Supplemental Data

Provider survey

As described in the main text, the survey was divided into two sections: a screener (questions S01 to S09) and the full questionnaire (questions A1 to A13 and B1 to B5) should the potential candidate not have been deselected from screener responses.

Provider screener questionnaire

S01: Country of practice (pre-filled since survey administrator selected candidates based on geography)

S02_1: How would you describe your main medical practice?

1	Anesthesiologist
2	Cardiologist (cath lab)
3	Critical or intensive care specialist
4	Emergency medicine
6	Gastroenterologist
7	Gynecologists
8	Pediatrician
9	Plastic surgeon
10	Radiologists
11	Sedation or anesthesia nurse
12	Other

S02_2: With what kind of healthcare institutions are you currently affiliated?
Please select all that apply:

1	Physician's Office
2	Private clinic
3	Private hospital
4	General hospital
5	Hospital outpatient clinic
6	University hospital
7	Other, please specify: _____

S03: Are you regularly involved in (or are dedicated to monitoring patient safety during) procedural sedation (moderate or deep) outside of the operating room?

1	Yes	
2	No	

S04: How many years of experience do you have in performing procedural sedation?

1	<2 years
2	2 – 5 years
3	> 5 years

S05: Approximately, how many moderate or deep sedation procedures are you involved in each month?

1	<10
2	10 to 50
3	> 50

S06: Could you please tell us about the duration of the procedural sedations that you are involved in? What percentage of your sedation procedures last:

1	<10 minutes	___%
2	10 – 30 minutes	___%
3	> 30 minutes	___%

S07: Which of these sedation agents are in regular use in your clinical practice?
Please select all that apply.

1	Ketamine
2	Midazolam
3	Fentanyl
4	Propofol
5	Demerol
6	None of these

S08: Could you please inform us, as to which of the following patient monitoring options you use during sedation?
Please select all that apply.

1	Pulse oximetry
2	Electrocardiogram (ECG)
3	Capnography
4	Heart rate
5	Blood pressure
6	Respiratory rate
7	None of the above

S09: Over the last year, which of the following complications potentially related to sedation have you observed?
Please select all that apply

1	Apnea, which requires intervention
2	Bradycardia, change of over 25% from baseline
3	Hypotension, change of over 25% from baseline
4	Oxygen desaturation, mild <90%
5	Oxygen desaturation, severe <80%
6	None of the above

Main Provider Questionnaire

Section A
A02: Are there guidelines in place at your institution for patient monitoring during and after procedural sedation?

1	Yes
2	No

A03: Please indicate which procedural sedation guidelines are in use at your institution:
Please select all that apply:

1	Local hospital / institute guidelines
2	National guidelines
3	International guidelines
4	Professional society guidelines

A04: [removed]

A05: In your team, is a sedation and monitoring plan based upon patient and/or procedural risk factors?

1	No
2	Yes, for both moderate and deep sedation
3	Yes, for moderate sedation only
4	Yes, for deep sedation only

A06: Which characteristics are used to inform your sedation and monitoring?
Please select all that apply:

1	Patient age
2	Patient comorbidities
3	Patient gender
4	Patient BMI
5	Patient weight
6	Patient ASA score
7	Procedure type
8	Procedure duration
9	Sedative used
10	Other, please specify: _____

A07: How many healthcare staff are generally present during the procedural sedation?

1	Nurses = _____ *[min 0, max 10]*
2	Physicians = _____ *[min 0, max 5]*
3	Anesthesiologists = _____ *[min 0, max 5]*
4	Other = _____ *[min 0, max 10]*

A08: From your previous answers, we are aware that you use the following patient monitoring modalities during procedural sedation. Which of these do you consider standard of care?

[tick boxes displayed for all options ticked in screener question, S08]

A08b Do you believe that your standard of care monitoring helps improve:

1	The clinical efficiency of procedural sedation?
1_1	Yes
1_2	No
2	Patient throughput in your procedural unit?
2_1	Yes
2_2	No

A08c: Please provide a brief description and any examples of how standard of care monitoring benefits your practice? [free text]

In the clinical efficiency of procedural sedation:

1	

In the patient throughput in your procedural unit:

1	

A09: As this/these monitoring modality/modalities is/are not standard of care, in which patients or group of patients do you use the monitoring modality? [asked for modalities not indicated to be standard of care]

		Non-selected modality 1	*Non-selected modality 2*	*Non-selected modality 3*
1	Patients stratified as high risk	□	□	□
2	Patients stratified as moderate or high risk	□	□	□
3	Patients with a history of respiratory problems	□	□	□
4	Elderly patients	□	□	□
5	Pediatric patients	□	□	□
6	Patients with obstructive sleep apnea	□	□	□
7	Other, please specify: _____	□	□	□

A10: Which of the following parameters do you use to guide clinical management in sedated patients?

1	SpO$_2$
2	Non-invasive blood pressure
3	ECG
4	End-tidal CO$_2$
5	Respiratory rate
6	Bispectral index
7	Pulse rate
8	Other please specify (maximum one parameter): _____
9	Other please specify (maximum one parameter): _____

A11: Please rank the parameters you selected in terms of how useful they are in guiding clinical management to prevent respiratory events in sedated patients?
Please drag and drop the parameters to the appropriate ranking or use the arrow keys. Most useful parameter =rank 1 to least useful parameter = rank

A12: In the following situations, please indicate to what extent patient monitoring impacts on how you manage the sedated patient.
Please use a scale of 1 to 10 where 1 = no impact and 10 = extremely impactful.

Patient monitoring impacts my decision as to…

1	… **when** to intervene during a sedation
2	… **how** to intervene during a sedation

A13 Please rank the following monitoring characteristics in order of importance to your clinical practice. *Please drag and drop the characteristics to the appropriate ranking or use the arrow keys. Most important =rank 1 to least important = rank 5*

1	Accurate – few false positive events
2	Sensitive – few missed events
3	Timely – provides an early warning of patient compromise
4	Actionable – data displays and alarms relate to clinical events
5	Simple – monitor is intuitive and easy to set up

Section B

As we now understand your clinical practice, we would like to gain insight in to how you intervene when a patient is compromised during procedural sedation. Next you will see seven adverse events as defined by "The World SIVA adverse sedation event reporting tool" [British Journal of Anesthesia. 108(1): 13–20 (2012)]. For each adverse event, we would like you to tell us:

- (1) How common it is in your clinical practice
- (2) Which interventions you would consider using to rectify the situation
- (3) How common use of those interventions is
- (4) The potential outcomes of such an adverse event

B1 For each of the below adverse events, please tick the box if you come across in your clinical practice and if so let us know how common you think it is and whether it ever resulted in an unplanned admission?

	(a) Observed in clinical practice?	**(b) Has this ever resulted in an unplanned admission?**	**(c) During how many procedures does it occur?**
[Adverse events in Table Error**! No text of specified style in document.**-1 *listed in random order]*	□	□	□ < 1 in 100 □ 1-5 in 100 □ 6-10 in 100 □ > 10 in 100

Table Error! No text of specified style in document.-1   **Adverse Events**

Code	Adverse event	Type†
1	Oxygen desaturation of between 75% and 90% for <60 seconds	A
2	Apnea which is not prolonged Airway obstruction	A
3	Airway obstruction	A
4	Failed sedation (the inability to attain suitable conditions to humanely perform the procedure)	A
5	Allergic reaction without anaphylaxis	A
6	Bradycardia (>25% change from baseline)	B
7	Tachycardia (>25% change from baseline)	A
8	Hypotension (>25% change from baseline)	B
9	Hypertension (>25% change from baseline)	A
10	Seizure	A
11	Severe oxygen desaturation, <75%	B
12	Prolonged oxygen desaturation, <90% for >60 seconds	B
13	Prolonged apnea (not airway obstruction), >60 seconds	B
14	Cardiovascular collapse/shock (clinical evidence of inadequate perfusion)	B
15	Cardiac arrest/absent pulse	B

†Adverse events were roughly categorized by type for those less severe or having lesser patient impact (A) and for more severe adverse events (B)

Treatment patterns (questions B2 – B5)

Six of the adverse events listed in Table Error**! No text of specified style in document.**-1 are selected pseudo-randomly. If the respondent has indicated experience with one of the more severe/rare Type B adverse events, these will be preferentially selected, up to a defined quota (Table Error**! No text of specified style in document.**-2). Otherwise, adverse events are selected at random.

B2

[Selected adverse event]
If this particular adverse event occurred in 100 hypothetical patients, which of the following interventions would you be likely to use?

Please distribute 100 hypothetical patients.

The sum of patients can be more than 100 because one patient can get several interventions.

At first please enter number of patients where you would not perform any intervention.
If you would perform one or more interventions in all of your hypothetical patients, please enter 0 for "No intervention performed".

		Please choose intervention you would use	Number of patients
1	No intervention performed		____in 100 patients
	OR		
2	Administration of:		
2_1	Additional sedative(s)	□	____in 100 patients
2_2	Antiemetic/Antihistamine	□	____in 100 patients
2_3	Supplemental oxygen	□	____in 100 patients
2_4	Reversal agents	□	____in 100 patients
2_5	Rapid intravenous fluid	□	____in 100 patients
2_9	Atropine	□	____in 100 patients
3	Perform/Provide:		
3_1	Airway repositioning	□	____in 100 patients
3_2	Tactile stimulation	□	____in 100 patients
3_3	Big valve mask assisted ventilation	□	____in 100 patients
3_4	Laryngeal mask airway	□	____in 100 patients
3_5	Oral / nasal airway	□	____in 100 patients
3_6	Continuous positive airway pressure	□	____in 100 patients
3_7	Chest compression	□	____in 100 patients
3_8	Tracheal intubation	□	____in 100 patients
4	Call the		
4_1	Anesthesiologist	□	____in 100 patients
4_2	Code blue / crash team ~~required~~	□	____in 100 patients

In the "Number of patients" column, entries are restricted to 0 – 100. If a value is entered on the "no intervention" line, then the subsequent rows are bound by the number of patients receiving some intervention. For example, if for an adverse event, a respondent indicates that 40 of the 100 theoretical patients would no receive an intervention, then the remaining rows can only receive values, minimum 0, maximum 100 – no intervention number = 100 – 40 = 60 patients maximum.

B3: In your experience, how many minutes on average do you think it would take to resolve this adverse event?

_____ minutes *[min 0, max 999]*

B3a: In what percentage of cases would this adverse event result in procedures in other patients scheduled to follow being substantially delayed or moved to a different day?

_____ % *[min 0, max 100]*

B4: What percentage of patients with this adverse event would you expect to:

1	Require an inpatient stay: ___% *[min 0% max 100%]*
2	Develop a permanent neurological deficit: ___% *[min 0% max 100%]*
3	Die: ___% *[min 0% max 100%]*
4	Have their procedure terminated (due to this adverse event): ___% *[min 0% max 100%]*

B5: [if appropriate] You indicated that an inpatient stay may be required for some patients. On average, how long would you expect the duration of this stay to be?
___ days *[min 0 max. 60]*

Table Error! No text of specified style in document.**-2**   *Quota for B2-B5*

Code	Answers	Times to be shown, per country
1	Oxygen desaturation of between 75% and 90% for <60 seconds	10
2	Apnea which is not prolonged Airway obstruction	10
3	Airway obstruction	4
4	Failed sedation	4
5	Allergic reaction without anaphylaxis	4
6	Bradycardia (>25% change from baseline)	10
7	Tachycardia (>25% change from baseline)	10
8	Hypotension (>25% change from baseline)	10
9	Hypertension (>25% change from baseline)	10
10	Seizure	4
11	Severe oxygen desaturation, <75%	10
12	Prolonged oxygen desaturation, <90% for >60 seconds	10
13	Prolonged apnea (not airway obstruction), >60 seconds	10
14	Cardiovascular collapse/shock	7
15	Cardiac arrest/absent pulse	7
	TOTAL	**120**

Provider respondent selection criteria

Independent survey administrators (Gfk Switzerland) maintained the list of candidates and sent survey invitations based on geography (Table Error**! No text of specified style in document.**-3). Respondents were therefore not separately queried.

Table Error! No text of specified style in document.**-3**   Geography targets

	S01(1) **France**	S01(2) **Germany**	S01(3) **Italy**	S01(4) **UK**	S01(5) **US**
TOTAL	**N=20**	**N=20**	**N=20**	**N=20**	**N=20**

Screener questions were designed to assess the candidate respondents' relevant expertise and experience. Those not considered to be within the remit of the study were excluded from the remainder of the questionnaire (Table Error**! No text of specified style in document.**-4). Additionally, quotas were set to achieve a variety of respondents, so that all were not of the same medical discipline (such as anesthesiologist). Once the quota for a country had been reached, further respondents in that country with these responses would be excluded (Table Error**! No text of specified style in document.**-5)

Table Error! No text of specified style in document.**-4**   **Screener question deselection criteria (geography independent)**

Query	Exclude from questionnaire if
S02_1	(8) Pediatrician or (12) Other
S03	(2) No (respondent not regularly involved in, or dedicated to monitoring patient safety during procedural sedation)
S04	(1) < 2 years (only respondents with at least 2 years' experience included)
S05	(1) < 10 (only respondents involved in more than 10 procedures per month included)
S06	Duration of procedures. Proportions must add to 100%, but if more than 60% of procedures are (1) < 10 minutes, exclude from questionnaire
S07	(6) None of these (only include respondents using at least one of the listed agents)
S08	(7) None of the above (only include respondents using at least one of the listed monitoring options)
S09	(6) None of the above (only include respondents who have observed at least one of the listed complications potentially related to sedation in the past year)

Table Error! No text of specified style in document.**-5**   Screener question quotas for respondent diversity

Query	Answer option	S01(1) **France**	S01(2) **Germany**	S01(3) **Italy**	S01(4) **UK**	S01(5) **US**
S02_1	(6) Gastroenterologists (11) Nurses (1) Anesthesiologists	- Max n=10 Max n=15	Max n=10 Max n=10 Max n=5	Max n=10 Max n=10 Max n=5	Max n=10 Max n=10 Max n=5	Max n=10 Max n=10 Max n=5
S02_2	if **only** Private clinic	Max n=6	Max n=6	Max n=6	Max n=6	-
S04	(2) 2-5 years	Max n=15	Max n=15	Max n=15	Max n=15	Max n=15
S07	if only Midazolam used	Max n=10	Max n=10	Max n=10	Max n=10	Max n=10
	If only Propofol used	Max n=10	Max n=10	Max n=10	Max n=10	Max n=10
	If neither Propofol or Midazolam	Max=4	Max=4	Max=4	Max=4	Max=4
S08	Capnography* not selected	Max n=12	Max n=12	Max n=12	Max n=12	Max n=12
S09	AEs observed do not include: Hypotension, change of over 25% from baseline, oxygen desaturation, severe <80% (Type B[†] complications)	Max n=10	Max n=10	Max n=10	Max n=10	-Max n=10

[†]Adverse events were roughly categorized by type for those less severe or having lesser patient impact (A) and for more severe adverse events (B)

*To obtain a sampling of respondents with and without experience of capnography, a limit was set on the number of respondents taken who do not use the method. Ultimately, no respondents were excluded on the bases of capnography use and reported results are thus representative of treatment patterns

Respondent exclusion

A total of 70 respondents were excluded from completing the main questionnaire (Table Error**! No text of specified style in document.**-6). By country, these were: France (13), Germany (2), Italy (8), UK (22) and US (25).

Table Error! No text of specified style in document.**-6**   **Excluded respondents and reasons for screening**

Geography	Reason	N
France	Medical specialty described as "other"	8
	Fewer than 10 procedures per month	5
Germany	60% or more of procedures last < 10 minutes (80%, 80%)	2
Italy	Medical specialty described as "other"	8
UK	Medical specialty described as "other"	14
	Not regularly involved in, or dedicated to monitoring patient safety during procedural sedation	3
	60% or more of procedures last < 10 minutes (60%, 65%, 90%)	3
	Uses none of the listed monitoring methods	1
	Has not seen any of the listed adverse events in the past year	1
US	Medical specialty "pediatric"	1
	Medical specialty described as "other"	12
	Not regularly involved in, or dedicated to monitoring patient safety during procedural sedation	3
	Less than 2 years of experience with procedural sedation	4
	Fewer than 10 procedures per month	1
	60% or more of procedures last < 10 minutes (60%, 75%, 98%, 100%)	4
Global	**Total**	70

Payer survey

As described in the main text, the payer survey was similarly divided into two sections: a screener (questions S01 to S07) and the full questionnaire (questions A1 to A7 and B1 to B8) should the potential candidate not have been deselected based screener responses. Specifically for the payer questionnaire, in every instance the respondent is asked about costs, he or she is also provided the guidance to enter 0 (zero) if it is believed there is no direct cost to the institution, that if a value is not known to select "don't know", and that "you are not expected to know the exact costs for all items. An informed estimate is acceptable."

Payer screener questionnaire

S01: Country of practice (pre-filled since survey administrator selected candidates based on geography)

S02: In what kind of institution do you work?

1	Clinic
2	Hospital
3	Federally funded healthcare insurer
4	Medical office
5	National health service
6	Other medical service
7	Private healthcare insurer
8	State health insurer
9	Other

S03 Does your institution undertake or cover moderate and/or deep procedural sedation?

1	Yes	
2	No	

S04 Which of the following best describes your current role?

1	Chief financial officer
2	Department administrator
3	Department head
4	Director
5	Insurance provider, broker or analyst
6	Manager
7	Medical administrator
8	Pharmacist
9	Nurse manager
10	Procurement
11	Quality manager
12	Other

S05 Which of the following features does your work include?
Please select all that apply.

		YES	NO
1	Budget management	□	□
2	Contracting	□	□
3	Pricing healthcare resources	□	□
4	Purchasing of medical devices/products/supplies	□	□
5	Resource allocation	□	□

S06 Do you have recent and accurate knowledge of the following topics?
Please select all that apply.

		YES	NO
1	Drug costs	□	□
2	Medical device costs	□	□
3	Operating room expenses	□	□
4	Staff costs	□	□

S07 How many years of experience do you have in healthcare finance?

1	< 2 years
2	2 – 5 years
3	> 5 years

Main Provider Questionnaire

SECTION A

A01 In total, how many moderate to deep sedations are performed or covered by your institution each year?

1	<1,000
2	1,000 to 10,000
3	>10,000

A02 What percentage of moderate to deep sedations provided or covered by your institution are non-complicated (i.e. no adverse events are reported)?

_____% [min 0, max 100]

A03 What is the approximate total average cost to your institution of a single, non-complicated procedural sedation?

1	[local currency symbol] _____ [min 0, no maximum]
2	Sedation-related complications during the procedure would increase this cost* by approximately ___% on average [min 0, max 1,000]

* Please consider administration, management, quality, legal and transport services; e.g. comprehensive or fully loaded costs

A04 If a patient required unplanned admission to hospital, this would cost:
If you do not know the answer to a question, please tick "Don`t know"

		Cost of unplanned admission to hospital in [currency]	Don't know
1	per day for standard ward		□
2	per day for intensive care unit		□

A05 Assuming no fault for the institution and no legal action, how much would a patient death related to a sedation-related adverse event during procedural sedation cost?

	Cost of a patient death related to a sedation-related adverse event during procedural sedation	Don`t know
1	[currency] ___ [min 0, no maximum]	□

A06: Which healthcare providers are covered for administering moderate to deep procedural sedation?
Please select all that apply:

1	Anesthesiologist
2	Anesthesiology nurse
3	Non-anesthesiologist physician trained in sedation
4	Non-anesthesiology nurse trained in sedation

A07: Please indicate the approximate cost per hour for the following healthcare providers that may be present in the procedural sedation room.
(options for value entry are only shown according to providers selected in question A06)

		Cost per hour in [currency]:	Don't know
1	Anesthesiologist		□
2	Anesthesiology nurse		□
3	Non-anesthesiologist physician trained in sedation		□
4	Non-anesthesiology nurse trained in sedation		□
5	Attending physician		□
6	Attending nurse		□

SECTION B
You will now see this list, and we would like you to tell us how much each intervention is likely to cost. Here, the cost includes purchase and administration in the sedation room but NOT time required for treatment nor subsequent care (such as admission to hospital).

B1 Please provide the approximate direct cost at your institution for purchase and administration of the following items, assuming it is used to treat an adverse event during procedural sedation.

Approximate direct cost in [currency] for purchase and administration of:

		Cost [currency]:	Don't know
1	Additional sedative		□
2	Antiemetic/Antihistamine		□
3	Supplemental oxygen		□
4	Reversal agents		□
5	Rapid intravenous fluids		□
6	Anticonvulsant		□
7	Neuromuscular block		□
8	Pressor/Epinephrine		□
9	Atropine		□

Range for all rows 1-9: [min 0, max 1,000]

B2 To test a patient's responsiveness, tactile stimulation may be used. Please indicate its approximate direct cost to your institution:

	Approximate direct cost for tactile stimulation	Don`t know
1	[currency] _____ [min 0, max 1,000]	□

B3: To maintain the patency of a patient's airway, the following interventions may be used. Please indicate the approximate direct cost to your institution of:

		Approximate direct cost in [currency] for…	Don`t know
1	Airway repositioning	*[min 0, max 1,000]*	□
2	Bag valve mask assisted ventilation	*[min 0, max 10,000]*	□
3	Laryngeal mask airway	*[min 0, max 10,000]*	□
4	Oral/nasal airway	*[min 0, max 10,000]*	□
5	Continuous positive airway pressure	*[min 0, max 10,000]*	□
6	Tracheal intubation	*[min 0, max 10,000]*	□

B4: To resuscitate a patient, the following interventions may be used. Please indicate the approximate direct cost to your institution of:

		Approximate direct cost in [currency] of…	Don`t know
1	Chest compressions	*Range [min 0, max 15,000]*	□
2	Code blue or crash team call	*Range [min 0, max 15,000]*	□

B5: In previous questions, you provide the approximate direct cost of interventions. The provision and maintenance of these interventions also incurs costs for your institution in terms of administrative staff time, quality control, risk management, legal, procurement, and delivery.
The comprehensive or fully loaded cost that is often substantially higher than the direct cost.
Which of the following options do you believe is most accurate, fully loaded costs are generally…

1	Less than double direct costs
2	2x higher than direct costs
3	3x higher than direct costs
4	4x higher than direct costs
5	5x higher than direct costs
6	More than 5 time higher than direct costs

B6: Sedation-related adverse events can lead to serious patient harm, such as permanent neurological deficit. In what range would you expect the total legal costs and potential damages to fall?

		[currency] Minimum	[currency] Maximum	Don't know
1	Expected range between …			□

B7: The occurrence of adverse events can result in subsequent scheduled procedures being delayed or cancelled and rearranged for another day. What cost does this impose on your institution?

		Approximate costs in [currency] of…	Don`t know
1	Delay	*[min 0, max 10,000]*	□
2	Cancellation	*[min 0, max 10,000]*	□
3	Procedure rearranged	*[min 0, max 10,000]*	□

Payer respondent selection criteria

Independent survey administrators (Gfk Switzerland) maintained the list of candidates and sent survey invitations based on geography (Table Error**! No text of specified style in document.**-7). Respondents were therefore not separately queried.

Table Error! No text of specified style in document.**-7   Payer geography targets**

	S01(1) France	S01(2) Germany	S01(3) Italy	S01(4) UK	S01(5) US
TOTAL	**N=5**	**N=5**	**N=5**	**N=5**	**N=5**

Screener questions were designed to assess the candidate respondents' relevant expertise and experience. Those not considered to be within the remit of the study were excluded from the remainder of the questionnaire (Table Error**! No text of specified style in document.**-8).

Table Error! No text of specified style in document.-8   Screener question deselection criteria (geography dependent and independent)

Query	Exclude from questionnaire if	
S02	For all geographies	(9) Other
	For US respondents only	(3) Federally-funded healthcare insurer
		(5) National health service
		(7) Private healthcare insurer
S03	(2) No (respondent institution does not undertake or cover procedural sedation)	
S04	For all geographies	(12) Other
	For US respondents only	(5) Insurance provider, broker, or analyst
S05	If more than three items from list of budget work responsibilities are selected 'No"	
S06	If more than two items from list of costs (drugs, device, operating room, staff) are selected 'No' for recent/accurate knowledge	
S07	(1) <2 years of experience in healthcare finance	