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Evaluation of recovery after intravenous sedation

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ABSTRACT : The Intravenous Sedation (IVS) Guideline Working Group of the Japanese Dental Society of Anesthesiology (JDSA) formulated guidelines for intravenous conscious sedation in dentistry. These guidelines were then published on the website of the JDSA in October 2009. These guidelines were developed in accordance with the "MINDS Handbook for Clinical Practice Guideline Development 2007" published by the Medical Information Network Distribution Service (MINDS), and were listed on the MINDS Website in February 2011. One of the authors participated in the planning of these guidelines and was responsible for the section on recovery period. The revised version has been published on the website of the JDSA in May 2017. In this review, the following three issues are explained : 1) basic points of view with regard to the recovery process after IVS ; 2) influence of aging on the physiological and pharmacological function and points of attention regarding IVS management in elderly patients ; and, 3) comparison results of recovery criteria among IVS and/or general anesthesia guidelines of domestic and international academic societies.

Key Words : intravenous sedation (IVS), recovery criteria, home readiness, guideline, elderly patients

Introduction

Intravenous Sedation (IVS) Guideline Working Group of the Japanese Dental Society of Anesthesiology (JDSA) formulated guidelines for intravenous conscious sedation in Dentistry. These clinical practice guidelines were reviewed by six related dental academic associations and were then published on the website of the JDSA in October 2009. These guidelines were developed in accordance with the "MINDS Handbook for Clinical Practice Guideline Development 2007" published by the Medical Information Network Distribution Service (MINDS). Therefore, these guidelines were listed on the MINDS Website in February 2011¹⁾. One of the authors participated in the planning of these guidelines and was responsible for the section on recovery period. The revised version has been published on the website of the JDSA in May 2017²⁾.

In this review, the following three issues have been explained : 1) basic points of view with regard to the

recovery process after IVS, 2) influence of aging on the physiological and pharmacological function and points of attention regarding IVS management in elderly patients, and 3) comparison results of recovery criteria among IVS and/or general anesthesia guidelines of domestic and international academic societies.

1. Evaluating items and recovery process

1) The items to be evaluated with regard to recovery after IVS

Items to be evaluated after anesthetic management and surgery are vital signs, cognitive and psychomotor functions, mobility and balance functions, postoperative nausea and vomiting (PONV), pain, and bleeding (Fig. 1). Nausea and vomiting are discharge prolonging factors in general anesthesia. However, they are not observed in IVS without the use of narcotics, as midazolam and propofol have prophylactic effects against them^{3, 4)}.

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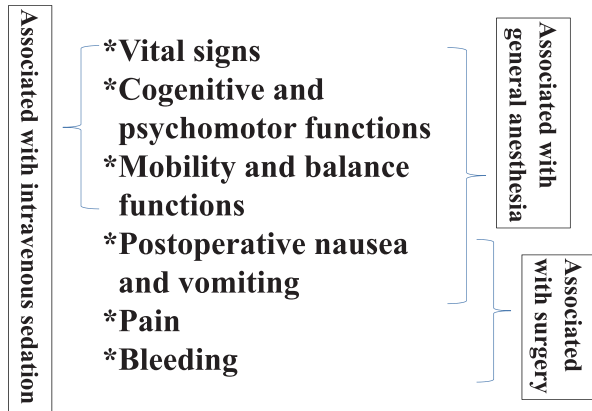


Fig. 1 Items to be evaluated after anesthetic management and surgery

2) Where should one focus as the endpoint of recovery?

Korttila⁵⁾ classified the recovery process after general anesthesia into three stages i.e., home readiness, street fitness, and complete recovery. This classification is equally applicable to recovery after IVS. Another classification includes three stages of early recovery, intermediate recovery, and late recovery⁶⁾. In this classification, home readiness is regarded analogous to intermediate recovery (Fig. 2).

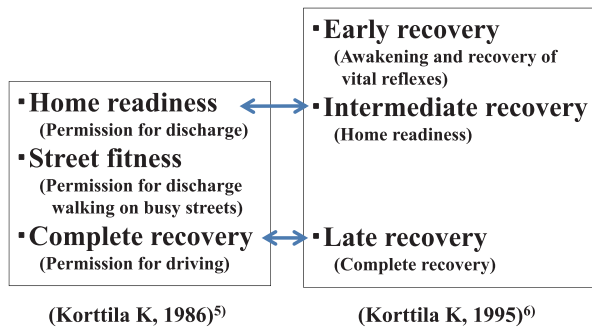


Fig. 2 Some classifications of the recovery process from general anesthesia

3) Permission for discharge: home readiness

The necessary condition for discharge is that the patient should be safe to undergo further recovery at his or her home with a responsible adult attendant. Table 1 shows the discharge criteria of our intravenous conscious sedation guidelines²⁾. Vital signs usually recover to normal levels by the time the patient is moved to the recovery room under conscious sedation. Cognitive and psychomotor functions are essential for the evaluation of the recovery process in cases of general anesthesia and IVS. However, from the perspective of home readiness, only the recovery of orientation (that is, orientation

Table. 1 Discharge criteria (home readiness) according to the revised IVS guidelines of the JDSA²⁾

1) Stable vital signs
2) Orientation to person, place, and time
3) Ability to walk without subjective and objective stagger, or ability to stand with feet closed tightly and eyes closed for 30 seconds
4) Absence of postoperative bleeding requiring treatment, excessive pain, or excessive nausea and vomiting
5) Distribution of written instructions for the postoperative period at home including contact phone number

It is preferable if the patients have no complaints. It is also recommended that the health providers call the patients to confirm whether they have any trouble after discharge.

to person, place, and time) is regarded as an essential condition⁶⁾. Therefore, it would not be an exaggeration to say that a patient can only be permitted to be discharged when he or she is able to walk without a subjective and objective stagger.

4) More precise evaluation of recovery for safer discharge

More precise evaluation of recovery is preferable in the following cases 1) for walking on busy streets, 2) anxiety about the quality of the attendant, or 3) necessity of safety margin for discharge. There are two types of computerized precise posturographies. One is conventional computerized static posturography (CSP) which examines swaying of gravity during standing with no perturbation stimuli⁷⁾. The other is computerized dynamic posturography (CDP) which examines the dynamic postural adjustment function (A and B in Fig. 3⁸⁻¹⁰⁾, and is more sensitive than CSP regarding the depressant effect of the equilibrium function of midazolam⁸⁻¹¹⁾. As a simple test for the recovery of dynamic balance function, the timed up and go test (TUG test, Fig. 4^{12, 13)} is available. This simple test is confirmed to be highly correlative with the perturbation stimuli test^{8, 9)}. In our previous study⁹⁾, the recovery after IVS with midazolam for elderly volunteers was recorded in terms of the recovery time, which was 70 min, 80 min, and 80 min by the Digit Symbol Substitution Test (DSST) which is regarded as a reliable psychomotor test with paper and pencil¹⁴⁾, perturbation stimuli test, and TUG test, respectively. Therefore, in many cases, when recovery of dynamic postural adjustment function is confirmed, high-level cognitive and psychomotor function seems to have recovered as well. Then, it is suggested that the simple dynamic balance function test can be a substitute for this confirmation in the clinical setting.

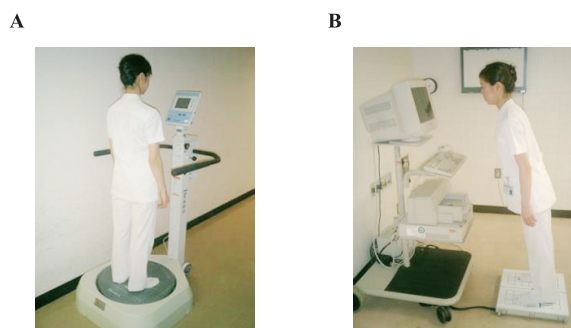


Fig. 3 Precise dynamic postural adjustment function tests in computerized dynamic posturography (CDPs)

A : The perturbation stimuli test^{8,9)}

An unstable platform tilts in all directions according to changes in body weight applied to the tip of the toes and the heels (that is, the subjects receive perturbation stimuli). The degree of platform tilt from the horizontal line in all directions during 20 seconds was evaluated.

B : The intentional dynamic balance function test¹⁰⁾

The subjects shifted their center of gravity by leaning their body to target frames indicated by a cursor moving on a computer screen in five directions. The percentage of the movement route to the shortest route and the time taken to reach the indicated site were evaluated. Photograph shows the forward position.

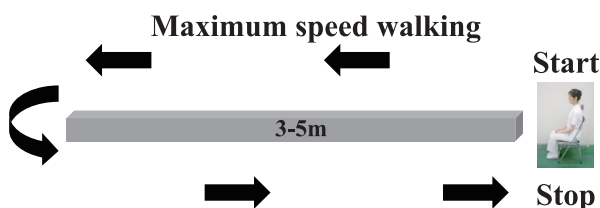


Fig. 4 Timed up and go test (TUG test)^{12, 13)}

The time required for the subject to stand up from a chair, walk forward for 3-5 m and return to the chair at maximum speed, and sit on the chair again was measured.

2. Attention points to IVS for the elderly patients

1) Aging and the evaluation of body balance

There are no significant differences between the elderly subjects and the young adult subjects in terms of the baseline values of precise static balance function test^{8, 9, 11)} and simple up-right standing test with closed-eyes called Romberg's test¹⁵⁾. In contrast, the baseline values of precise dynamic balance function in elderly individuals are lower than those in young adults^{8, 9, 16)}. Moreover, the recovery time from IVS in elderly patients was prolonged as compared to that in young adults in the evaluation of the intentional dynamic balance function¹⁰⁾. These results imply that in the elderly, the dynamic postural adjustment function may be impaired, although their static balance function (upright posture with eyes closed) may not be markedly impaired. Therefore, we should consider that the elderly patient cannot always be adjudged safe based solely upon the results of Romberg's test which may be within the baseline value after IVS.

2) Pharmacological points of attention for IVS with midazolam

The simulated curves of blood concentration and the depth of sedation after the intravenous administration of an equivalent amount of a sedative in the young and the elderly patients are shown in Fig. 5 (A). Excessive sedation is likely to occur due to increase in the pharmacological effect in elderly patients. In addition, it may take a longer time for the elderly patients to recover and reach the level required for permission for discharge

Table. 2 Points of attention to IVS with midazolam for elderly patients and countermeasures against them from the perspective of pharmacokinetics and pharmacodynamics¹⁷⁻²⁴⁾

Item	Points of attention	Reason and mechanism	Countermeasure
Water volume divided by body weights	Excessive dose when administered with weight equivalent conversion	Rich lipid, and poor water or muscle content in the elderly ¹⁷⁾	Administration of small amounts in divided doses
Protein binding	Excess efficacy due to increase in non-protein binding type which has drug potency	Elderly patients are prone to hypoalbuminemia. ¹⁷⁾	Administration of small amounts in divided doses
Drug sensitivity ¹⁸⁾	Excess efficacy, side effects	Sensitivity of GABA _A receptors to BZD increases in the elderly.	Administration of small amounts in divided doses
Metabolism and excretion (elimination)	Delayed recovery	Decrease in hepatic and renal functions due to aging ¹⁹⁾	1) Administration of small amounts 2) Reduction of additional administration amount
Individual variation	Excess efficacy, side effects, and delayed recovery	There is a lot of individual variation regarding physiological functions and pharmacological response in the elderly. ^{17, 20)}	Administration of small amounts in divided doses, performing induction slowly over time
Drug interaction with habitual drug* (regular medication)	1) Decrease in drug efficacy, or conversely 2) Delayed recovery	1) Tolerance (enzyme induction ^{21, 22)} or change of sensitivity of receptor ²³⁾ , or conversely 2) Competitive inhibitory effect (for example, ritonavir shows inhibition of CYP3A4 which is an enzyme for midazolam metabolism ²⁴⁾)	1) Increase in additional administration amount 2) Decrease in additional administration amount

IVS, intravenous sedation ; GABA, γ -aminobutyric acid ; BZD, benzodiazepine ; CYP, cytochrome P 450

* : The elderly are likely to face side effects derived from drug interaction due to superposition of multiple diseases and polypharmacy.

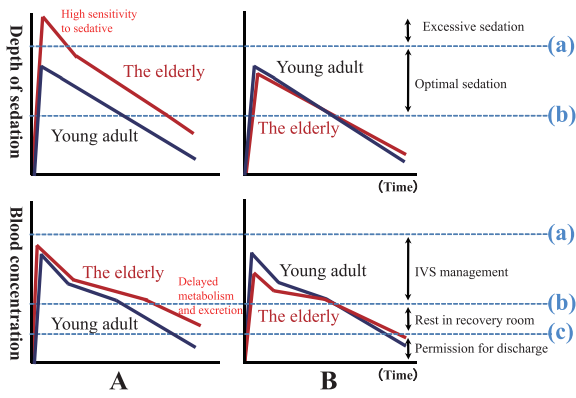


Fig. 5 The predictable simulated curves of blood concentration and depth of sedation after the intravenous administration of bolus dosage of sedative in young adults and the elderly

A : Administration of an equivalent amount per kg
 B : Administration of a smaller amount to the elderly level (a), onset level of side effect ; level (b), lower limit of sedation effect ; level (c), attained level to recovery

due to delayed metabolism and excretion. However, if we performed adequate IVS management on the basis of pharmacokinetic and pharmacodynamic characteristics in the elderly patients (Table 2)¹⁷⁻²⁴, effective and safe management can be performed, just as in young adults (B in Fig. 5)

3. Comparison of guidelines

Comparisons of recovery criteria among the revised intravenous conscious sedation guidelines of the JDSA²⁾,

general anesthesia guidelines of medical societies of anesthesiology (Table 3)²⁵⁻²⁷⁾, and IVS guidelines of international academic societies (Table 4)²⁸⁻³⁴⁾ were made.

1) Indication of discharge criteria for safe discharge following ambulatory surgery

Only “motor function” is described as the evaluation item of mobility and balance function for discharge criteria in the Japanese Society of Anesthesiologists (JSA) guidelines²⁶⁾. Use of a scoring system is considered to be of some help in the American Society of Anesthesiologists (ASA) guidelines²⁷⁾. “Walking well without dizziness” is one of the evaluation items in revised post-anesthetic discharge scoring systems³⁵⁾ frequently used in the USA. This is almost equally true for the IVS guidelines in many countries. Only one research paper in English³⁶⁾ and papers of the JDSA have adopted Romberg’s test. “Ability to walk without dizziness” is the universal standard of evaluation of motor and balance function after general anesthesia and IVS.

2) Patient escort requirements

Out of all guidelines examined, eight^{2, 26, 27, 29-31, 33, 34)} required the presence of an attendant for the patient to be discharged. Two guidelines^{28, 32)} had no mention of an attendant. The JDSA guidelines²⁾ prohibit the patient from leaving the hospital alone but make an exception. Recovery of psychomotor function in cases of propofol

Table. 3 Comparison of recovery criteria between the IVS guidelines of the JDSA and general anesthesia guidelines of medical societies of anesthesiology^{2, 25-27)}

Comparison item/academic society	JDSA (revised guidelines for intravenous conscious sedation) 2017 ²⁾	JSA (day care anesthesia guidelines) 2001, 2009 ^{25, 26)}	ASA (general anesthesia guidelines) 2013 ²⁷⁾	Difference between intravenous conscious sedation guidelines of the JDSA and medical general anesthesia guidelines in regard to the degree of strictness
Postoperative assessment and monitoring of patient	SpO2 (Blood pressure and pulse rate are preferable)	Blood pressure, heart rate, SpO2, respiratory rate ²⁵⁾	Airway patency, respiratory rate, oxygen saturation, pulse, blood pressure, mental status, temperature, pain, nausea and vomiting, hydration status, drainage, and bleeding should be routinely assessed during emergence and recovery.	Medical general anesthesia guidelines are stricter.
Discharge criteria	Refer to Table 1	Patients should be evaluated with certain criteria regarding the following 6 items: mental status, respiratory function, cardiovascular function, motor function, bleeding, and pain ²⁶⁾	Patients should be observed until they are no longer at an increased risk for central nervous system or cardiorespiratory depression after discharge.	Make a little difference
Patient escort requirement	In principle, an essential factor (absolutely essential factor for diazepam and flunitrazepam)	Essential factor (Moreover, the attendant can take care of the patient in his or her home) ²⁶⁾	Essential factor	Make a little difference
Drinking clear fluids for discharge criteria	Not essential for discharge	Remains contentious ²⁵⁾	Not essential for discharge	JSA guideline is stricter.
Urination for discharge criteria	Not essential for discharge	Remains contentious ²⁵⁾	Not essential for discharge	JSA guideline is stricter.
Street fitness	Preferable to evaluate with simple dynamic balance test	Permission 24h after the operation ²⁵⁾	Not described	JSA guideline is very strict.
Driving a car	Prohibited on the day of the procedure	Prohibited for up to 24 h ²⁵⁾	Not described	JSA guideline is stricter.

IVS, intravenous sedation ; JDSA, Japanese Dental Society of Anesthesiology ; JSA, Japanese Society of Anesthesiologists ; ASA, American Society of Anesthesiologists

Table 4 Comparison of recovery criteria among IVS guidelines of domestic and international academic societies^{2, 28-34)}

Comparison item/ academic society	JDSA (revised guidelines for intravenous conscious sedation) 2017 ²⁾	Dentistry		Societies of Anesthesiologists		Societies of medicine other than anesthesiologists		
		ADA (sedation and general anesthesia by dentists) 2016 ²⁸⁾	NDAC (SDCEP) 2012 ²⁹⁾	ASA (sedation by non-anesthesiologist) 2002 ²⁶⁾	ESA (sedation by non-anesthesiologist) 2007 ²⁷⁾	BMJ (sedation for the exam or procedure in children) 2011 ³²⁾	BSG (sedation for gastrointestinal endoscopy)1991 ³³⁾	ASGE (sedation for gastrointestinal endoscopy)2003 ³⁴⁾
Postoperative assessment and monitoring of patient	SpO2 (Blood pressure and pulse rate are preferable)	Blood pressure, heart rate, oxygenation and level of consciousness in moderate sedation	Monitoring needed	Oxygenation, ventilation, and circulation	Pulse oximetry, blood pressure measurement, electrocardiogram, and continuous visual observation of breathing and its frequency	Respiration, oxygen saturation, and heart rate	Clinical monitoring must always be continued into the recovery period.	Vital signs and level of consciousness
Discharge criteria	Refer to Table 1	The time when level of consciousness, oxygenation, ventilation, and circulation are satisfactory for discharge	Returning to a normal level of responsiveness and orientation for age and mental status and walking unaided	1) Alert and oriented, 2) Stable vital signs, 3) Responsible adult who will accompany the patient home, 4) Distribution of written instructions regarding post-procedure diet, medications, activities, and a phone number to be called in case of emergency	1) Full consciousness and appropriate response, 2) Ability to stand and walk unaided, 3) Stable vital signs lasting for at least 30 min, 4) Controlled pain, discomfort, nausea and vomiting	Vital signs have returned to normal levels, the patient is awake, there is no risk of further reduction in the level of consciousness, and any nausea, vomiting, and pain have been adequately managed.	Not described	Vital signs are stable and the patient has reached an appropriate level of consciousness
Patient escort requirement	In principle, an essential factor (absolutely essential factor for diazepam and flunitrazepam)	Not described	Essential	Essential	Essential (and care for the first 24h)	Not described	Essential	Essential
Drinking clear fluids for discharge criteria	Not essential for discharge	Not described	Not described	Not described	Not described	Not described	Not described	Not described
Urination for discharge criteria	Not essential for discharge	Not described	Not described	Not described	Not described	Not described	Not described	Not described
Street fitness	Preferable to evaluate with simple dynamic balance test	Not described	Not described	Not described	Not described	Not described	Not described	Not described
Driving a car	Prohibited on the day of the procedure	Not described	Prohibition for the remainder of the day (consumption of alcohol and operating machinery including kitchen equipment are also prohibited)	Not described	Not described	Not described	Prohibited for up to 24h	Prohibited (period of prohibition not described)

IVS, intravenous sedation; JDSA, Japanese Dental Society of Anesthesiology; ADA, American Dental Association; NDAC, National Dental Advisory Committee; SDCEP, Scottish Dental Clinical Effectiveness Programme; ASA, American Society of Anesthesiologists; ESA, European Society of Anaesthesiology; BMJ, British Medical Journal; BSG, British Society of Gastroenterology; ASGE, American Society for Gastrointestinal Endoscopy

was more rapid than that in cases of midazolam³⁷⁾. The recovery time was 30 minutes after cessation of continuous infusion of propofol³⁷⁾. Therefore, IVS management with propofol is suitable for patients who cannot find an attendant to accompany through the discharge from hospital by any possibility and can not live in hospital²⁾. In these cases, it seems innocuous for the patient to return home by taxi, one or two hours after sufficient clinical recovery²⁾.

3) Is drinking clear fluids an essential criterion for discharge?

Necessity of drinking clear fluid remains a contentious issue for discharge in the JSA guidelines²⁵⁾, while it is not a requirement for discharge according to the JDSA and the ASA guidelines^{2, 27)}. A paper reported that only 14% of the elective drinkers vomited compared to 23% of the mandatory drinker group in the day surgery unit ($P < 0.001$)³⁸⁾. It has also been reported that there was no significant difference in the frequencies of PONV following ambulatory surgery between the mandatory drinking and the nondrinking groups, either in the hospital or after discharge³⁹⁾. Current mainstream belief is that drinking oral fluids is not a requirement for discharge from ambulatory surgical unit.

4) Is voiding an essential criterion for discharge?

Necessity of voiding remains contentious for discharge in the JSA guidelines²⁵⁾, while voiding is not a requirement for discharge in the JDSA and the ASA guidelines^{2, 27)}. Patients at low risk of urinary retention can be discharged without voiding³⁵⁾.

5) Street fitness

Street fitness is a contentious matter. Various ideas have been proposed, that is, equal to home readiness³⁶⁾, between home readiness and complete recovery¹¹⁾, equal to complete recovery²⁵⁾. The judgment of the JSA²⁵⁾ seems to be too severe. The contents of surgery may be added to the judgment.

6) Permitted time for driving a car

The revised intravenous conscious sedation guidelines of the JDSA²⁾ and the Scottish Dental Clinical Effectiveness Programme (SDCEP)²⁹⁾ prohibit driving on the day of the procedure. In contrast, those of the JSA²⁵⁾ and the British Society of Gastroenterology³³⁾ prohibit driving for at least 24 h postoperatively. The American Society of Gastrointestinal Endoscopy³⁴⁾ also prohibits driving; however, the prohibition term is not described. There are no descriptions about driving postoperatively in the other guidelines. Recent anesthetics offer a fast road

to recovery and a high-evidence report confirms the relevance of early recovery of driving function after general anesthesia and sedation⁴⁰, although many foreign reviews still recommend the prohibition of driving for more than 24 h after surgery under general anesthesia or sedation^{41, 42}. There is no good evidence to suggest that driving should be prohibited for more than 24 h postoperatively⁴². Prohibition time is likely to shorten due to the accumulation of future evidences of early recovery⁶. The criterion of the JDSA guideline² seems to be appropriate in the IVS management with propofol or midazolam, based on the present evidence.

Conclusion

1. The main items to be evaluated with regard to recovery after IVS :
Vital signs, cognitive and psychomotor function, mobility and balance function
2. Simplest and most important item to be evaluated for home readiness :
Ability of walking without a subjective and objective stagger
3. IVS management for elderly patients :
Special attention to dynamic balance function and dosage of sedative administrated
4. Comparison among guidelines about recovery criteria after IVS and general anesthesia
 - 1) IVS vs. general anesthesia
Little difference with regard to home readiness and instructions for the preoperative period at home
 - 2) Among IVS guidelines
Little difference except for prohibition duration for driving a car after IVS
(from “not described” to “prohibited for up to 24 h”)

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