

10. 心不全の睡眠障害

—チェーン・ストークス症候群を中心に—

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はじめに

慢性心不全(chronic heart failure; CHF)患者では、心機能分類上の重症化に従って睡眠中の低酸素血症が増悪する¹⁾。睡眠中のチェーン・ストークス呼吸(Cheyne-Stokes respiration; CSR)を伴う中枢性無呼吸はCHF患者の27~40%に認められ、血圧および心拍数の変動と覚醒を伴い、周期的に漸増・漸減する呼吸パターンとして認められる^{2,3)}。CSR後の反復的な酸素飽和度の低下と覚醒によって、交感神経系の亢進が惹起される。一方、慢性的にCHFで増加する交感神経性の活性は、左心室機能に影響を及ぼし、運動耐容能と生命予後の低下を伴う。したがって、CSRはCHFの経過に悪影響を及ぼし、夜間のCSRの治療がCHF患者のQuality of life (QOL)と生命予後の改善に効果を示す可能性が期待される⁴⁾。

定義

CSRでは、呼吸の漸増・漸減が最低3サイクルあり、1時間以上の睡眠中に5回以上の中枢性睡眠時無呼吸(central sleep apnea; CSA)、あるいは低呼吸が起こるか、漸増・漸減のサイクルが最低10分間持続する⁵⁾。

原因

CHF患者におけるCSRの主要なメカニズムは、第一に心拍出量の低下により循環時間の延長を生じ、肺でのガス交換を終えた血液が化学受容体に到達するまでに時間がかかるため、換気が過矯正されてしまい過換気と無呼吸が繰り返される。第二に、低酸素血症による慢性的な過換気が低炭酸ガス血症を引き起こし、入眠期に炭酸ガス濃度が閾値に達するまで無呼吸を生じる。この間に血中酸素濃度が低下し覚醒する結果、反応性に過換気が生じる^{6,7)}。第三に、心容量の増加に伴

う肺容量の減少により肺での酸素・二酸化炭素の蓄積量が減少するため、わずかな換気の変化が血中ガス分圧を大きく変化させ、呼吸を不安定化させる⁸⁾。その他、低酸素や高炭酸ガス血症に対する呼吸中枢の反応性亢進と静脈圧の上昇に伴う上気道のうっ血が考えられている。

症例呈示

症例：61歳、男性。

主訴：睡眠中の周期性呼吸。

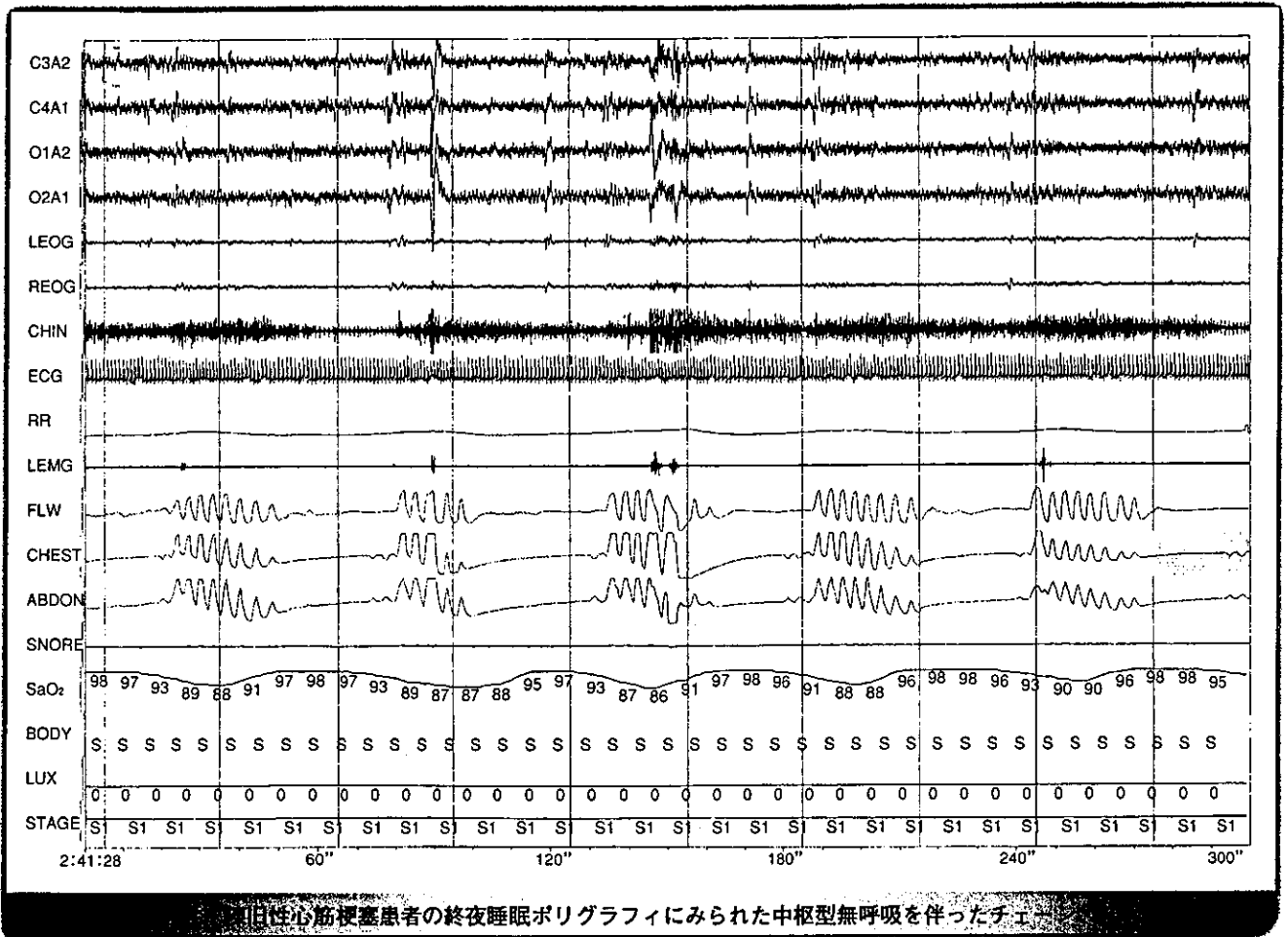
家族歴：特記事項なし。

既往歴：約10年前から高血圧のため近医で降圧薬を投与されていた。その頃より、左上肢に感覚異常を認めたが麻痺はなく、頭部CT検査では多発性脳梗塞を指摘された。3年前に狭心症と高脂血症を合併し内服治療を追加された。昨年冬、スキー旅行中に、左前下行枝の急性心筋梗塞を発症して緊急入院したとき、左心機能の著しい低下による急性心不全を合併し、治療された。その退院後は、循環器内科の外来で通院治療を受けていた。

現病歴：急性心筋梗塞後の心不全も軽快し退院、その5カ月後に妻から夜間睡眠中に頻回な無呼吸を伴う周期性呼吸を指摘され、睡眠時無呼吸症候群の疑いで当附属病院の睡眠医療センターを紹介され精査入院となった。

検査所見：血液検査：WBC $5.2 \times 10^3/\mu\text{L}$, RBC $4.10 \times 10^3/\mu\text{L}$, Hgb 12.6 g/dL, PLT $221 \times 10^3/\mu\text{L}$, Glucose 84 mg/dL, BUN 11.6 mg/dL, Cre 0.85 mg/dL, AST 18 IU/L, ALT 21 IU/L, LDH 256 U/L, CK 40 IU/L, Na 144 mEq/L, K 4.0 mEq/L, Cl 107 mEq/L, T-cho 252 mg/dL, TG 269 mg/dL, HDL-C 147 mg/dL, IRI $3.4 \mu\text{U}/\text{mL}$, Dopamine 42 pg/dL, Epinephrine 92 pg/mL, Norepinephrine 744 pg/mL。

胸部レントゲン：軽度肺うっ血、胸水なし、CTR =



53%.

心電図：陳旧性前壁中隔心筋梗塞，肢誘導の低電位。

心エコー：左心室前壁中隔側に収縮低下，左室の軽度拡張および駆出率の低下(LVDd=57.2 mm, EF=35.3%)。

治療内容：治療前の終夜睡眠ポリグラフィ(poly-somnography; PSG)の結果を図1に示す。無呼吸低呼吸指数(apnea hypopnea index; AHI)は1時間当たり41.0回，最低動脈血酸素飽和度(minimum SaO₂)は86%であり，CSRを認めた。経鼻的持続陽圧呼吸(nasal continuous positive airway pressure; nCPAP) titration後のPSGではCSRは消失したが，AHIは24.0/hと依然として高値で，minimum SaO₂は90%であった。

CSRは19世紀に見出された古い臨床所見であるが，睡眠呼吸障害の診断と治療法が普及しつつある昨今，わが国でもようやくその意義が見直されてきた。

CHF患者に合併するCSRの治療法としては，nCPAPの導入，酸素・炭酸ガスの投与，テオフィリンなどによる呼吸器系に影響を及ぼす薬剤，β遮断薬やACE阻害薬などの投与が試みられている⁹⁾。CHFのCSRにおけるnCPAPの作用は，前負荷および後負荷の軽減による循環時間の短縮，低酸素血症・低炭酸ガス血症の改善，肺容量の増加，上気道の開存が考えられる。CSRはCHFの重要な病態で，nCPAPなどを用いてCSRを消失させるという治療法は，CHF患者のQOLおよび生命予後にも好影響を与えるのではないかと期待されている。

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過眠症検診の可能性について

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いのうえ ゆういち のむら たかし やえがしひろのぶ

- 睡眠障害のスクリーニングシステムは、わが国はもちろん欧米でも十分に確立されているとは言えない。
- 罹患率の高い閉塞性睡眠時無呼吸症候群 (OSAS)、特発性過眠症、ナルコレプシー、睡眠不足症候群、概日リズム睡眠障害などをスクリーニングすることが当面の目標である。
- 一次スクリーニングとしては、自己評価尺度である Epworth Sleepiness Scale (ESS) が適している。
- OSAS は眠気が乏しくても心血管系障害のリスクとなるため、眠気・常習性イビキ・夜間呼吸停止のいずれかがあれば、簡易ポリソムノグラフィやパルスオキシメーターによって OSAS か否かを判定する必要がある。

Key Words

過眠症、閉塞性睡眠時無呼吸症候群 (OSAS)、Epworth Sleepiness Scale (ESS)、簡易ポリソムノグラフィ、パルスオキシメーター

はじめに

睡眠障害は、頻度は高いものの、長年にわたって軽症病態で社会生活・心身の健康に及ぼす影響は乏しいものと考えられてきた。しかし、1990年代以降の疫学的な検討により、身体機能、作業エラー・事故発現リスクの増加などの可能性を含めて、睡眠障害のもたらす諸問題が明らかになってきている。また、2003年2月の、閉塞性睡眠時無呼吸症候群 (OSAS) に罹患していた新幹線運転手が居眠り運転するという事件が起きて以来、従来不眠症に比べて影の薄かった過眠症への注目が急速に高まった感がある。これらの流れを受けて、睡眠障害診療を専門とする医療機関が増えつつあるとともに、業務上のエラーや事故を防ぐために過眠 (夜間十分な睡眠時間が得られているにもかかわらず、昼間慢性的な眠気を生じているものを指す) をきたしうる疾患の早期スクリーニングの重要性が各方面で強調されている。睡眠障害に関するスクリーニングシステムは、睡眠医療がわが国より先行して発達した欧米でも十分確立されておらず、試行錯誤の状態がまだ当分続くと思われるが、現時点での国内の状況と今後の問題点、展望について、一部のデータをまじえて私見を述べたい。

どのようなケースがスクリーニングの対象になるのか

慢性的な自覚的眠気についての実態調査結果では、ヨーロッパでの Ohayon ら¹⁾の報告、日本人の企業従事者を対象とした Doi らの報告²⁾ともに、慢性的な過眠症状に悩んでいる人の割合は10%以上の水準に達している。したがって、慢性的な眠気の検診を行うと、かなりの人数が陽性 (=眠気あり) になると思われる。

表1に、われわれの施設に過眠症状を主訴として来院した初診患者の内訳を示す。そのなかでもっとも頻度が高かったのはやはり OSAS で、ついで特発性過眠症 (ナルコレプシーのようなレム睡眠に関連した症状が認められない原発性過眠症)、ナルコレプシー (情動脱力発作や、睡眠麻痺、入眠時幻覚などのレム睡眠関連症状を示す原発性過眠症)、睡眠不足症候群 (睡眠不足症候群は一般人口での割合はかなり高いと思われるので、検診ではより高率に検出されるのではないかと推測される)、概日リズム睡眠障害が上位で、これらで全体の2/3以上を占めていた。したがって、これらの上位5つの疾患をスクリーニングすることが過眠検診の当面の目標といえるだろう。病的な過眠症のなかでもっとも頻度が高いのが OSAS であること³⁾、また上に述べたように昨今 OSAS に対する一

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表1 日中過眠を主訴として受診した患者の内訳
(n=1243)

診 断	患者数	%
睡眠時無呼吸症候群	431	34.7
特発性過眠症	136	10.9
ナルコレプシー	109	8.8
睡眠不足症候群	88	7.1
概日リズム睡眠障害	76	6.1
精神疾患・向精神薬による過眠	54	4.3
レストレスレッグ症候群・周期性四肢運動障害	33	2.7
不眠症	30	2.4
睡眠時随伴症	14	1.1
長時間睡眠者	12	1.0
長時間睡眠傾向(夜間睡眠時間7~10時間未満)	7	0.6
反復性過眠症	3	0.2
2疾患以上の合併 (うち、睡眠不足症候群+その他の過眠症)	69	5.6
診断未確定	181	14.6

般の関心が高まってきていることから考えて、OSASスクリーニングを軸にして他の過眠性疾患を見落とさないようにカバーすることが、検診体制を組むうえでの当面の目的となるだろう。また、

事故や作業エラーを抑止するために検診を行うということになると、現場作業に従事している人や、長時間運転業務者など、比較的可変的な勤務についている労働者人口が過眠スクリーニングの対象になる可能性がある。この場合には、上記5疾患だけでなく、交代制勤務睡眠障害(不規則な勤務スケジュールにより、生体リズムが不規則化し、これにより日中の眠気が生じうる)も比較的高頻度に含まれてくる可能性があるため、これについても注意すべきと思われる。

スクリーニングの手順

眠気その他覚醒的生理学的指標としては、易入眠傾向を定量評価する多回睡眠潜時反復検査(multiple sleep latency test: MSLT)(図1)がgolden standardとして用いられており⁴⁾、その平均入眠潜時5分以内が明らかな病的過眠水準、5~10分が境界域、10分以上が正常と定義されている。本検査は、各種過眠性疾患の診断、重症度判定に用いられることが多く有用性は高いが、検査に時間がかかり多人数をカバーするうえで難点があるため一次スクリーニングには不向きである。

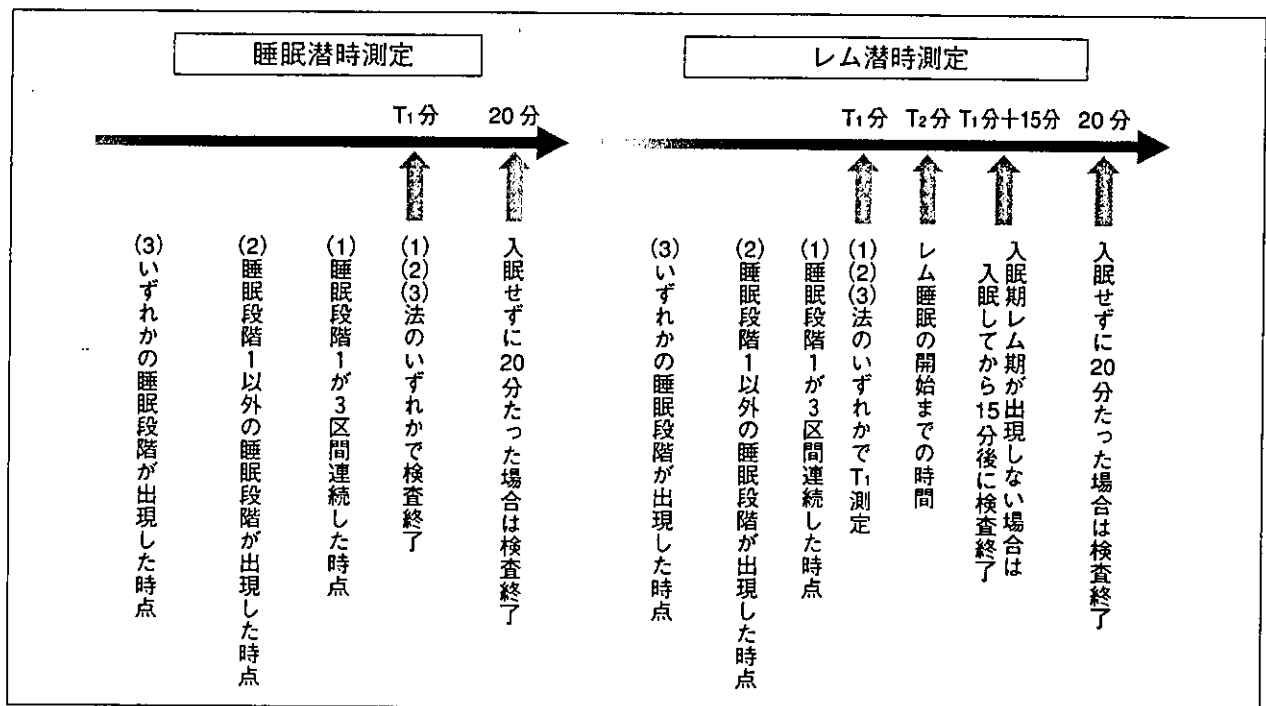


図1 眠気の客観的評価法:多回睡眠潜時検査
睡眠潜時: T_1 分, レム潜時: $T_2 \sim T_1$ 分

記入上のお願

1. あなたご本人が、できるだけありのままにお答え下さい
2. 答えは、あてはまる番号を○で囲むか、または、空欄に直接ご記入ください
3. 時刻を記入する場合は、午前、午後のいずれかを○で囲んでください

記入例：

就寝時刻	1. 午前	②	午後	10時 30分ころ
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*昼の12時は「午後0時」、夜の12時は「午前0時」となります

ご氏名 _____

電話番号 _____

記入	平成	年	月	日
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問1 過去1ヵ月間における、あなたの心身の状態についておたずねします

過去1ヵ月間について大部分の日の昼と夜を考えて、以下の質問項目にできる限り正確にお答えください

1) 過去1ヵ月間において、通常何時ころ寢床につきましたか？

就寝時刻	1. 午前	2. 午後	時	分	ころ
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2) 過去1ヵ月間において、寢床についてから眠るまでにどのくらい時間を要しましたか？

約	分
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3) 過去1ヵ月間において、通常何時ころ起床しましたか？

就寝時刻	1. 午前	2. 午後	時	分	ころ
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4) 過去1ヵ月において、実際の睡眠時間は何時間くらいでしたか？

これは、あなたが寢床の中にいた時間とは異なる場合があるかもしれません

睡眠時間	1日平均	約	時間	分
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5) 過去1ヵ月において、どれくらいの頻度で、以下の理由のために睡眠が困難でしたか？ 最も当てはまるものに1つ○印をつけてください

A. 寢床についてから30分以内に眠ることができなかったから

1. なし	2. 1週間に1回未満
3. 1週間に1~2回	4. 1週間に3回以上

B. 夜間または早朝に目が覚めたから

1. なし	2. 1週間に1回未満
3. 1週間に1~2回	4. 1週間に3回以上

C. トイレに起きたから

1. なし	2. 1週間に1回未満
3. 1週間に1~2回	4. 1週間に3回以上

D. 息苦しかったから

1. なし	2. 1週間に1回未満
3. 1週間に1~2回	4. 1週間に3回以上

E. 咳が出たり、大きいいびきをかいたから

1. なし	2. 1週間に1回未満
3. 1週間に1~2回	4. 1週間に3回以上

F. ひどく寒く感じたから

1. なし	2. 1週間に1回未満
3. 1週間に1~2回	4. 1週間に3回以上

G. ひどく暑く感じたから

1. なし	2. 1週間に1回未満
3. 1週間に1~2回	4. 1週間に3回以上

H. わるい夢をみたから

1. なし 2. 1週間に1回未満
3. 1週間に1~2回 4. 1週間に3回以上

I. 痛みがあったから

1. なし 2. 1週間に1回未満
3. 1週間に1~2回 4. 1週間に3回以上

J. 上記以外の理由があれば、次の空欄に記載してください

【理由】

そういったことのために、過去1ヵ月間において、どれくらいの頻度で、睡眠が困難でしたか？

1. なし 2. 1週間に1回未満
3. 1週間に1~2回 4. 1週間に3回以上

6) 過去1ヵ月において、ご自分の睡眠の質を全体として、どのように評価しますか？

1. 非常によい 2. かなりよい
3. かなりわるい 4. 非常にわるい

7) 過去1ヵ月において、どれくらいの頻度で、眠るために薬を服用しましたか（医師から処方された薬あるいは薬屋で買った薬）？

1. なし 2. 1週間に1回未満
3. 1週間に1~2回 4. 1週間に3回以上

8) 過去1ヵ月において、どれくらいの頻度で、車の運転中や食事中や社会活動中など眠ってはいけないときに、起きていられなくなり困ったことがありましたか？

1. なし 2. 1週間に1回未満
3. 1週間に1~2回 4. 1週間に3回以上

9) 過去1ヵ月において、物事をやり遂げるのに必要な意欲を持続するうえで、どれくらい問題がありましたか？

1. まったく問題なし
2. ほんのわずかだけ問題があった
3. いくらかの問題があった
4. 非常に大きな問題があった

10) 家族/同居人がおられますか？→おられない方は問2に進んでください

1. どちらもいない
2. 家族/同居人がいるが寝室は別
3. 家族/同居人と同じ寝室であるが寝床は別
4. 家族/同居人と同じ寝床

上記の問で、2または3または4と答えた方のみにおたずねします。

あなたご自身のことについて、ご家族または同居されている方に、以下の各項目について過去1ヵ月間の頻度をおたずねください

A. 大きないびきをかいていた

1. なし 2. 1週間に1回未満
3. 1週間に1~2回 4. 1週間に3回以上

B. 眠っている間に、しばらく呼吸がとまることがあった

1. なし 2. 1週間に1回未満
3. 1週間に1~2回 4. 1週間に3回以上

C. 眠っている間に、足のピクンとする動きがあった

1. なし 2. 1週間に1回未満
3. 1週間に1~2回 4. 1週間に3回以上

D. 眠っている途中で寝ぼけたり混乱することがあった

1. なし 2. 1週間に1回未満
3. 1週間に1~2回 4. 1週間に3回以上

E. 上記以外に、じっと眠っていないようなことがあれば、次の空欄に記載してください

【その他じっと眠っていないようなこと】

こういったことが過去1ヵ月間において、どれくらいの頻度で起こりましたか？

1. なし 2. 1週間に1回未満
3. 1週間に1~2回 4. 1週間に3回以上

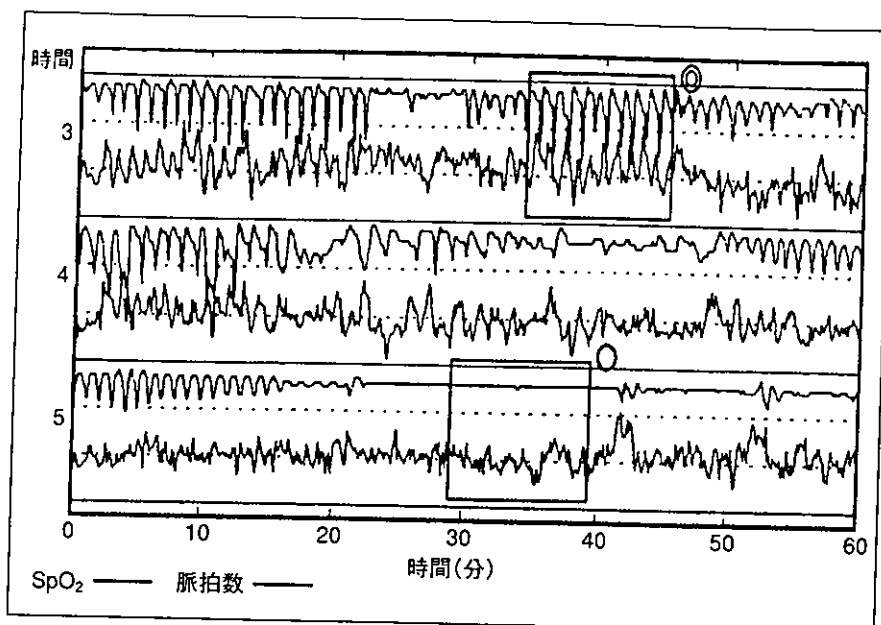


図3 パルスオキシメトリーのデータ
 Y軸：70%～100% (SpO₂) 50 bpm～110 bpm (脈拍数)
 ○：正常な動脈血酸素飽和度を示しており(約95%)，それと一致する脈拍部分も安定した脈拍数(約70回/分)を示している。
 ◎：睡眠時の無呼吸による動脈血酸素飽和度の低下と，呼吸再開にともなう動脈血酸素飽和度の上昇の繰り返しを示しており(10分間に約10回の繰り返し，動脈血酸素飽和度は最低約85%まで低下している)，それと一致して脈拍数も上昇と下降を繰り返し，上昇時には約90回/分になっている。
 (谷川 武¹⁰⁾より)

ムノグラフィと異なり，脳波，眼球運動，筋電図など，睡眠段階判定に用いる指標を省略して，呼吸，動脈血酸素飽和度，心電図などOSASの判定に用いる指標のみを計測するもの)を行い，OSASか否かを判定しておく，その後の確定診断・治療へのルートとして，OSASを専門に扱う呼吸器系の医療機関で精査を受けるのが適当か，それ以外の病気を扱う神経・精神科領域の医療機関を受診させるのがよいかどうかの筋道を立てやすくなると思われる。これらの二段階スクリーニングを経て，明らかに過眠症状が存在することが確認され，おおよそその診断の準備が整ったところで，睡眠専門医療機関での精密な診断に進むのがよいだろう。

OSAS スクリーニング

他の過眠性疾患の場合には，眠気による障害の可能性を防ぐことが検診の目的となるが，OSASの場合には，眠気が乏しくても呼吸障害頻度が多い場合には心血管系の障害が合併する可能性が高くなる⁹⁾ので，これを考慮して呼吸障害の積極的なスクリーニングを行うべきであるという風潮が強くなってきている。一次スクリーニングで自覚的な眠気があるかどうかを調べると同時に，常習性イビキと夜間の呼吸停止の有無を調べ，眠気・常習性イビキ・呼吸停止のどれかがあれば，積極的に

簡易ポリソムノグラフィ (Portable monitoring: PM) によって呼吸障害頻度を調べる，もしくはパルスオキシメーター記録 (図3¹⁰⁾) により夜間動脈血酸素飽和度 (SaO₂) が3%以上低下するイベントの頻度 (ODI 3) を調べるというやり方をとっている機関はかなり多いようである。またOSASスクリーニングの対象として，過眠症状を有する人だけでなく，本症候群の発現リスクの高い肥満者や，OSASの合併症として頻度の高い高血圧を有する人口を対象としているケースもあるようである。

筆者の私見としては，パルスオキシメーターによる夜間SaO₂のみの記録だと，SaO₂下降の乏しい呼吸障害イベントを検出することが困難だし，肺機能障害ないし心不全により低酸素血症が存在すると無呼吸低呼吸によるSaO₂下降か否かの判断ができなくなることがあるので，胸腹壁の呼吸運動と換気気流モニターを含んでいるPMのほうが精度が高いと思われる。PMは睡眠段階判定ができないため，正確な無呼吸低呼吸指数 (AHI: 単位時間あたりの呼吸障害頻度) を算出することができないという弱点が存在するが，微小体動を感知するミニモーションロガー (MML) を併用し，これにより覚醒/睡眠の判定を行って夜間睡眠時間を算出¹¹⁾すれば，精度が向上する。われわれが58例のOSAS疑い患者に対してPMとMML併用による検査と終夜ポリソムノグラフィ検査結果を行い

表5 各カットオフレベルにおける簡易 PSG の評価

AHI のカットオフレベル (AHI)	5		15		30	
MML 併用 (MML)						
感度	98.1	100	83.7	95.3	62.5	70.8
特異度	25.0	25.0	73.3	66.7	88.2	88.2
偽陽性率	1.9	0.0	0.0	4.7	37.5	29.2
偽陰性率	75.0	75.0	26.7	33.3	11.8	11.8
陽性的中率	50.0	100	61.1	83.3	76.9	81.1
陰性的中率	94.6	94.7	90.0	89.1	78.9	81.0

AHI：無呼吸低呼吸指数

MML：ミニモーショングラフ

PM・MML 併用簡易検査の OSAS 診断精度を検討した結果では、AHI 5 ないし AHI 15 をカットオフにした場合、その感度は 90% 以上であった (表 5)。AHI 30 以上の重症例についての診断感度がかなり下降すること、全体的に特異度に問題がある (すなわち偽陽性が出やすい) という欠点はあるが、PM・MML 併用簡易検査はスクリーニング手段としては満足できる水準にあるといえるのではないだろうか。全世界的な基準において PM の検査精度は低いと考えられているので、OSAS の確定診断や重症度判定に簡易検査を用いるべきではない²⁾が、前述したように OSAS がきわめて頻度の高い疾患であることを考えると、大規模の集団に対してスクリーニング検査する場合には、このような簡易検査を行わざるをえないというのが実情である (これによる陽性例に対しては、必ず検査室での精密な終夜睡眠ポリグラフィにより確定診断すべきである)。OSAS スクリーニングは、心血管系疾患の発現を予防するために行われる一般成人病検診と同様の意義があると思われるので、今後この方面での技術がさらに向上していくことを期待したい。

おわりに

以上のような手順を用いれば、OSAS をはじめとする過眠性疾患はかなりの頻度で検出できると思われる。眠気は生理的な現象なので、重症で生活への障害がかなり強い場合を除くと病的か否かの自己診断がかなり難しい。このため、検診にあたっては、その意義を十分に対象者に理解してもらって検診へのモチベーションを高めること、ESS のような評価尺度と睡眠日誌のような生活記録を

併用し、第三者からの情報を取り入れることによって精度を高めることが必要のように思われる。現在道路交通法において、重篤かつ未治療の過眠症は、居眠り運転のリスクを避けるため、自動車運転免許の保留・停止の対象になっている。過眠症状は特殊な症例を除けば大半が治療によって抑止可能なので、積極的な診断・治療を促進すべきであることを強調したい。

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Mental Health Status, Shift Work, and Occupational Accidents among Hospital Nurses in Japan

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Abstract: Mental Health Status, Shift Work, and Occupational Accidents among Hospital Nurses in Japan: Kenshu Suzuki, et al. Department of Public Health, School of Medicine, Nihon University—A questionnaire survey was conducted with questions from the 12-item General Health Questionnaire, among others, targeting 4,407 nurses in 8 general hospitals in Japan, in the hope of improving the work environment of nurses and to provide data that will allow a discussion of the measures necessary for preventing medical errors, thus improving occupational health. For each type of accident, the percentage of those who had made medical errors was significantly higher for the “mentally in poor health” group than for the “mentally in good health” group ($p < 0.0001$). The percentage of nurses in the “mentally in good health” and “mentally in poor health” groups who had experienced occupational accidents over the past 12 months (i.e., whether they were “with errors” or “without errors”) was calculated for each of the following four types of medical accident: (1) drug-administration errors, (2) incorrect operation of medical equipment, (3) errors in patient identification, and (4) needlestick injuries. For each type of accident, the percentage of those who had made medical errors was significantly higher for the “mentally in poor health” group than for the “mentally in good health” group ($p < 0.0001$). Multiple logistic regression analyses revealed significant associations between experience of medical errors in the past 12 months and being mentally in poor health, with night or irregular shift work, and age.

(J Occup Health 2004; 46: 448-454)

Key words: Mental-health status, General Health Questionnaire (GHQ-12), Occupational accidents, Shift work, Nurses, Japan

The number of women who work is increasing, but in Japan, nursing remains the profession that comprises the largest percentage of female workers. Female workers are generally exposed to more physical and mental stress than are male workers, because in addition to their jobs, additional burdens, such as household chores, childcare, pregnancy and childbirth tend to add to the stress^{1,2}. It is notable that nurses are particularly prone to mental health problems compared with those who are engaged in other types of jobs because they work night or irregular shifts more often than others, which affects the circadian rhythm and disturbs other biorhythms, leading to failure of various physiological functions³. It is said that nurses are exposed to more mental stress than are other health-care professionals because in addition to working in a more mentally stressful work environment, nurses are required to develop increasingly higher skill levels because of advances in medical care and technology³⁻⁷. It is therefore very important from the viewpoint of personnel administration to clarify the mental health status of nurses.

Sleep problems among nurses are also important and must be addressed. In the case of nurses who work night shifts, their sleeping hours will inevitably be in the daytime, the activities of others often making it difficult to secure enough sleep. Nurses who live with their families tend to have a shorter sleep duration because of their family's schedules, or they tend to wake up more often during sleep, and their quality of sleep tends to be poor because of noise and/or brightness^{8,9}. Occupational errors or accidents involving nurses have a direct and critical influence on the life and prognosis of their patients, as such it is clear that this is yet another important

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issue that must be addressed. Moreover, as prevention of medical errors and accidents is an urgent issue to be addressed from the viewpoint of industrial hygiene, working conditions that may lead to occupational errors or accidents among nurses also began to be addressed through various advanced approaches. That is, attempts are being made to analyze the workplace problems that increase the risk of medical accidents. These analyses have been made under the assumption that such accidents represent specific and remediable hazards rather than problems with individual nurses, and include studies on the factors associated with the typical working state of nurses (e.g., hypoglycemia)^{10, 11}, a study on subjective calculation methods for error rates¹², and error analyses based on the reporting system that is promoted by the Ministry of Health, Labor, and Welfare of Japan¹³. But it is also important to analyze factors related to medical accidents that can be attributed to individual nurses, such as working style, mental health, and whether or not they have sleep problems. There are two main methods for assessing medical errors and accidents: one is to define only reported accidents as medical accidents and count them, and the other is to define all occupational-error or -accident cases that have been recognized as errors or accidents by the subjects themselves who participate in self-administered questionnaire surveys⁸. The latter method was adopted in the present study since it may yield data on otherwise unreported and unrevealed occupational errors or accidents.

We therefore conducted a questionnaire survey targeting 4,407 nurses in Japan, focusing on occupational accidents (medical errors), in order to (1) measure the actual mental health status among nurses, and (2) analyze associations between mental health and medical errors, in the hope of securing better working conditions for nurses and to provide data that would enable a constructive discussion of measures for preventing occupational accidents and thus improve occupational health for these workers.

Methods

Subjects and method of data collection

The subjects of this study were nursing staff working in eight general hospitals equipped with 400 beds or more that were located in Metropolitan Tokyo or other cities in Japan. The survey was conducted for one month during September 2003. The target hospitals were those in which the staff agreed to cooperate in our study, and they included four hospitals that are affiliated with medical colleges in Metropolitan Tokyo, two hospitals in other cities that are also affiliated with medical colleges, and two other public hospitals in other cities. The number of responses to the questionnaire was 4,407, and the collection rate was 94.0%. Of these, 4,279 female

inpatient nurses were selected as subjects.

Survey method

First, the person in charge of the survey at each hospital (the director of nursing) explained the purposes of the present study and requested the cooperation of the person responsible for each ward of the hospital, who in turn asked for the cooperation of his or her subordinate nursing staff. The distribution and collection of questionnaires was also performed through the person in charge of the survey at each hospital. An anonymous self-administered questionnaire was used, and to protect the privacy of the subjects and obtain the most candid responses possible, it was stated clearly on the questionnaire that completed questionnaires would not be seen by the staff of the institutions and that they would be collected in sealed envelopes. This survey was approved by the Ethics Committee of Nihon University, prior to its commencement.

Questionnaire

Identical anonymous self-administered questionnaires were used at all eight participating hospitals. In addition to questions on mental health, sleep, and occupational accidents, there were questions on subject characteristics (age, gender) and the shift-work system that they worked under. The sleep-related items included: (1) a subjective evaluation of their own sleep, (2) sleep duration, (3) whether they were with/without difficulty in going to sleep, (4) whether they were with/without difficulty in maintaining sleep, and (5) early-morning awakening and difficulty in getting back to sleep. The actual questions, which were taken from the Japanese version¹⁴ of the Pittsburgh Sleep Quality Index (PSQI) questionnaire developed by Pittsburgh University, are shown here:

1. Do you get as much sleep as you need?
(very sufficient/sufficient/insufficient/very insufficient/uncertain)—subjective sleep evaluation
2. On average, how many hours do you sleep?—sleep duration
3. Do you have difficulty falling asleep at night?
(always/often/sometimes/seldom/never)—difficulty in going to sleep
4. Do you wake up too often during the night after you have gone to sleep?
(always/often/sometimes/seldom/never)—difficulty in maintaining sleep
5. Do you wake up too early in the morning and have difficulty getting back to sleep?
(always/often/sometimes/seldom/never)—early morning awakening

Since nurses can be involved in various types of occupational accident, the questionnaire included questions on whether or not they had experienced the four types of accident that are most commonly reported

among nursing staff: (1) drug-administration errors, (2) incorrect operation of medical equipment, (3) errors in patient identification, and (4) needlestick injuries, in the past 12 months. The Japanese version of the 12-item General Health Questionnaire (GHQ-12) was used to measure mental health status.

Analyses

SPSS for Windows Version 11.0 was used for statistical processing. The GHQ-12 was used as a scale for measuring the mental health of the nurses. The reliability of the GHQ-12 is given by a Cronbach alpha coefficient of $\alpha=0.8606$, which means that the internal consistency and reliability of the question items of the GHQ-12 was sufficiently high¹⁵. A cutoff point of 3/4 was chosen.

(1) The mental health of the nurses who took part in the survey was examined first. The distribution, mean value, and median of the GHQ-12 scores were calculated.

(2) The associations between night or irregular shift work and mental health were examined. The rates of those who were mentally in poor health in the "with shift work" group and "without shift work" group were compared. Chi-squared test was used, and the level of statistical significance was set at 5%. In addition, the mean values of the GHQ-12 scores for the "with shift work" group and "without shift work" group were compared. As the GHQ-score distribution was normal, Student's *t* test was used, and the level of statistical significance was set at 5%.

(3) The associations between mental health and occupational accidents in the past 12 months were examined. A comparison of the "mentally in good health" group and the "mentally in poor health" groups was conducted with respect to whether or not the participating nurses had experienced any of the following four types of occupational accident: (i) drug-administration errors, (ii) incorrect operation of medical equipment, (iii) errors in patient identification, and (iv) needlestick injuries. Chi-squared test was used, and the level of statistical significance was set at 5%. In addition, the mean values of the GHQ-12 scores in the "with errors" group and "without errors" group were compared. Student's *t* test was used, and the level of statistical significance was set at 5%.

(4) Finally, univariate analyses and multiple logistic regression analyses were conducted with regard to medical errors experienced in the past 12 months. Those who had experienced any of the four types of error analyzed in the present study in the past 12 months were assigned to a "with errors" group, and those who had not were assigned to a "without errors" group. We took "with errors" and "without errors" as dependent variables, and we took mental health (in good health, in poor health), subjective sleep evaluation (insufficient, sufficient), with/without difficulty in initiating sleep, with/without

difficulty in maintaining sleep, with/without early-morning awakening, age (in their 20s, 30s, 40s and 50s or older), with/without spouse, and with/without night/irregular shift work as independent variables. Univariate analyses and multiple logistic regression analyses were conducted to produce odds ratios and 95% confidence intervals. With regard to subjective sleep evaluation, those who answered "3. insufficient" or "4. very insufficient" were assigned to an "insufficient sleep" group, and those who answered "1. very sufficient" or "2. sufficient" were assigned to a "sufficient sleep" group. For difficulty in going to sleep, difficulty in maintaining sleep, and early-morning awakening, those who answered "4. often," or "5. always" were assigned to a "with" group, and those who answered "1. never," "2. seldom," or "3. sometimes" were assigned to a "without" group, and these data were used as independent variables.

Results

Characteristics of the survey participants

Of the entire subjects, 63.0% were 20–29 yr old, 20.8% were 30–39 yr old, 1.5% were 40–49 yr old, and 6.0% were 50 yr old or older. The average (SD) age was 30.3 (8.9) yr. Tokyo was the workplace of 62.8% of the participants, and the remaining 37.2% worked in other cities in Japan. With regard to marital status, 75.1% of participants were not married, and the remaining 24.9% were married (Table 1). The type of hospital, its location, number of beds, number of nurses, average age of the nurses, number of married nurses, and the response rate at each participating facility are given in Table 2.

GHQ-12 scores of the survey participants

The percentage of those who scored 3 points or less (considered to be mentally in good health) was 31.2%; the remaining 68.8% scored 4 points or more (considered to be mentally in poor health; Table 3). The mean (SD) GHQ-12 score was 5.42 (3.29), and the median was 5.0.

Night/irregular shift work and mental health

Of the "with shift work" group, 69.8% were mentally

Table 1. Attributes of targets analyzed

Age	20–29 yr	63.0%
	30–39 yr	20.8%
	40–49 yr	10.2%
	50+	6.0%
	Total (N=4279)	
Marital status	Not married	75.1%
	Married	24.9%
	Total (N=4279)	
Residence	Tokyo	62.8%
	Other cities	37.2%
	Total (N=4279)	

Table 2. Characteristics of participating facilities

	Type of hospital	Location	Number of beds	Number of full-time, inpatient nurses	Average age (SD)	Number of married nurses	Response rate (%)
Facility 1	University hospital	Tokyo	712	787	30.5 (9.1)	151	90.9
Facility 2	University hospital	Tokyo	905	933	27.8 (6.5)	118	93.2
Facility 3	University hospital	Tokyo	885	898	28.2 (6.9)	135	94.7
Facility 4	University hospital	Tokyo	441	369	27.0 (6.1)	49	92.1
Facility 5	University hospital	Tohoku district	571	390	33.3 (9.3)	164	98.7
Facility 6	University hospital	Kanto district (except Tokyo)	412	402	29.6 (9.4)	65	91.0
Facility 7	Public general hospital	Chubu district	417	407	31.7 (6.1)	173	100.0
Facility 8	Public general hospital	Kinki district	430	500	33.1 (9.7)	206	95.0

SD: Standard deviation

Table 3. Distribution of GHQ-12 scores

Score	Freq. (No. of people)	Cum. %
0	288	6.7
1	331	14.5
2	338	22.4
3	377	31.2
4	427	41.2
5	461	51.9
6	463	62.7
7	414	72.4
8	326	80.0
9	290	86.8
10	201	91.5
11	212	96.5
12	151	100

Table 4. Relationships between mental health and occupational accidents in the past 12 months

Mental health/accidents	N	Drug-administration errors	
		Without	With
In good health	1,322	64.0	36.0
In poor health	2,927	56.5	43.5
		Misoperation of medical equipment	
		Without	With
In good health	1,320	79.8	20.2
In poor health	2,920	72.7	27.3
		Errors in patient identification	
		Without	With
In good health	1,318	92.1	7.9
In poor health	2,930	89.8	10.2
		Needlestick injuries	
		Without	With
In good health	1,298	65.3	34.7
In poor health	2,936	63.0	37.0

Chi-square test $p < 0.0001$

in poor health, compared to 55.6% in the "without shift work" group; the difference was significant ($p < 0.0001$). Furthermore, the mean GHQ-12 score of the "with shift work" group (5.49) was significantly higher than that of the "without shift work" group (4.53; $p < 0.0001$).

Associations between mental health and experience of occupational accidents in the past 12 months

With regard to (1) drug-administration errors, (2) incorrect operation of medical equipment, (3) errors in patient identification, and (4) needlestick injuries, the rates of those with or without medical errors in the "mentally in good health" and "mentally in poor health" groups were compared. The rates for those with medical

errors were significantly higher in the "mentally in poor health" group than in the "mentally in good health" group for all four error types. In addition, the mean (SD) GHQ-12 score of the group of subjects who had made any of the four types of medical error included in the present study over the past 12 months was significantly higher at 5.69 (3.25) than for the group of those who had not [4.70 (3.21), $p < 0.0001$; Table 4].

Factors related to occupational accidents experienced in the past 12 months

Significant associations were observed between experience of medical accidents over the past 12 months and being mentally in poor health, without a spouse, with

Table 5. Univariate and multiple logistic regression analyses regarding factors related to occupational accidents in the past 12 months

Factor	N	Univariate Unadjusted		Multivariate Adjusted	
		OR	95% CI	OR	95% CI
Mental health					
In good health	1,191	1.00		1.00	
In poor health	2,627	1.72	1.48–1.99	1.55	1.32–1.82
Subjective sleep evaluation					
Insufficient	2,105	1.00		1.00	
Sufficient	1,713	0.87	0.74–0.98	1.00	0.86–1.18
Difficulty in initiating sleep					
Without	2,890	1.00		1.00	
With	928	1.17	0.99–1.38	0.96	0.79–1.16
Difficulty in maintaining sleep					
Without	2,921	1.00		1.00	
With	897	1.07	0.90–1.26	0.99	0.81–1.12
Early-morning awakening, difficulty in getting back to sleep					
Without	3,389	1.00		1.00	
With	429	1.06	0.84–1.32	1.03	0.80–1.33
Age					
20s	2,441	1.00		1.00	
30s	785	0.69	0.58–0.83	0.96	0.81–1.14
40s	379	0.49	0.39–0.62	0.66	0.52–0.85
50s or older	213	0.34	0.26–0.46	0.62	0.45–0.85
Spouse					
Without	2,883	1.00		1.00	
With	935	0.59	0.50–0.69	0.90	0.74–1.09
Shift work*					
Without	274	1.00		1.00	
With	3,544	2.54	1.99–3.25	1.78	1.35–2.34

R² (Nagelkerke)=0.52

CI: Confidence interval OR: Odds Ratio, Adjusted for other factors in multiple logistic regression analysis with stepwise elimination, *Night/split/irregular

night/irregular shift work, and age (with the value for the 20–29 yr age group as a reference, associations were observed in the 40–49 and 50–59 yr age groups; Table 5).

Discussion

Few systematic surveys have been conducted on associations between mental health or sleep disorders and occupational accidents among nurses in Japan. Indeed, to our knowledge, no such report exists. The present report therefore represents the first such large-scale study.

The GHQ-12 questionnaire is the criterion developed by Goldberg in the United Kingdom as a screening test for nonorganic, nonpsychosis mental disorders^{16–18}. It was reported that two factors that had been extracted from a factor analysis of a study on the GHQ-12 targeting workers (mental anguish and social dysfunction)^{10, 11}, and the GHQ-12 was considered to be appropriate for use in

the present study. Fukunishi reported that the sensitivity, specificity, and error rate of the GHQ-12 were 85.6%, 66.9%, and 22.1%, respectively, for a cutoff point of 1/2, 74.2%, 88.5%, and 18.9%, respectively, for a cutoff point of 2/3, and 74.2%, 88.5%, and 19.9%, respectively, for a cutoff point of 3/4¹⁹. Furthermore, Mari *et al.* reported that when a cutoff point of 3/4 was chosen, the sensitivity and specificity were 85% and 79%, respectively²⁰. As a consequence of these findings, a cutoff point of 3/4 was employed in the present study.

The rate of those who scored 3 points or less (i.e., considered to be mentally in good health) was only 31.2%, but that of those who scored 4 points or more (i.e., considered to be mentally in poor health) was 68.8%. The mean (SD) value of the GHQ-12 scores was 5.42 (3.29), and the median was 5.0. These results suggest that mental health of the target nurses was quite poor. It has already been established that nursing is a personal

service caring for patients who have become emotionally unstable because of their health problems, and that it involves excessively heavy work with night or irregular shift work, which may lead to irregular life patterns, usually with a lot of overtime and a heavy work load³⁻⁷⁾. In addition, shift work has been shown to increase the risk of suffering from one of several diseases²¹⁾. Associations between shift work and physical and mental diseases therefore deserve further attention in future studies.

The factor that has the strongest association with experience of medical errors in the past 12 months was night/irregular shift work. It was reported in a study conducted in the USA targeting hospital nurses that nurses working in rotating shifts tended to have more accidents while working and driving, and made more errors during work⁹⁾. The results of our study are in accord with these findings, and lead us to the conclusion that improvement of mental health among the nurses is of critical importance.

Estryn-Behar *et al.* established associations between occupational stress among hospital workers and sleep disorders²²⁾. Since nursing is a profession that typically involves shift work, sleep problems are also critical for nurses. In the present survey, however, no association was observed between shift work and occupational accidents. In some studies, associations have been found between sleep disorders and occupational accidents, but in others, no such associations were noted. This discrepancy may be attributable to differences in the type of job, classification of occupational accidents, and the definition of occupational accidents used.

There are many reports on associations between night-shift work and sleep problems among nurses all over the world. Gold *et al.* pointed out that the percentage of those experiencing daytime sleepiness was higher among nurses who worked night-and-day shift schedules⁸⁾. Escriba *et al.* noted a decrease in sleep duration and a degradation of sleep quality that was attributable to night-shift work⁹⁾. In Japan, Ohida *et al.* reported that there was no association between sleep problems and night-shift work²³⁾. Takahashi *et al.* focused on differences between two-shift and three-shift systems, and reported that with regard to sleep problems, there were no significant differences between them²⁴⁾. Since the results of studies on associations between sleep problems and night-shift work are equivocal, further investigations are necessary.

The present study is significant from a public health point of view. There are, however, several limitations to this survey. First, a self-administered questionnaire was used, and as such there may be a reporting bias. In addition, the methods used for recognizing occupational accidents were subjective; more objective ones must be used in the future. Case-control studies must be

conducted to examine the associations observed in the present study between occupational accidents and various risk factors for accidents. Although the reliability and validity of the GHQ-12 are uncertain in Japan, for the present study, we chose to use a cutoff point of 3/4 for analyses, referring to the findings of previous studies. In addition, since the present study was a cross-sectional study, causal relationships between poor mental health and occupational accidents remain to be determined. Finally, it is well known that organization factors are associated with medical errors²⁵⁾. This probably induced medical errors through personnel administration problems, but this study directly investigated the organization factors underlying medical errors. These limitations need to be borne in mind when interpreting the results of this study.

In conclusion, the results of the present study have revealed that the mental health of the hospital nurses studied was quite poor, as shown by the quite high mean GHQ-12 score (5.42), and that mental health is a factor that appears to be associated with occupational accidents among nurses. To ameliorate such conditions, it may be urgently required to take measures such as adopting stress-coping programs as one of the strategies for personnel administration. These findings represent the first step toward establishing measures for preventing medical errors among nurses and for improving their occupational health.

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