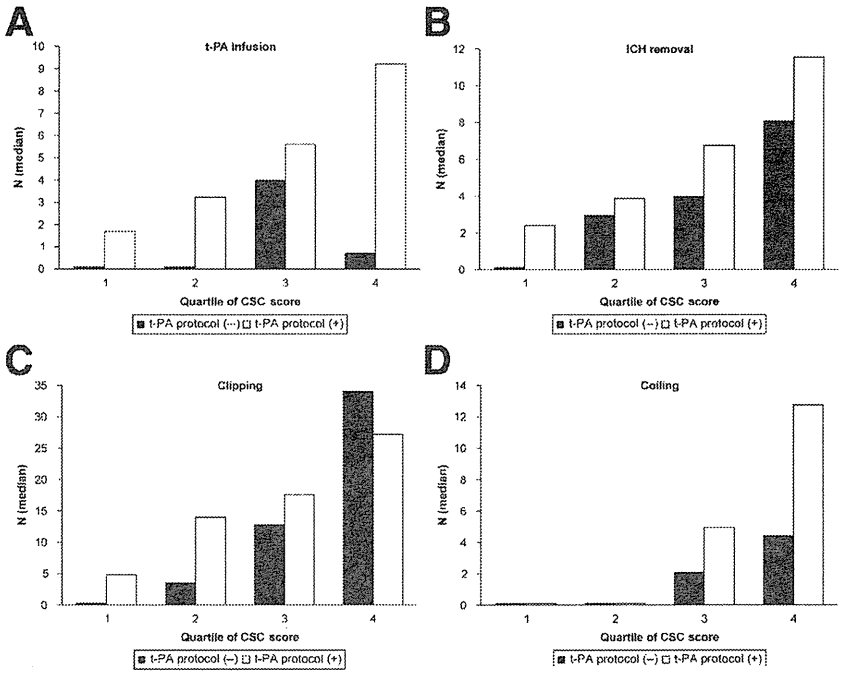

Figure 1. *A bar graph showing the impact of total CSC score (Q1-Q4) and the implementation of a tPA protocol on the annual case volume of stroke interventions (A, t-PA infusion; B, ICH removal; C, clipping; and D, coiling of intracranial aneurysms) in the participating hospitals. Abbreviations: CSC, comprehensive stroke center; t-PA, tissue plasminogen activator.*

Geographical Disparity of Primary and Comprehensive Stroke Care in Japan

These findings could assist in identifying underserved, high-population density areas that may benefit from professional and hospital education by national organizations, such as the Japan Stroke Society and Japan Neurosurgical Society. In light of insufficient advanced acute stroke capacities, these findings represent fundamental information for the establishment of a spoke-and-hub stroke care system.[2] Such a system could maximize use of acute reperfusion therapies for IS and surgical/endovascular management of hemorrhagic stroke, depending on the personnel and specific expertise of the hospital and the geographical access of the potential population in Japan.

The Impact of Comprehensive Stroke Care Capacity on the Hospital Volume of Stroke Interventions

The present study demonstrated a significant impact of comprehensive stroke care capacity, as represented by the total CSC score, but not the availability of a t-PA protocol, on the hospital volume of stroke interventions performed in Japan in 2009, after adjustment for other hospital characteristics. High volume is associated with better outcomes across a wide range of procedures and conditions; however, the magnitude of the association varies greatly.[16] High annual hospital volume was reported to be consistently associated with lower IS mortality.[17] In the field of comprehensive stroke care, in-hospital mortality increases when the annual number of craniotomies for aneurysms is lower than 30[18] and when CEA is performed by less experienced surgeons (<5 procedures/y).[19] Conversely, a previous Japanese nationwide study found no correlation between case volume and outcome after cerebral aneurysm clipping.[20] The mechanism via which volume influences outcomes remains uncertain. Specific processes of care, which are correlated with volume, are the most likely explanatory factors.[16] The strong associations between comprehensive stroke care capacity and hospital volume of the stroke interventions observed in this study may support this notion. Further studies are necessary to establish the association between comprehensive stroke care capacity and in-hospital mortality after all types of stroke. If such association is established, as recently reported for PSC,[21] the total CSC score may be used as a quality indicator of comprehensive stroke care capacity for benchmarking purposes.

Limitations

This study was likely to have included a potential information bias (self-report, recall, and nonresponse). Hospitals actively working to improve stroke care are more likely to respond to the questionnaire. The fact that a greater proportion of the responding DPC hospitals treated more than 10 cases of hemorrhagic stroke in the latter half of the previous year than did the nonresponding DPC hospitals may support such selection bias. We did not attempt to assess the self-report bias as no official information was available that could have been used to verify the data.

Conclusion

The present study demonstrated a significant impact of comprehensive stroke care capacity, as represented by the total CSC score on the hospital volume of stroke