表2　Mini-nutritional assessment short form（MNA-SF）

A. 過去3カ月間に食欲不振，消化器系の問題，咀嚼・嚥下困難などで食事摂取が減少しましたか？
　0＝強度の食事量の減少
　1＝中等度の食事量の減少
　2＝食事量の減少なし
B. 過去3カ月間の体重減少がありましたか？
　0＝3 kgを越す減少　　1＝わからない
　2＝1～3 kgの減少　　3＝体重減少なし
C. 運動能力
　0＝ベッド（布団）または椅子から自分で離れることができる？
　1＝ベッドや車椅子を離れられるが，外出はできない
　2＝自由に外出できる
D. 精神的ストレスや急性疾患を過去3カ月間に経験しましたか？（マニュアルを参照）
　0＝はい　　2＝いいえ
E. 神経・精神的問題の有無
　0＝高度の認知症またはうつ状態　　1＝中程度の認知機能障害
　2＝精神的問題なし
F-1. BMI指数（身長が計測できない場合は，マニュアルを参照し，膝長からの推定身長を計算し，BMIを測定してください）
　0＝BMIが19より少ない　　1＝BMIが19以上，21未満
　2＝BMIが21以上，23未満　　3＝BMIが23以上
何らかの理由で，BMIが計算できない方はF-1のかわりにF-2の指標を使用してください．
F-2. 下腿周囲長（測定法はマニュアルを参照）
　0＝31 cm未満　　3＝31 cm以上

A～Fの合計：　　点/14点
12～14ポイント：正常　　8～11ポイント：低栄養のリスクあり　　0～7ポイント：栄養不良

特にbody mass index（BMI），体重変化，上腕周囲長，上腕皮下脂肪厚，血液検査などを合わせて診断するケースが多い[3)4)]．

身体計測は介護施設，在宅でも実施できることもあり，栄養評価の基本である．しかし，身長は円背や，四肢の拘縮等がある場合は測定しづらい．身長が不正確だとBMIの値は信頼が薄れる．体重の変化を観察することは栄養指標の基本であるが，在宅療養中の寝たきり高齢者のように在宅で体重測定が困難なケースも少なくない．できるだけ通所サービスなどの利用時に体重測定を行う必要がある．どうしても体重が測定出来ないケースでは上腕身体計測を使用する．上腕身体計測は皮下脂肪厚，上腕周囲長を測定することにより，上腕筋面積（または筋周囲長）を計算で求めることが出来，脂肪の量と筋肉量の目安とすることができる．この上腕身体計測は日本人でも生命予後の予測因子となることが報告されている[5)]．一方，下腿周囲長もよく使用されるが，一般には下腿周囲長は皮下脂肪よりも骨格筋を反映するといわれている．しかし，いずれも体重が測定できない時にはその代用となりうる．

さらに包括的栄養評価法として種々の方法が報告されている．高齢者用に開発され，現在欧米の臨床の現場でよく使用されつつあるのがmini-nutritional assessment（MNA®）である．ここでは詳細は省くが，このfull versionの欠点は経口摂取ができない対象者には回答できない項目があること，またコミュニケーション障害，または高度の認知機能障害が存在すると，回答できない項目が存在する（一応介護者が答えることができるとはされている）．このshort-formが存在し，スクリーニング法としては優れている．BMIが測定できない時のために下腿周囲長で代用することもできる（表2）．

低栄養予防と対策

既に極度の栄養不良になってしまった高齢者を救うのはなかなか困難である．多くのケースは既に感染症，褥瘡などの難治性の合併症を抱えていることがほとんどである．普段より定期的に栄養評価（スクリーニング・アセスメント）を実施し，低栄養になる前の段階，低栄養リスク状態の高齢者を抽出し，何らかの介入をすることが極めて大事である．栄養療法は低栄養に陥る原因検索から，基礎疾患との関連性，薬剤との関連，口腔内の問題，摂食嚥下の問題，栄養のアクセスルートの選定，投与カロリーの決定，栄養構成の決定，モニタリングなど非常に多くの内容を含み，医師だけで実施することは困難である．従って，これらの問題に介入するには多職種（管理栄養士，看護師，言語聴覚士，歯科医師，歯科衛

生士，医師，家族）が関与する必要が有る．チーム医療ができない環境では栄養の本格的介入は困難である．

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≪高齢者特有の症状に対応する——老年症候群≫
低栄養

葛谷雅文*

要旨

- 医療現場ではメタボリック・シンドローム，糖尿病，インスリン抵抗性，内臓肥満など過栄養が関わる病気が氾濫している．
- しかし，実際には後期高齢者では，逆に低栄養のリスクが増加し，それによる健康障害が生ずることが多い．
- いまだに体重が減ってきた後期高齢者に若い患者と同様の画一化された生活指導をしている医療現場があり，油もの，肉の摂取を控えた虚弱な後期高齢者がいる．

低栄養とは○

生体が生命活動を営むうえで必要とされる栄養素，ならびにエネルギーを産生・利用するための代謝関連物質の需要・貯蔵状態を評価する総合的な指標を栄養状態という．一般的に全体的な摂取カロリー不足，またはある種の栄養素の摂取不足により，健康上何らかの支障がある状態を低栄養といい，栄養不良，栄養失調と同義である．

低栄養状態はマラスムスとクワシオルコルの2つに分けることができる[1]．マラスムスとは主としてエネルギー不足による低栄養状態で，摂取エネルギーの不足の結果，身体活動の低下，基礎代謝の低下などの適応が起こった状態を指す．著しいやせ，筋力低下，皮下脂肪減少などが現れるが，重症以外では，肝機能，血清蛋白濃度，免疫能などは保たれていることが多い．一般に，徐々に進行し，適切な治療を受ければ予後良好である．クワシオルコルは主として蛋白質摂取不足による低栄養状態で，蛋白質不足に対して糖質の摂取が保たれているときはインスリン分泌が増加し，副腎皮質ホルモンの分泌が低下するので，皮下脂肪や筋肉蛋白質の分解が抑制される．その反面原料が供給されないため，内臓蛋白質の合成が抑制されて内臓細胞の機能障害が起きる．肝臓機能障害により，血漿蛋白合成が障害され，低アルブミン血症，浮腫が出現し，リポ蛋白質合成障害により，脂肪肝をきたし，肝腫大，腹部膨痛が出現する．また造血器機能障害により貧血，免疫能低下が出現する．一般に急速に進行することが多く，症状が完成した場合は予後不良である．

実際の高齢者に起こる低栄養状態の多くは，マラスムス・クワシロルコル型である．蛋白質ならびにエネルギーの摂取不足により，体重減少，成長障害，消耗がもたらされることを蛋白質・エネルギー欠乏症（protein-energy malnutrition：

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Table 1. 低栄養指標

1）身体計測

体重減少率

(平常時体重－現在の体重)÷平常時体重×100(%)

期　間	軽　度	中等度以上栄養障害
1カ月	5% 未満	5% 以上
3カ月	7.5% 未満	7.5% 以上
6カ月	10% 未満	10% 以上

triceps skin fold thickness，TSF(上腕三頭筋皮周脂肪厚)

midupper arm circumference，AC(上腕周囲長)

midupper arm muscle circumference，AMC(上腕三頭筋周囲長)＝AC－π(円周率)×TSF

midupper arm muscle area，AMA(上腕筋面積)＝$AMC^2 \div 4\pi$

日本人年齢別標準値を基準とする*

標準値の 60% 未満	高度栄養障害
60～80% 未満	中等度
80～90% 未満	軽度
90% 以上	正常

2）血液データ

	低栄養基準値	半減期
アルブミン	3.5 g/dl 未満	17～23 日
プレアルブミン(トランスサイレチン)	10 mg/dl 未満	1.9 日
トランスフェリン	200 mg/dl 未満	7～10 日
レチノール結合蛋白	3.0 mg/dl 未満	0.5 日
血清総コレステロール	150 mg/dl 未満	

*日本人の身体計測基準 JARD 2001(栄養評価と治療 19 巻[suppl]，2002)．

PEM)ということもある[1]．

また，低栄養を原因別に飢餓(starvation)と悪液質(cachexia)と分けることもできる．

飢餓とは必要なカロリーが摂取できないことによる低栄養状態をさす．臨床現場では介護力不足や摂食嚥下障害を抱える高齢者はこれにあたる．一方悪性腫瘍ならびに感染症，慢性炎症性疾患，さらには心不全，呼吸不全，肝，腎不全などの存在により，炎症性サイトカインの過剰産生による食欲低下ならびに筋蛋白を主体とする蛋白崩壊を伴う低栄養状態を「悪液質/カヘキシア」と呼ぶ．飢餓状態は適切な栄養療法により，栄養状態の改善が期待できるが，悪液質では栄養療法への反応が不良なケースがある．

低栄養の診断○

低栄養の明確な基準は存在しないが，体重などの身体計測，さらには生化学検査のデータを用い判断がされる場合が多い，さらに包括的な評価法によっても判定することができる．身体計測，生化学検査では Table 1 のような基準が使用されることが多い．また Table 2 に高齢者用に開発された Mini Nutritional Assessment(MNA)の栄養状態評価表を提示する[2]．この包括的栄養評価法はヨーロッパで開発されたものであるが，日本人高齢者でも使用できることが明らかにされている[3]．

低栄養の有病率○

一般的には，介護施設入所者，在宅療養中の高

Table 2. Mini Nutritional Assessment (MNA) の簡易栄養状態評価表

スクリーニング

A 過去3ヵ月間に食欲不振，消化器系の問題，咀嚼・嚥下困難などで食事摂取が減少しましたか？
0＝強度の食事量の減少
1＝中等度の食事量の減少
2＝食事量の減少なし □

B 過去3ヵ月間の体重減少がありましたか？
0＝3 kg を超す減少
1＝わからない
2＝1～3 kg の減少
3＝体重減少なし □

C 運動能力
0＝寝たきりまたは車椅子を常時使用
1＝ベッドや車椅子を離れられるが，外出はできない
2＝自由に外出できる □

D 精神的ストレスや急性疾患を過去3ヵ月間に経験しましたか？
0＝はい 2＝いいえ □

E 神経・精神的問題の有無
0＝高度の認知症またはうつ状態
1＝中程度の認知障害
2＝精神的問題なし □

F BMI 指数
0＝BMI が 19 未満
1＝BMI が 19 以上，21 未満
2＝BMI が 21 以上，23 未満
3＝BMI が 23 以上 □

スクリーニング値：小計(最大 14 ポイント) □
12 ポイント以上：正常，危険なし→これ以上の検査必要なし
11 ポイントまたはそれ以下：栄不良の疑いあり→検査続行

アセスメント

G 独立して生活(養護施設入所・入院していない)
0＝いいえ 1＝はい □

H 1日に4種類以上の処方薬を内服
1＝いいえ 0＝はい □

I 身体のどこかに褥瘡または皮膚潰瘍がある
1＝いいえ 0＝はい □

J 1日に何回食事を摂っていますか？
0＝1回 1＝2回 2＝3回 □

K 蛋白質摂取状態を示す指標
・1日に少なくとも1品の乳製品
(牛乳，チーズ，ヨーグルト)を摂取
□はい □いいえ
・1週間に豆類または卵を2品以上摂取
□はい □いいえ
・肉類，魚のいずれかを毎日摂取
□はい □いいえ
0.0＝はい，0～1つ
0.5＝はい，2つ
1.0＝はい，3つ □

L 1日に2品以上の果物または野菜を摂取
0＝いいえ 1＝はい □

M 水分(水，ジュース，コーヒー，茶，牛乳など)を1日どのくらい摂取しますか？
0.0＝コップ3杯未満
0.5＝3～5杯
1.0＝6杯以上 □

N 食事の状況
0＝介護者なしでは食事不可能
1＝多少困難ではあるが自分で食事可能
2＝困ることなしに自分で食事可能 □

O 栄養自己評価
0＝栄養状態は不良と思う
1＝わからない
2＝問題ないと思う □

P 同年齢の他人と比べ自分の健康状態をどう思いますか？
0.0＝よいとは思わない
0.5＝わからない
1.0＝同じだと思う
2.0＝他人よりよいと思う □

Q 上腕(利き腕でない方)の中央の周囲値(cm)：MAC
0.0＝MAC が 21 未満
0.5＝MAC が 21 以上，22 未満
1.0＝MAC が 22 以上 □

R ふくらはぎの周囲値(cm)：CC
0＝CC が 31 未満 1＝CC が 31 以上 □

アセスメント値：小計(最大：16 ポイント) □
スクリーニング値 □
総合評価(最大 30 ポイント) □
栄養不良指標スコア
17～23.5 ポイント：栄養不良の危険性あり
17 ポイント未満：栄養不良

[文献2)より引用，改変]

Table 3. 高齢者低栄養の要因

社会的要因	疾病要因
貧困	臓器不全
独居	炎症・悪性腫瘍
介護力不足・ネグレクト	薬物副作用
孤独感	義歯など口腔内の問題
精神心理的要因	摂食・嚥下障害
認知機能障害	ADL 障害
うつ	疼痛
誤嚥・窒息の恐怖	消化管の問題(下痢・便秘)
その他	加齢の関与
食形態の問題	臭覚，味覚障害
栄養に関する誤認識	食欲低下(中枢神経系の関与)
医療者の誤った指導	

齢者では 30～40% が低栄養であると報告されている．デイケア利用者の低栄養有病率を MNA を使用して検討すると，要介護度がわるくなるにつれ，低栄養有病率が増加し，要介護 5 では 66.7% にも及んだ[4]．欧米のナーシングホームにおける低栄養の頻度は 17～65% とされる．一方地域で自立した生活が可能な高齢者における低栄養の頻度は数%～10% 程度と報告されている[5]．したがって，要介護状態にある高齢者における低栄養の有病率は明らかに高い．

低栄養の及ぼす健康障害○

低栄養状態が高齢者に及ぼす悪影響に関しては，今まで多くの報告がある．低栄養の一つの指標である血清アルブミン値は重要な生命予後の指標であることは多くの論文で証明され，低体重(低 BMI 値)や体重減少は生命予後の重要な予測因子である．また低栄養は日常生活動作(activity of daily living：ADL)の低下にも関与し，ADL の低下は栄養状態の悪化と連動することが報告されている[6,7]．さらに，低栄養は免疫能の低下を伴い，感染症を引き起こしやすくする．また褥瘡の形成に関与するのみならず，主要疾患の治癒を遅らせ，合併症を容易に引き起こすことが知られる．さらに低栄養状態は入院期間の延長を引き起こし，医療費の高騰にもつながることが報告されている[5]．

低栄養の要因○

ヒトは一般的に加齢とともに徐々に食事量が低下してくる．高齢者では身体活動の低下，安静時基礎代謝量の低下，さらには除脂肪体重(lean body mass)の低下があり，これらによって高齢者の必要摂取熱量は低下する．若年時と比較すると食物摂取量は低下するが，それが必ずしも低栄養につながるわけではない．しかし，加齢に伴う生理的，社会的，経済的問題は高齢者の栄養状態に大きな影響を与える．Table 3 に高齢者の代表的低栄養要因をあげ，以下にその解説を述べる．

1．社会的要因

独居老人はそれだけで栄養障害のリスクとなる．ADL の障害がなくても，1 人暮らしのため十分な食事量を摂取していなかったり，食事内容が偏ったりする場合がある．ADL 障害がある高齢者は十分な介護力，適切な介護がなければ，摂取量は確実に低下する．経済的な問題があり満足に食事を取れない場合も低栄養の要因になるのはいうまでもない．

2．精神心理的要因

認知機能障害により食事をするのを忘れたり，空腹感を感じなかったりすることはまれでない．認知症が進行すると味覚，臭覚の低下が進むことも，食事摂取量が低下する一つの原因である．「うつ」は「消化管の問題」，「悪性腫瘍」に並ぶ高齢者の食欲不振・体重減少の原因として頻度が高い．明らかな食欲不振・体重減少の原因がない場合は，「うつ」の存在を疑う必要がある．また嚥下障害がある場合，誤嚥を恐れるため本人，介護者が食事摂取量を制限している場合がある．

3．疾患要因

悪性腫瘍ならびに感染症，慢性炎症性疾患の存在，さらには心不全，呼吸不全，肝，腎不全などが食欲低下の大きな誘引になる．さらにこれらの疾患は代謝性ストレスに直結し，必要エネルギー量は増大し，食欲低下と相まって低栄養につなが

る．腰痛，頭痛，膝関節痛などの疼痛は食欲低下の誘引になる．歯の問題は咀嚼機能の低下を含め栄養障害を引き起こす重要な因子である．とくに義歯の不調，口腔ケア不足による歯槽膿漏などは低栄養の誘引として重要である．また薬剤が高齢者の食欲低下，体重減少に係わっているケースは想像以上に多く，高齢者の食思不振の35%は医原病によるとの報告もある．さらに嚥下障害があれば，当然十分な経口摂取は期待できなく，放置すれば短期間に低栄養に陥る．

4．その他

成人時代の過栄養に対する食事指導を体重減少がすでに現れている高齢になっても引きずっている場合がある．また医療者も後期高齢者を対象に成人と同様な食事指導を行っている場合がある．

低栄養をめぐる問題点とその対策○

1）もっとも重要なことは，高齢者本人または家族，周囲の医療関係者が低栄養のリスクが出てきていることに気がつくことである．摂食量の把握も重要であり，客観的なデータとしては体重のモニタリングがもっとも重要である．ADL障害のため在宅で体重が測定できないときは介護保険サービスの通所サービスなどの使用時に最低月一度は測定し，記録を残すことが大事である．後期高齢者を定期的に診療しているかかりつけ医は，体重を定期的にモニターすることが素早く低栄養のリスクを把握するために重要である．

高度な栄養障害に陥ると，感染症，褥瘡などの合併症を抱えてしまっていることが多く，回復をさせることが困難であり，低栄養のリスクがある段階で対応することが重要である．

2）低栄養を引き起こしている原因を明らかにすることが大事なのはいうまでもない．しかし，原因不明の食思不振は高齢者でも多く，対応が困難な場合がある．見逃しやすいのは疼痛の存在，薬剤副作用，抑うつ状態などである．高齢者は痛みが存在すると食欲減退が顕著であり，適宜鎮痛薬などの使用もやむをえないことがある．また薬剤による食思不振は絶えず鑑別にあげるべきであり，できるだけ疑われる薬剤は中止してみることも重要である．また抑うつの存在は高齢者の食思不振の要因の中で重要である．適宜抑うつに対する介入が必要である．

3）発熱をはじめ，炎症が存在すれば食欲は著しく低下する．また臓器不全が存在すれば高齢者は食欲が著しく低下する．これらの場合は基礎疾患の治療を行いつつ，適宜低栄養に陥らないよう栄養療法を実施する必要がある．

4）要介護高齢者である場合は，その介護状況をケアマネジャーなどより情報収集する必要がある．不適切な介護・ネグレクトは意外に多い．また独居の場合，不適切な食事をしている可能性もあり，適宜配食サービスなどの導入を考慮する．

5）摂食・嚥下障害を認め，食事中にムセなどが起こり十分量が摂取できないケースはまれではない．このような高齢者ではまずは嚥下の評価を行う必要がある．嚥下障害に関しては他稿を参照いただきたい．そのような嚥下障害が存在する場合は，食形態の変更，とろみ剤の使用などである程度は対応できる．不適な食形態により，誤嚥が起きやすくなることはよく経験する．

6）経管栄養を受けている高齢者で低栄養に陥っている者をみることがある．このケースは十分な栄養が投与されているかどうかを再度確認する必要がある．よくあるのが経腸栄養剤(濃厚流動食)を導入後，モニター(血清アルブミン値などの生化学検査や体重測定)をせず，放置していることである．日本人の食事摂取基準(2010年版)における高齢者の推定エネルギー必要量は，身体活動レベルⅡでは，男性2,200 kcal/day，女性1,700 kcal/dayとしている[3]．しかしこれらは平均の推奨量であり，栄養療法を行うときはハリスベネディクトの公式などを使用して個別の必要カロリー量を算定する必要がある．計算したとしてもあくまで推定量であるので，上記のように定期的にモニタリングすることが重要である．

7）後期高齢者になっても若い時代に受けた生

活習慣病対策の食事指導を頑なに守り続けていることがある．加齢とともに徐々に体重が減少し，低栄養に傾きやすい．油は高齢者にとって効率のよいカロリー供給源である．肉も重要な蛋白供給源である．かかりつけ医も若年者と同様の画一的な生活習慣病に対する指導を考え直すべきである．もちろん，後期高齢者といえども，虚血性心疾患，糖尿病の存在，また関節症などの存在のため体重管理や厳格な食事療法(カロリー制限，動物性脂肪の制限)が必要な場合がある．しかし，それ以外の場合無理な減量，食事療法によりかえって栄養状態を悪化させることもあり，画一的な指導には十分注意する必要がある．

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Tooth loss as risk factor for foreign-body asphyxiation in nursing-home patients

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ABSTRACT

Foreign body asphyxiation causes severe medical conditions including pneumonia in the elderly requiring nursing care. The objective of this study was to elucidate the relationships between insufficient occlusal support due to tooth loss and the onset of asphyxiation accidents, and determine preventive measures for such accidents in nursing homes in Japan. The subjects were 437 elderly (110 men and 327 women) requiring nursing care. The frequency and risk factors for asphyxiation accidents and the food causing asphyxiation were examined in these subjects for 2.5 years, from June 2006 to December 2008. During the study period, 51 of the 437 subjects suffered asphyxiation. Self-feeding ability and loss of occlusal support were associated with a covariate-adjusted relative ratio for asphyxiation of 3.1 (95% confidence interval (CI) = 1.50–6.44) and 1.7 (95% CI = 1.12–2.74), respectively. To prevent asphyxiation in elderly people, it was found that maintaining or restoring occlusal support may be required. It was concluded that self-feeding ability and loss of occlusal support are significant risk factors for foreign-body asphyxiation among elderly people requiring nursing care.

1. Introduction

Asphyxiation occurs when any object is aspirated into the larynx or tracheobronchial tree, and causes airway obstruction: this obstruction can result in inability to breathe, with the need for rapid intervention to prevent asphyxial death (Ekberg and Feinberg, 1992). Therefore, asphyxiation cases are identified by signs and symptoms of dyspnea, abnormal respiratory rate, rhythm/depth of breathing, restlessness and cyanosis. Asphyxia is reported to be a common cause of death not only in the general population (Feinberg et al., 1992), but also in infants (<1 year of age) and the elderly. To date, a high frequency (incidence: 0.66 fatalities/100,000) of asphyxia has been reported in the general population each year (Fioritti et al., 1997). In Japan, deaths from asphyxiation have increased since the 1980s. Moreover, the mortality from asphyxiation incidents in infants has decreased by more than 60% in the past 30 years. However, mortality from asphyxiation in the elderly has increased rapidly (Ichikawa and Marui, 2000). This represents an important warning regarding asphyxiation to both elderly receiving care and their caregivers.

Samuels and Chadwick (2006) reported rapid eating, cramming of food into the mouth, and premature transfer of food into the pharynx as possible causes of asphyxiation in the elderly. Several reports have also suggested that oral stage dysfunction and cognitive impairment contribute to asphyxiation (Carter and Jancar, 1984; Feinberg et al., 1992; Finestone et al., 1998). A huge number of elderly people, including those requiring nursing care, lose teeth and/or occlusal support, resulting in decreased oral function (Hatch et al., 2001). Since wearing dentures is related to oral function, speech function and independent activities of daily living (Minakuchi et al., 2006), elderly people who lose occlusal support must wear dentures. However, it is sometimes difficult for elderly people requiring nursing care to wear dentures, for many reasons including mismanagement of dentures, losing dentures, and shortage of oral-care services. There have been few reports on the relationship between asphyxiation accidents and insufficient occlusal support due to tooth loss or failure to restore occlusal support by means of dentures. Haddon suggested that it is possible to eliminate these risk factors related to accidental death. Even when accidents do occur, the worst outcome can be avoided by thorough application of appropriate measures during and after an accident (Haddon, 1980).

In the present study, we examined the risk factors for asphyxiation accidents among the elderly in nursing homes, and determined the relationships among insufficient occlusal support caused by tooth loss, restoration of occlusal support by means of dentures, and asphyxiation accidents.

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2. Materials and methods

2.1. Participants

The survey was conducted in 486 individuals (mean age: 85.0 ± 8.5 years), whose guardians gave consent to their participation in the present study, among elderly people requiring care in 13 nursing homes in Japan. Of them, those who were discharged from nursing homes ($n = 49$) because of other reasons than asphyxiation were excluded from this study, since we could no longer peruse them. The study was performed on 437 subjects (110 men and 327 women; mean age, 80.8 ± 8.3 years for men and 86.4 ± 8.1 years for women; Barthel index, 25.1 ± 25.0).

2.2. Survey of asphyxiation

Asphyxiation occurring while eating food over a period of 2 years and 6 months from June 2006 to December 2008 was examined, and the outcomes were also determined. In this study, asphyxiation accidents were limited to those caused by food.

Asphyxiation cases were identified by signs and symptoms such as dyspnea, abnormal respiratory rate, rhythm/depth of breathing, restlessness and cyanosis as reported by the North American Nursing Diagnosis Association (2003).

2.3. Examination of risk factors for asphyxiation

The following six items were assessed to examine the risk factors for asphyxiation. In terms of the oral environment and oral function, the procedures used by dentists and physicians in each nursing home were studied.

2.3.1. Self-feeding ability

Subjects who could feed themselves at least partly without any help were assigned to the "independent group" and those who were able to eat only with assistance were assigned to the "dependent group".

2.3.2. Activity of daily living (ADL)

ADL in these subjects was evaluated using the Barthel Index (Mahoney and Barthel, 1965). When the index was 45 points or higher, ADL was considered to be maintained, and when the index was less than 40 points, ADL was considered to be decreased.

2.3.3. Cognitive function

The severity of senile dementia was evaluated according to "ADL independence of demented elderly", designed by the Ministry of Health, Labour and Welfare of Japan (http://www.mhlw.go.jp:80/topics/kaigo/kentou/15kourei/san-kou4.html; Hirakawa et al., 2008). Cognitive impairment was identified at rank 2 and higher of this scale (Table 1).

Table 1
ADL independence of demented elderly (Ministry of Health, Labour and Welfare of Japan).

Rating criteria	Description
Rank 0	Clear mentality
Rank 1	Although demented, the subject is almost independent in ADL at home or elsewhere
Rank 2	The subject shows slight impairment of cognition, but is independent under a carer's observation
Rank 3	The subject sometimes shows impairment of cognition, thus a carer is required
Rank 4	The subject often shows impairment of cognition, thus a carer is required all time
Rank 5	The subject shows serious mental symptoms or problematic behavior, thus specific medical care is required

2.3.4. Tongue coating

Tongue coating was visually evaluated according to the report by Miyazaki et al. (1995). We divided the scores into two groups (no, score 0 and 1; yes, score 2 and 3).

2.3.5. Food residue

We assessed food residue in the oral region after a meal (Ono et al., 2007).

2.3.6. Xerostomia

The presence or absence of xerostomia was examined. The categories reported by Kakinoki et al. (2004) were dry, mildly dry, wet (normal) and wet (high). The categories of dry and mildly dry were considered to indicate xerostomia.

2.4. Assessment of oral function

Assessment of oral function was performed based on the current number of teeth, occlusal condition and presence or absence of swallowing disorder.

2.4.1. Assessment of occlusal condition

With regard to the occlusal condition, the Eichner classification of occlusal support regions (Eichner, 1955) was used for reference. Subjects with an Eichner occlusal support classification of A1–B1, who had occlusal support in at least three sites in the molars, were assigned to the "natural occlusal support group". Those in whom occlusal support was restored with removable dentures were assigned to the "denture occlusal support group". Those with occlusal support in two or fewer sites with an Eichner classification of B2–C3, with no occlusal support in the molars, and unrestorable occlusal support using removable dentures were assigned to the "occlusal support disruption group".

2.4.2. Swallowing disorder

Swallowing disorder was defined as cases in which choking or accidental aspiration occurred, and cases that showed a gurgling sound on auscultation of the neck region (Takahashi et al., 1994) after swallowing 3 ml of water.

2.5. Survey of diagnosis

The presence or absence of general conditions that might have affected swallowing function was determined.

2.6. Survey of concomitant medication

Medication that might have affected oropharyngeal function (e.g., psychotropic agents, antidepressants) (Carl and Johnson, 2006) was investigated.

2.7. Statistical analysis

Chi-squared test was used to determine the independence of each group in two-group comparisons. Risk factors were screened by logistic analysis of variance using the presence or absence of a history of asphyxiation as a dependent variable and the presence of significant factors as an independent variable. The stepwise method (backward elimination method) was used for variable selection. Windows Japanese version SPSS (Ver. 16) was used for statistical analysis, and the level of significance was a p value of <0.05.

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Table 2
Univariate analysis of subjects' demographics.

		Asphyxiation ($n=51$)	No asphyxiation ($n=386$)	Relative risk (95% CI)	p value
Sex	Male	10	100	1.43 (0.69–2.97)	0.21
	Female	41	286		
Self feeding	Independent	41	209	3.47 (1.69–7.13)	<0.001
	Dependent	10	177		
ADL	Maintained	34	312	2.11 (1.12–3.98)	0.02
	Decreased	17	74		
Cognitive function	Maintained	28	117	2.80 (1.55–5.06)	<0.001
	Decreased	23	269		
Tongue coating	Yes	20	135	1.20 (0.66–2.19)	0.55
	No	31	251		
Food residue	Yes	20	157	0.93 (0.51–1.69)	0.32
	No	31	222		
Xerostomia	Yes	15	132	0.80 (0.42–1.52)	0.44
	No	36	254		
Occlusal support	Natural occlusal support	5	83		
	Denture occlusal support	16	153		0.02
	Occlusal support disruption	30	150		
Swallowing disorder	Yes	27	124	2.38 (1.32–4.29)	0.03
	No	24	262		
Previous stroke	Yes	19	212	0.72 (0.40–1.32)	0.18
	No	32	174		
Drug administration	Yes	16	110	1.15 (0.61–2.16)	0.39
	No	35	276		

3. Results

3.1. Incidence of asphyxiation

Fifty-one subjects suffered asphyxiation due to food (10 men and 41 women; mean age, 85.6 ± 7.1 years). The annual incidence of asphyxiation accidents was 4.7%. Four subjects had two or more episodes of asphyxiation during the period (four times: one subject, three times: two subjects, two times: one subject). Death caused by asphyxiation occurred in two subjects.

The food causing asphyxiation was fruit in seven subjects, vegetables in four, meat in four, fish in four, rice in three, bread in one, and others in six. There were 29 unclear cases where several foods were involved. There could be multiple causes in those subjects. After the onset of asphyxiation, 13 subjects (25.5%) were transferred to an emergency clinic or hospitalized, but two of them died in hospital within 24 h.

3.2. Risk factors

Factors showing a significant relationship with the onset of asphyxiation were self-feeding [$p < 0.001$, relative risk = 3.47 (1.691–7.131)], ADL [$p = 0.02$, relative risk = 2.11 (1.12–3.98)], and cognitive function [$p < 0.001$, relative risk = 2.80 (1.55–5.06)]. Among 180 subjects who had lost occlusal support with their natural teeth and did not regain occlusion, 30 subjects (16.7%) suffered asphyxiation. However, among 169 subjects whose occlusal support was restored with dentures, 16 subjects (9.5%) suffered asphyxiation, and among 88 subjects with occlusal support with their natural teeth, 5 subjects (5.7%) suffered asphyxiation. The incidence of asphyxiation showed a significant difference ($p = 0.016$) among the three groups (Table 2) (Fig. 1).

3.3. Survey of diagnosis

The presence or absence of general conditions that might have affected swallowing function was determined, and found out that none of them had affected swallowing function (Table 3).

3.4. Results of logistic analysis

Risk factors were screened by logistic analysis of variance using the presence or absence of a history of asphyxiation as a dependent variable and the presence of significant factors in univariate analysis as an independent variable. The stepwise method (backward elimination method) was used for variable selection. As a result, "self-feeding" ($p < 0.001$, relative risk = 3.11, 95% CI:

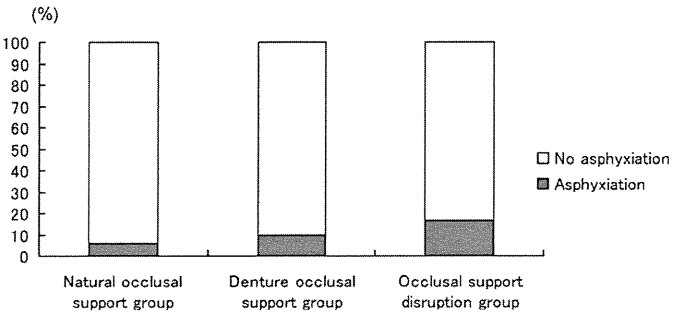

Fig. 1. Relationship between dental status and incidence of asphyxiation. Among 171 subjects who had lost occlusal support with their natural teeth and did not regain occlusion with dentures, 30 subjects (17.5%) suffered asphyxiation. Among 215 subjects whose occlusal support was restored by means of dentures, 21 subjects (9.8%) suffered asphyxiation. Among 113 subjects with occlusal support with their natural teeth, 5 subjects (4.4%) suffered asphyxiation ($p = 0.016$, chi-squared test).

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Table 3
Univariate analysis of subjects' general conditions.

		Asphyxiation ($n=51$)	No asphyxiation ($n=386$)	Relative risk (95% CI)	p value
Cerebrovascular disease	Yes	19	212	0.72 (0.40–1.32)	0.180
	No	32	174		
Neuromuscular disease	Yes	5	25	1.57 (0.57–4.30)	0.264
	No	46	361		
Cardiac disease	Yes	4	48	0.60 (0.21–1.74)	0.242
	No	47	338		
Respiratory disease	Yes	4	18	1.74 (0.57–5.36)	0.247
	No	47	368		
Diabetes	Yes	1	5	1.52 (0.17–13.31)	0.527
	No	50	381		
Bone and joint disease	Yes	16	97	1.36 (0.72–2.57)	0.395
	No	35	289		

1.50–6.44) and "occlusal support" ($p = 0.01$, relative risk = 1.75, 95% CI: 1.12–2.73) were selected as significant explanatory variables (Table 4).

4. Discussion

The annual incidence per capita of asphyxiation accidents in the present study was 4.7 per 1000 population in Japan; this is lower than the results from previous research carried out at day-care facilities for elderly people (Takahashi et al., 1994). The incidence of asphyxiation among elderly people in care facilities for the aged was clearly higher than that of elderly people living at home. The elderly people in care facilities appeared to be frailer than those who received care at home. Although the frequency was generally low, accidents were often fatal. Our results show that many individuals were hospitalized after asphyxiation accidents and some of them died. Among the subjects with asphyxiation, approximately 8% had several asphyxiation episodes during the study period, which is four times higher than that reported previously (Suda et al., 2008). Those who suffered several asphyxiation accidents were considered to be at higher risk of death.

We demonstrated that factors related to asphyxiation accidents include self-feeding, ADL, cognitive function, occlusal support of molars, and swallowing disorders. Of these, there was a strong correlation between occlusal support of molars and the incidence of asphyxiation. Many elderly people lose their teeth because of dental caries or periodontal disease, and many of those in the present study had lost occlusal support with their natural teeth. This may lead to reduced chewing ability in elderly people (Hatch et al., 2001). However, the rate of use of dentures, especially among frail individuals, is known to be low. The ability to use dentures is reduced by impaired cognitive function, apraxia, and spatial cognition disorders and is known to be affected by a decrease in ADL (Carter and Jancar, 1984).

We demonstrated that cognitive function is one of the risk factors for asphyxiation. In elderly people with reduced cognitive function requiring nursing care, it has been reported that swallowing without chewing as well as cramming food into the mouth often occurs (Samuels and Chadwick, 2006). These people have also been reported to show symptoms of fast-eating syndrome (Bazemore et al., 1991). In fact, many elderly people with dementia die because of accidental swallowing or asphyxiation (Brunnström and Englund, 2009). In comparison with patients with cerebrovascular dementia, patients with frontotemporal dementia are known to have abnormal eating habits, including cramming food and eating fast (Bathgate et al., 2001), which makes it necessary to take measures to prevent asphyxiation in accordance with the type of dementia.

Table 4
Independent predictors of asphyxiation.

	Coefficient (±S.E.)	p value	Relative risk	95% CI	
				Lower	Upper
Self feeding	1.13 (±0.37)	<0.001	3.11	1.50	6.44
Occlusal support	0.56 (±0.23)	0.01	1.75	1.12	2.73

S.E.: standard error.

It is interesting that the incidence of asphyxiation showed a strong association with the ability to self-feed. The ability to understand the use of eating utensils, a sufficient range of arm motion, and coordination of both arms and oral function are necessary for self-feeding. Good management of self-feeding ability is an important factor in maintaining quality of life of the elderly. According to Volicer et al. (1987), (50)% of patients with Alzheimer disease lose the ability to self-feed within 8 years after diagnosis. Apraxia and spatial-cognitive disorders cause problems in self-feeding ability. Many diseases associated with dementia are considered to impair self-feeding ability. To improve or maintain self-feeding ability, it is necessary to undertake very complex measures based on an understanding of one's own chewing function and swallowing function, and on selection of food in accordance with those functions. If selection of food is necessary, reprocessing of food could be undertaken such as by subdividing, cutting or mixing, to make the food match the functions mentioned above. Every individual must consider the pace of eating by coordinating the amount of food in each bite to prevent accidents.

The results of this study suggest that absence of occlusal support is a risk factor for asphyxiation. Individuals who had lost occlusal support with their natural teeth showed a higher risk of asphyxiation than those with occlusal support. These results suggest that restoration of occlusal support with dentures might be an effective procedure to prevent asphyxiation. If dentists undertook measures based on continuous dental management for frail elderly people, more people might become able to wear dentures (Kawana et al., 2010). Prevention of dental caries and periodontal diseases that cause tooth loss is, of course, essential to prevent loss of occlusal support, and should be included in the management plan. Maintenance of occlusal support for frail elderly people by means of continuous management by dentists is also effective to prevent asphyxiation.

To further prevent asphyxiation and eat safely in elderly people with little ability to control the speed and amount of food, it is important to assist such people while taking food, rather than encourage them to improve their self-feeding ability.

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Conflict of interest statement

None.

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Videoendoscopic assessment of swallowing function to predict the future incidence of pneumonia of the elderly

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SUMMARY **The purpose of the present study was to examine what dysphagic signs identified by videoendoscopy (VE) could predict the incidence of pneumonia and body weight loss in elderly patients living in nursing homes. This study was performed at six nursing care facilities in Japan from March 2007 to February 2009. The 148 subjects (85·1 ± 8·0 years, male/female: 43/105) were evaluated for their feeding and swallowing movements by clinical and VE examinations during the consumption of a regular meal. The VE examination items included the existence/absence of pharyngeal residue, laryngeal penetration, and aspiration of food and saliva. The patients were followed-up for 3 months with individualized feeding therapy based on the results of the clinical/VE examination at baseline, and the incidence of pneumonia was examined as the primary outcome. In patients without pneumonia, the body weight change was also measured as a secondary outcome. The risk factors for pneumonia and body weight loss (of 3% or more) were identified among the clinical/VE examination items by a Cox proportional hazard analysis. Even with elaborative feeding therapy, 12 (8·1%) of the 148 patients developed pneumonia during the 3 months follow-up period. The existence of signs of 'silent aspiration of saliva' or 'aspiration of saliva' detected by VE examination was a significant risk factor for both pneumonia and a body weight loss of 3% or more. This study shows that 'aspiration of saliva' detected by VE is a significant risk factor for both pneumonia and body weight loss in elderly patients living in nursing homes.**

KEYWORDS: **videoendoscopy, aspiration-related pneumonia, dysphagia, aspiration of saliva, body weight loss**

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Introduction

Dependent elderly patients are at high risk for feeding and swallowing disorders as a consequence of disease and/or aging (1–3). Studies done in long-term care facilities have shown a prevalence of such disorders ranging from 60% to 87% (4, 5). Among the various disorders, special attention has been given to dysphagia because it may lead to malnutrition with immune system compromise, dehydration, asphyxiation, or even aspiration pneumonia (1–3). Moreover, a previous follow-up study of patients with dysphagia in such care facilities revealed an incidence of pneumonia of 43% and a mortality rate of 45% at 1 year following the detection of their swallowing disorder (6). Therefore, clinicians should be able to identify dysphagia in order to predict those patients at risk of developing complications secondary to dysphagia, as well as to develop and implement a rehabilitation plan stressing prevention and compensation.

Videofluorography (VF) has been regarded as the most popular adjunctive instrument for the

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examination of patients with suspected oropharyngeal dysphagia. Previous studies have examined the use of VF as a means to predict those at risk for dysphagia and its complications (7, 8). For instance, Mann *et al.* (7) found that the single best independent predictor for chest infection following an acute stroke was a delayed or absent swallowing response in acute stroke patients. Teraoka *et al.* (8) found that the single best predictor of oral intake in post-stroke patients with dysphagia was the presence of aspiration detected by VF assessment. Nevertheless, one major disadvantage of VF for patients living in long-term care facilities is that the patients need to be transported to a hospital setting, which is sometimes inconvenient or may disorientate the patient because of the sudden change in the environment. Other disadvantages are related to the exposure to X-ray radiation and the risk of aspiration during VF assessment in some patients with severe physical or mental alterations (9).

On the other hand, videoendoscopic (VE) examination of swallowing allows for easy assessment of patients in their usual environment because the instrument is portable and does not require a radiology suite (10). Additionally, although VE is most useful for the examination of the integrity of the upper airway before and after a swallow response, it enables the evaluation of the tongue function during mastication and deglutition, as well as the detection of aspiration by the objective visualization of the airway (11, 12).

Videoendoscopic examination has been shown to successfully estimate the existence of accumulated oropharyngeal secretions, thus resulting in excellent prediction of aspiration (13, 14). In addition, Ota *et al.* (15) reported that the secretion scale based on the VE examination is a useful evaluation tool for predicting not only aspiration, but also pneumonia, in acute-phase dysphagic stroke patients. Furthermore, Link *et al.* (16) reported that there was a relationship between the VE-based pooled hypopharyngeal secretions, laryngeal penetration, aspiration and recurrent pneumonia with neurological disorders in pediatric patients. It is therefore evident that VE is the best tool to examine pooled hypopharyngeal secretions, laryngeal penetration, and aspiration. Therefore, even though the agreement rate between the VF and VE findings on dysphagia was shown to be high (90%) (17), VE examinations are becoming increasingly popular for examining the aspiration of saliva and food at the bedside and in long-term care facilities (17, 18).

In a prospective study with acute stroke patients, Lim *et al.* (19) found a strong association between aspiration detected by VE and the development of aspiration pneumonia. However, the predictors of aspiration pneumonia in dependent elderly patients with dysphagia in long-term care facilities have not been sufficiently investigated using VE. Therefore, the purpose of this prospective cohort study was to investigate whether the dysphagic signs identified by VE were risk factors for pneumonia and body weight loss in patients living in long-term care facilities.

Materials and methods

Subjects

Six hundred and forty-seven inpatients were initially identified from six nursing care facilities in Tokyo, Japan from March 2007 to February 2009 (Fig. 1). All patients, except for 28 subjects who were tube-fed, were screened for dysphagia by a check-list given to the patient's caregiver. The screening check-list contained 11 items: pooling of food, uncomfortable feeling in the throat, previous history of asphyxiation, previous history of aspiration, previous history of pneumonia, increased phlegm production, choking on saliva, choking on food, choking after a meal, prolongation of their eating time, and insufficient intake. The 171 patients who had at least one item checked positively by the caregiver were suspected to have dysphagia and comprised the intended sample population. However, 23 patients were excluded because of cognitive failure or refusal to participate in this study. Consequently, the final study population consisted of 148 patients (male/female: 43/105) with a mean age of 85·1 ± 8·0 years and an age range from 59 to 100 years. The protocol for this study was approved by the Ethics Committee of the Nippon Dental University School of Life Dentistry at Tokyo (#08-10).

Baseline measurements and feeding therapy

At the baseline measurement, a medical doctor assessed the patients' general health condition, and none of the patients fulfilled the Mann's criteria (7) for a diagnosis of pneumonia, that is, the presence of at least three of the following signs and symptoms: fever >38 °C, productive cough with sputum, tachypnea higher than 22 breaths per minute, inspiratory crackles,

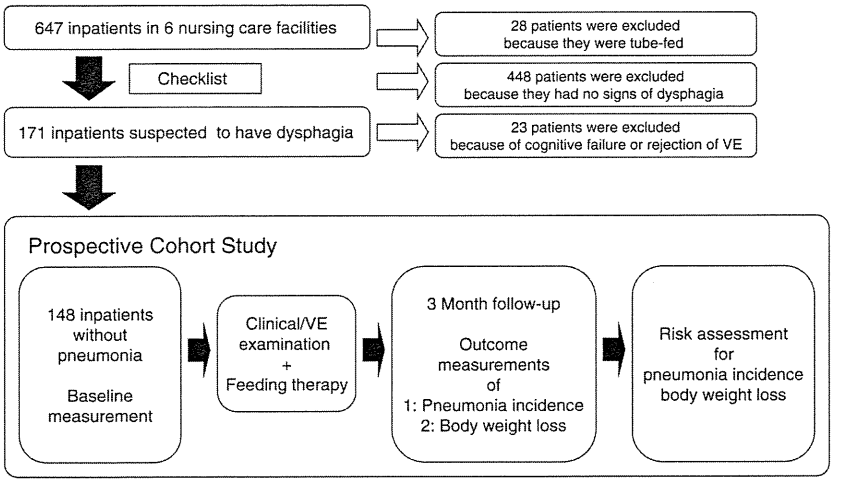

Fig. 1. The sampling process used for this study.

an abnormal chest x-ray, or positive gram staining and cultures.

All included subjects had their eating ability and dysphagic signs and symptoms evaluated clinically according to a clinical examination form regarding the signs and symptoms of dysphagia (spilling food, pooling food, oral food residue after a swallow, inability to open the mouth, choking/coughing, increased phlegm while eating, dyspnea, wet hoarseness, other), the hand and mouth coordination during the meal (feeding posture, prolongation of eating time) and the caregiver's technique used for feeding assistance.

In addition, each patient's swallowing function was examined by VE, which consisted of a flexible endoscope (ENF-V2*) connected to a high-intensity compact light source (CLH-SC*) and a video recorder (OTV-SC*).The endoscope was passed transnasally to the hypopharynx at a vantage point that provided a full view of the laryngeal vestibule, and was kept in place for a period of 10–15 min to assess the patient's eating ability, or saliva swallows when the patient was not consuming a meal. The patients were examined in their usual eating position, that is, the ambulatory patients were seating in the upright position, while the bed-bound patients were sitting on a bed. All swallows were recorded on videotapes for the further analyses by experienced physicians familiar with endoscopic swallowing studies and who were blinded to the intentions of the study. Each patient's video-recording data were reviewed for the presence or absence of pharyngeal residue, and penetration and aspiration of food or saliva. 'Penetration' was defined as a passage of material into the larynx that does not pass below the vocal folds, while 'aspiration' was defined as passage of material below the level of the vocal folds. In cases where the aspiration of food or saliva did not induce a cough, it was defined as 'silent aspiration' according to the criteria proposed by Rosenbek *et al.* (1996) (20). To assess the inter-rater reliability of the swallowing evaluations, the three investigators who were unaware of the original evaluation results, separately reviewed a random 10% sample of these evaluations. The overall agreement rate between investigators was substantial according to the Landis and Koch criteria (21) (kappa coefficient = 0·660).

On the basis of these aforementioned evaluations, the patients received various feeding therapies (22) during the follow-up period, for example, confirmation of feeding conditions [76 patients (51·4%) of 148 patients, multiple answers possible], appropriate feeding assistance [69 patients (46·6%)], food modification [32 patients (21·6%)], modification in feeding posture [19 patients (12·8%)] and modification in food intake [four patients (2·0%)] for 3 months. Food modification involved changing the dietary consistency. We modified the food and liquid texture individually according to the National Dysphagia Diet recommendations (23). Food intake and feeding assistance required modifications to accommodate the individual needs of the patients, such as changes in the rate and amount of the food consumed, appropriate utensils and the

*Olympus Corporation, Tokyo, Japan.

method used for self-feeding (22). Modifications in the feeding posture were applied in order to maximize the physical capabilities and improve swallowing, and involved strategies such as head-turn or chin-tuck maneuvers or whole body-positioning strategies including the patient tilting to the side or back, side-lying, or maintaining an upright posture (22). All patients received oral health care after every meal by the caregiver who was instructed once a week about the oral care procedures by a dental hygienist. Caregivers cleaned each patient's oral cavity using a toothbrush for approximately 5 min after each meal. The brushing was carried out as usual for daily tooth brushing without paste, and included brushing the palatal and mandibular mucosa and tongue dorsum. Dentures were also cleaned with a denture brush every day.

The 3 month follow-up and outcome measurement

The first outcome variable after 3 months of follow-up was the incidence of pneumonia diagnosed according to the same criteria applied at the baseline measurement. Once the patients received a diagnosis of pneumonia, they were sent to a local hospital for treatment, without exception. Consequently, their oral feeding was prohibited to prevent further aspiration pneumonia and their body weight typically decreased as a result (24). The incidence of pneumonia and body weight loss were therefore strongly correlated after the development of pneumonia. Thus, when pneumonia was identified, follow-up measurements of the patient's body weight were terminated.

The second outcome variable during the follow-up period was a change in body weight demonstrated by monthly measurements. Since there is a close relationship between pneumonia and body weight loss, the incidence of body weight loss of 3% or more was examined in patients who had not been diagnosed with pneumonia during the 3 months of follow-up. Once the patients developed a body weight loss of 3% or more, the patients received some form of nutrition therapy, and thus, the follow-up observation was terminated.

Statistical analysis

A survival curve of the patients who had not been diagnosed with pneumonia was drawn for a Kaplan–Meier analysis. According to the presence/absence of pneumonia during the 3 months of follow-up, we divided the final sample population into pneumonia and non-pneumonia sub-groups, and performed a *t*-test, chi-square analysis or Fisher's exact test to analyse the differences between the two groups.

Similarly, a survival curve of those patients who had not lost more than 3% of their body weight was drawn for a Kaplan–Meier analysis (outcome event: the incidence of body weight loss of 3% or more). Differences between the weight gain/no change sub-group (body weight gain, or a small weight loss of no more than 3% of the initial body weight) and the weight loss group (body weight loss of 3% or more (10, 25)) were analysed with the same statistical tests utilized for the incidence of pneumonia.

Additionally, a Cox proportional hazard analysis was performed to identify the risk factors for the incidence of pneumonia and the body weight loss of 3% or more. The analysed predictors were age, self-feeding ability, the Barthel activities of daily living (ADL) index, a body mass index (BMI) lower than 18·5, pharyngeal residue, laryngeal penetration, aspiration of food and aspiration of saliva. Regarding the aspiration of food or saliva, the data were handled as ordinal variables (negative, positive, positive as silent aspiration). The data were analyzed with the Statistical Package for the Social Sciences software program (SPSS version 15.0[†]). A *P*-value <0·05 was considered to be statistically significant.

Results

Baseline condition of the patients

Examination of the medical conditions of the initial 148 patients showed the presence of a prior stroke in 83 (comorbidity admitted) (56·1%), dementia in 74 (50·0%), Parkinson's disease in 10 (6·8%), cardiovascular disease in 10 (6·8%), hypertension in 8 (5·4%), previous pneumonia in 5 (3·4%), diabetes mellitus in 3 (2·0%), fractures in 3 (2·0%) and other comorbidities in 14 patients (9·5%).

The clinical examination regarding the eating ability and signs and symptoms of dysphagia before the VE evaluation showed choking/coughing in 110 out of 148 patients (multiple choice admitted), pooling of food in 28, prolongation of the eating time in nine, inability to

[†]SPSS Japan Inc., Tokyo, Japan.

open the mouth in two, and spilling of food in one patient.

The VE evaluation detected pharyngeal residue in 97 (65·5%) out of the 148 patients, laryngeal penetration in 67 (45·3%), aspiration of food in 41 (27·7%), silent aspiration of food in 19 (12·8%), aspiration of saliva in 8 (5·41%), and silent aspiration of saliva in 10 (6·76%) patients (Table 1).

Risk factors for pneumonia and body weight loss

Even with elaborative feeding therapy, during the 3 months of follow-up after the baseline measurement, 12 (8·1%) of the 148 patients developed pneumonia (Fig. 2). In addition, among the non-pneumonia patients, 90 (66·2%) of them presented with weight gain, no change or weight loss of 3% or less (weight gain/no change group), while 46 patients (33·8%) lost 3% or more of their body weight (weight loss group) (Fig. 3).

The differences between the pneumonia and non-pneumonia groups concerning the clinical/demographic data and the dysphagic signs detected by VE are shown in Table 1. The unpaired *t*-test showed that there were no significant differences in the patient age ($P = 0·505$), gender ($P = 0·244$), self-feeding ability ($P = 0·419$), number of patients with a BMI lower than 18·5 ($P = 0·190$), and the Barthel Index ($P = 0·060$) between the subjects with and without pneumonia. On the other hand, there was a significant difference in the frequency of 'aspiration of saliva' between the pneumonia and non-pneumonia patients ($P = 0·026$). In contrast, a comparison between the body weight gain/no change and body weight loss groups showed that there were no significant differences concerning any of the analysed variables (Table 2).

The results of the Cox proportional hazard analysis revealed that a sign of the 'aspiration of saliva' detected by VE was a significant risk factor for pneumonia (Table 3) and for a body weight loss of 3% or more (Table 4).

Discussions

The presence of aspiration-related pneumonia is known to be associated with a high mortality rate in the elderly. Patients in nursing homes may have a higher incidence of pneumonia because of their multiple underlying diseases, which may lead to immunosuppression, excessive use of medications, generalized decreased functional status, as well as factors related to malfunctioning of the masticatory and orophraryngeal systems and inadequate oral care. In particular, dysphagia is known to be strongly associated with aspiration pneumonia. Teramoto *et al.* (26). reported

Table 1. The relationship between the clinical/VE signs and the incidence of pneumonia

	Total subjects	No pneumonia ($n = 136$)	Pneumonia ($n = 12$)	*P*-value
Age (mean ± s.d.)	148	85·0 ± 8·1	86·8 ± 5·4	0·505†
Male/female	148	38/98	5/7	0·244††
Self-feeding (yes/no)	148	47/89	5/7	0·419††
Barthel Index (mean ± s.d.)	116*	13·1 ± 18·1	7·2 ± 7·12	0·060†
BMI < 18·5**	118**	43/110 (39·1%)	5/8 (62·5%)	0·190††
Pharyngeal residue	148	88 (64·7%)	9 (75·0%)	0·354††
Laryngeal penetration	148	62 (45·6%)	5 (41·7%)	0·519††
Aspiration of food	148			0·326††
Silent aspiration	19	19	0	
Aspiration	41	38	3	
NA	88	79	9	
Aspiration of saliva	148			0·026††
Silent aspiration	10	7	3	
Aspiration	8	7	1	
NA	130	122	8	

*Of 116 patients, 107 were in the no pneumonia group and nine were in the pneumonia group.
**Of 118 patients, 110 were in the no pneumonia group and eight were in the pneumonia group.
†*T*-test.
††Chi-square test.

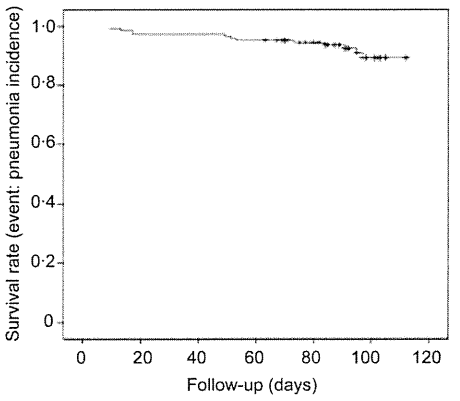

Fig. 2. The survival curve of the patients who did not suffer from pneumonia. The survival curve was drawn for a Kaplan–Meier analysis (outcome event: incidence of pneumonia).

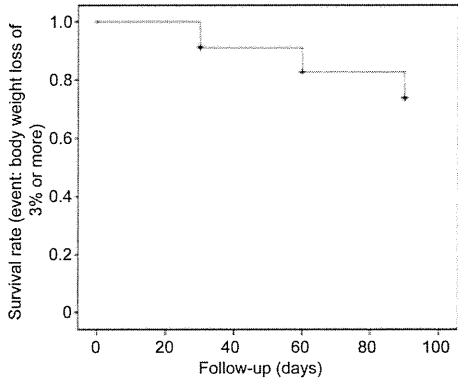

Fig. 3. The survival curve of the patients who did not suffer from a body weight loss of 3% or more. The survival curve was drawn for a Kaplan–Meier analysis (outcome event: incidence of body weight loss of 3% or more).

that 70% of the pneumonia in the elderly occurred due to aspiration, and Yamaya *et al.* (27). reported a high prevalence of silent aspiration in older persons leading to the deterioration of swallowing function due to cerebrovascular disease. In a previous study, Doggett *et al.* (28) estimated that approximately 43–54% of stroke patients have dysphagia and aspiration of food or saliva, and that approximately 37% of these patients would develop aspiration-related pneumonia.

In this present study, penetration and aspiration (apparent or silent) was observed in 67 subjects (45·2%) and 60 subjects (40·5%), respectively. The prevalence of aspiration found in this investigation was relatively high compared to previous studies utilizing VE examination (29%) (29), but was similar to the range observed in a previous review article where it was reported to occur in 15–39% of subacute dysphagic stroke patients (30). According to this review, the exact prevalence of aspiration remains unknown because of the differences in the size and methodology used in the existing studies.

The incidence of pneumonia was 12 (8·1%) among the 148 subjects (Table 1), which is in accordance with the study by Lim *et al.* (19), who reported that five patients (10%) developed pneumonia during their inpatient stay, and that all of them were at risk of aspiration of saliva or food as determined by a VE examination. On the other hand, Croghan *et al.* (6) reported that 55% of their nursing home patients presented with aspiration on VF examination, and 43% developed pneumonia.

One possible reason for such a discrepancy in the association of pneumonia and aspiration or penetration could be due to the technique (VE vs. VF) utilized to assess the swallowing disorders. Although a number of methods have been used to detect the symptoms of dysphagia, it is very difficult to evaluate 'silent aspiration of saliva' with a bedside clinical assessment alone, because it has been shown that it is missed in up to 40% of the patients aspirating silently (31, 32). At present, VF and VE are regarded as the best methods to evaluate swallowing function. In particular, VF has been used as a gold standard to evaluate swallowing because it can detect aspiration. However, it may not be as accurate in identifying 'silent aspiration of saliva', as compared to VE, because the latter enables direct visualization of the aspiration of saliva (18, 33, 34). Kelly *et al.* (35) reported that penetration and aspiration are perceived more sensitively in VE images than in VF images of the same swallows. It is also well known that VE can identify the microaspiration and aspiration of secretions with a high reliability, whereas VF cannot (36, 37). Additional advantages of VE are related to its application. Inpatients may become agitated or fatigued in the radiology suite or may not respond well to the taste of barium-coated boluses, or may even reject the radiation exposure, limiting the applications of VF. Videoendoscopy allows the patient's examination to be performed regardless of his/her altered mental status or immobility (38). Finally, Wu *et al.* (39) stated that VE is conclusively a safe, more efficient and sensitive method than VF for evaluating swallowing.

Another reason for the discrepancy could be the effect of the feeding therapy provided in this study, which could have reduced the symptoms of dysphagia,

Table 2. The relationship between the clinical/VE signs and the change in body weight

	Total subjects	Gain/no change (n = 90)	Weight loss (n = 46)	P-value
Age (mean ± s.d.)	136	84·6 ± 8·0	85·7 ± 8·6	0·464†
Male/female	136	25/65	13/33	0·553††
Self-feeding (yes/no)	136	29/61	16/30	0·454††
Barthel Index (mean ± s.d.)	107*	14·9 ± 18·7	9·6 ± 17·0	0·163†
BMI < 18·5	110**	30/74 (40·5%)	13/36 (36·1%)	0·655††
Pharyngeal residue	136	61 (67·8%)	27 (58·7%)	0·294††
Laryngeal penetration	136	44 (48·9%)	18 (39·1%)	0·2797††
Aspiration of food	136			0·975††
Silent aspiration	19	13	6	
Aspiration	38	25	13	
No aspiration	79	52	27	
Aspiration of saliva	136			0·342††
Silent aspiration	7	4	3	
Aspiration	7	3	4	
No aspiration	122	83	39	

Weight loss was diagnosed as the loss of 3% or more of the body weight from the baseline measurement.
*Of the 107 patients, 72 were in the gain/no change group and 35 were in the weight loss group.
**Of the 110 patients, 74 were in the gain/no change group and 36 were in the weight loss group.
†T-test.
††Chi-square test.

Table 3. The results of the Cox proportional hazard analysis for the possible predictors of the incidence of pneumonia

Predictors	B	P-value	HR	95% CI
Age	0·011	0·860	1·011	0·900–1·135
Self-feeding	0·105	0·909	1·111	0·182–6·785
Barthel Index	−0·010	0·769	0·990	0·927–1·057
BMI < 18·5	2·064	0·070	7·874	0·844–73·440
Pharyngeal residue	−0·621	0·615	0·537	0·048–6·067
Laryngeal penetration	0·571	0·642	1·771	0·160–19·644
Aspiration of food (negative/positive/positive with SA)	−0·216	0·830	0·805	0·112–5·794
Aspiration of saliva (negative/positive/positive with SA)	1·290	0·025	3·634	1·174–11·242

HR, hazard ratio; CI, confidence interval; SA, silent aspiration.

Table 4. The results of the Cox proportional hazard analysis for the possible predictors of a body weight loss of 3% or more

Predictors	B	P-value	HR	95% CI
Age	0·019	0·448	1·019	0·971–1·070
Self-feeding	0·530	0·228	1·698	0·718–4·014
Barthel Index	0·000	0·992	1·000	0·976–1·025
BMI < 18·5	0·859	0·032	2·362	1·074–5·191
Pharyngeal residue	−0·060	0·896	0·942	0·381–2·325
Laryngeal penetration	0·019	0·970	1·019	0·374–2·780
Aspiration of food (negative/positive/positive with SA)	−0·203	0·569	0·816	0·405–1·644
Aspiration of saliva (negative/positive/positive with SA)	1·186	0·000	3·275	1·828–5·866

HR, hazard ratio; CI, confidence interval; SA, silent aspiration.

pharyngeal residue, laryngeal penetration, and aspiration of food, as demonstrated by the fact that 66% of the subjects were able to increase their body weight or keep the body weight loss to within 3%. Nevertheless, a detailed analysis of the effectiveness of feeding therapy on the reduction of the symptoms of dysphagia could not be performed, because it was beyond the scope of this study.

Additionally, the differences in the target populations and their respective medical conditions could also have affected the overall incidence of pneumonia. This study gathered a heterogeneous patient population consisting of patients presenting with well-known disorders/diseases associated with the symptoms of dysphagia (e.g. stroke, Parkinson's disease, dementia) as well as other non-debilitating diseases/disorders (hypertension, fractures). On the other hand, a strong point in this study was the inclusion of a relatively high number of subjects from six nursing care facilities, which was large compared to other follow-up studies. Therefore,