Target Controlled Infusions for Moderate Sedation in Dentistry

1. History and Development of Target Controlled Infusion Sedation for Dentistry in New Zealand.
   Dr. David Chrisp – Oral Surgeon

2. BIS Guided TCI Procedural Sedation. Refreshing the Blueprint for Procedural Sedation.
   Dr. Don Macalister – Oral Surgeon

   Dr. Don Macalister – Oral Surgeon

4. Target Controlled Infusion Sedation in General Dentistry.
   Dr. Graham Shaw – General Dentist
History and Development of Target-Controlled Infusion Sedation for Dentistry in New Zealand
Dr. David Chrisp – Oral Surgeon
Tauranga, New Zealand

Dr. Don Macalister (Oral Surgeon, Auckland, New Zealand) initiated Target-Controlled Infusion (TCI) sedation for dental procedures in New Zealand in 2003 on the recommendation by a senior anesthetic colleague. Dr. Macalister had extensive procedural sedation experience for oral surgery and was involved in a teaching environment with the anesthetist who had developed an appreciation for his sedation skills and knowledge.

Dr. Macalister developed the TCI sedation technique over the course of one year in his private practice and then mentored me as I had a similar background and scope of work.

The initial TCI pump was the Diprifusor (AstraZeneca) using a single-use preloaded syringe of propofol (sedative/hypnotic) and driven by the Marsh plasma target model. The next evolution was in 2006 with the switch to the Alaris PK (CareFusion) pump series running the Schnider effect-site target or brain level model for propofol.

Our initial experience with propofol-only sedation occasionally produced poor operating conditions, commonly due to patient euphoria at the lower doses we were comfortable using. We tried with some success to modulate this with the addition of small doses of midazolam (sedative) and on occasion fentanyl (opioid).

Dr. Macalister then made contact with Dr. Charles Minto, a medical anesthetist and developer of the Minto model for effect-site TCI using remifentanil (ultra-short acting opioid). We readily adopted a second pump to run remifentanil simultaneously with propofol and take advantage of the synergism and improved quality of the sedation, while at the same time reducing overall dosages of both drugs. This dramatically improved both the fine control of the sedation and the operating conditions.

BIS\(^1\) or Bispectral Index monitoring was added to guide the sedation; this was in addition to the usual monitoring of NIBP, pulse oximetry, sidestream capnography with supplemental oxygen via nasal prongs, and ECG for patients over 60 or with a cardiac history.

We both function as operator/procedural sedationists and are assisted by two TCI trained registered nurses, one of which has the sole duty of patient monitoring and assists with the sedation.
To date we have chosen not to actively teach the technique but have mentored a small carefully selected group of similarly experienced colleagues and now have a shared experience in excess of 40,000 cases over the past decade.

BIS-guided propofol/remifentanil sedation has become our standard technique for rooms-based procedural sedation during various oral surgery procedures. We use it on a very wide range of patients including: ASA 1, 2 and select ASA 3 patients, generally no restrictions on upper age limit and a lower age limit of venipuncture acceptance only.

TCI’s ability to produce very stable brain concentrations enables rapid, accurate and precise titration to the desired effect. The stability of the effect site concentration and the rapid offset of the agents gives the technique its safety, efficiency and versatility.

We target light to moderate sedation whereby patients will respond to verbal stimulation alone or verbal with light tactile stimulation and can predictably achieve amnesia as required. We do not use general anesthesia for any of our routine private oral surgery patients.

The most common problem encountered is transient respiratory depression, which is usually readily resolved by simply asking patients to take a deep breath or by improving the airway with the patient’s assistance. If necessary, persistent or slight respiratory depression can readily be alleviated by simply choosing a lower target for one or both drugs and the effect is seen rapidly. In comparison to traditional midazolam/fentanyl sedation our patients appear to be less sedated but are still profoundly amnesic. The recovery is superior and rapid.

We believe we are now practicing with a more controlled and therefore safer technique which is readily adaptable for the increasingly wide range of patients we need to sedate.

The New Zealand Dental Council regulations are regularly updated to reflect contemporary practice together with changes in technology. The New Zealand Society for Sedation in Dentistry has worked closely with the Dental Council to assist them during the development of dental sedation regulation, and we are fortunate to have regulators that recognize our work as contributing to safe sedation practices.

David Chrisp BDS, FRACDS, FFDRCS

1 BIS is a form of brain function monitoring involving the use of a processed electroencephalogram – pEEG that assists in monitoring of patient awareness during TCI-PSA (procedural sedation and analgesia), and TCI-TIVA (total intravenous anesthesia).
Intravenous sedation forms an integral and important part of the sedation continuum. Target-Controlled Infusion (TCI) pump technology provides control and stability to position a patient where desired on that continuum for the duration of the procedure. I accept that many still believe sedation can be challenging, particularly in paediatric cases, and can often end up as deep sedation when using the midazolam/fentanyl blueprint. It is time to refresh that blueprint; an option being BIS-guided TCI utilizing propofol/remifentanil which can achieve a level of safety and stability presently unattainable with traditional manual intermittent bolus drug delivery.

The goal of i.v. sedation is to provide patient comfort while minimizing their anxiety, fear, memory, and pain, thus allowing patients to tolerate unpleasant dental procedures. To safely achieve this effect, we need sufficient therapeutic concentrations of the sedative and analgesic drugs at the patient's brain-receptor sites.

Optimal sedation is achieved by maintaining a steady-state concentration of drug at these receptors for the duration of the procedure. TCI provides that stability, whereas keeping a steady state of suitable sedation by hand-administered intermittent bolus technique is difficult. For example, when administering midazolam, the time to peak effect (TTPE) is now estimated to be 10 - 13 minutes and this explains the potential dangers of dose-stacking during titration.

Brief History of TCI Development
Historically, the search to produce steady-state drug concentrations, clinicians turned to manual syringe-driver infusion pump technology. This required the clinician to administer a bolus of the drug, then followed by a set rate constant infusion often based on mg/kg/hour formula.

The problem is that the relationship between what is set as an infusion rate and the brain concentration is changing every second, and a manual syringe-driver cannot account for that. TCI uses a syringe driver controlled by a pharmacokinetic algorithm for the drug being delivered to produce an accurate and stable brain concentration. TCI achieves this steady state by reducing the time-dependent variability of the infusion by continuously updating the infusion rate to consider the drug's characteristic of accumulating in the body.

TCI is described as using a BET scheme. That is referring to BOLUS, ELIMINATION and TRANSFER. The BET principle is used to approximate a constant plasma level of drug (however, the algorithms in pharmacokinetic pumps like TCI, use more precise analytical solutions).
TCI pharmacokinetic software model calculates the initial bolus considering the patient's covariates that have been programmed into the pump, such as age, height, weight and gender. The pump's pharmacokinetic modelling enables it to calculate continuously the drug lost from elimination or metabolism. The model also continuously calculates the transfer and distribution of the drug between the peripheral compartments.

Pharmacokinetic behaviour can often be described by a three-compartment open model, with a redistribution phase followed by the elimination phase. By giving values to the volumes of these compartments and the rate constants for the exchange of drug between compartments, and the drug's elimination, we can construct a formula, which allows us to calculate the concentrations obtained over time. Once we know the concentration of the drug to produce the sedation effect, we need to establish the dose of the drug required to obtain that concentration.

TCI is an infusion controlled in such a way as to achieve a user-defined drug concentration in a body compartment or tissue of interest. You can think of TCI as using pharmacokinetics in reverse. You choose the desired concentration on the receptors or effect site, and the computer calculates the administration rate using the pharmacokinetic model for the drug. TCI is the logical solution to finding a safer more accurate method of administering drugs of sedation.

TCI Pharmacokinetic Modelling
The drug models or algorithms supplied with TCI pumps are the Minto model (plasma and effect-site) for remifentanil, the Schnider model (effect-site) for propofol, and the Marsh model (plasma site) for propofol. For this article, the models of interest are the Minto and Schnider effect-site for remifentanil and propofol respectively.

With effect-site targeting, the TCI system manipulates the plasma concentration to achieve the effect-site concentration as rapidly as possible. When the effect-site target concentration is increased, the TCI system briefly increases the plasma concentration to an optimal level above the target effect-site concentration before temporarily stopping the infusion to allow the plasma concentration to decrease to the level of the chosen target effect-site concentration. The systems use mathematical formulae to determine the magnitude of the optimal plasma concentration overshoot. That is the peak plasma concentration that generates a gradient sufficient to cause the most rapid increase in effect-site concentration but without overshooting the effect-site concentration above your target.

If the target effect-site concentration is reduced the system stops the infusion, allowing the plasma concentrations to fall causing a concentration gradient out of the effect-site, until the estimated effect-site concentration has dropped to the new target. At this stage, the plasma concentration will be less than the effect-site concentration, and so the system to maintain the target administers a small bolus to increase the plasma concentration to match the new target concentration.
TCI pumps maintain three superimposed infusions, one at a constant rate to replace drug elimination and two rapidly decreasing infusions to match drug removed from the central compartment to other peripheral compartments of distribution. So often people attempt to dismiss TCI by inferring that the algorithm can't be trusted as there is no blood sampling.

The TCI algorithm gets you to within 20% of the actual blood concentrations, but that's acceptable. It is very like the vaporizer used with the volatile agents of general anaesthesia as they are of similar accuracy. TCI gives you stable plasma and effect site concentrations, even if they are not 100% accurate as they are estimations it doesn't matter. Titration to effect with steady concentrations is more accurate as stable concentrations are easier to titrate. With a more stable concentration you can better assess dose response. If the level of sedation is suitable, you can leave it and the concentration will remain stable. If you wish to adjust effect up or down, then it is easily and rapidly done.

TCI pumps consist of a user interface, a microprocessor and an infusion pump. The microprocessor controls the graphic interface and enables the pharmacokinetic model for the drug on that pump. It allows the input of patient data and instruction by the user. It performs the necessary mathematical calculations, to control and monitor the infusion device.

The user programs the pump with the patient's data, being age weight, height and gender. The user enters a target drug concentration that they wish the pump to deliver at the effect site.

With TCI, the drug is now being administered by a device that has modelled at least 50% of that patient's variability into its drug delivery. It is like a very smart syringe.

Brain Function Monitoring to Guide TCI Titration.

A Bispectral Index monitor is used to guide the sedation process. It is a neurophysiologic device that reads the electroencephalogram (EEG) from the patient's frontal cortex and assigns a numerical value that broadly represents the depth of hypnosis for that patient.

BIS provides an objective way to measure a patient's level of hypnosis. BIS also provides information on the pharmacokinetic variability of the individual as well as the patient's drug tolerance and their response to stimulation during a procedure.

The system consists of a sensor which attaches to the forehead of the patient and detects the EEG coming from the frontal cortex. The BIS algorithm processes the raw EEG data derived from the sensor array by comparing it with its EEG database.

The index is a number between 100 and zero, where 100 indicates an alert and awake patient and zero would show a lack of EEG activity.

BIS is not an indicator of the level of consciousness. In a very general sense BIS levels for procedural sedation lie in the range of 65 to 85. BIS can be variable, and you cannot count on it. Some agents, such as remifentanil are poorly represented in the BIS.

Experience with BIS clarifies its shortcomings relating to such factors as neurologic disorders, particular medication, and recreational drug use. BIS monitoring is used as another parameter to aid titration.
TCI Drug Agents – Propofol and Remifentanil
The drugs used in BIS-guided TCI procedural sedation are propofol and remifentanil. Propofol is the drug that most closely attains the requirements of what an ideal sedative drug should be. It has a rapid onset and a dose-related sedative effect with anxiolysis and amnesia. It is antiemetic, has a rapid offset and provides a fast induction with an easy alteration to sedative level and a very crisp slightly euphoric recovery. It provides no analgesia and can cause a mean fall in arterial BP, but at the levels of administration in sedation, the incidence of this change is low.
Remifentanil is the adjuvant of choice for the hypnotic propofol and acts as a hypnotic sparing agent. Its synergism and different sedative properties improve the quality of the sedation. It too has a rapid onset which aids the ease of its titration by this method. It provides very effective dose-dependent analgesia and has an extremely rapid termination of effect independent of the time of its infusion rendering the need for an antagonist unnecessary.

TCI sedation commences with the pumps being programmed with the patient's covariates plus an initial effect site concentration target for each drug. An effect site target concentration on start-up of 1 microgram per ml for propofol and 1 nanogram per ml for remifentanil.
The pumps can be started concurrently or separately after observing peak effect for the individual drug. The patient is observed as the initial boluses have an effect within 20-30 seconds.
Guided by voice communication and BIS we titrate towards a desired level of sedation. Titration is achieved by selecting a higher (or lower) effect site target concentration and then waiting until the plasma level and the effect site level have equilibrated before making any further adjustments.
Once the appropriate level of sedation is reached, the pumps will then maintain that target concentration at the effect site for the duration of the procedure so producing a steady, stable, safe, predictable sedation that you can adjust on demand.

With the use of propofol and remifentanil we are targeting a percentage occupancy of different receptors. Propofol targets the GABA receptors giving us sedation, amnesia, and euphoria, while for remifentanil it is the Mu opioid receptors giving us analgesia, euphoria and sedation.

The exact ideal ratio varies from patient to patient and from procedure to procedure. In all sedation, hypoxemia is the potential mechanism of injury. Therefore, we have increased emphasis on monitoring ventilation versus saturation. Accordingly, the requirement is for accurate, real-time monitoring for the possibility of an evolving hypercarbia.
Sidestream capnography and supplemental oxygen are routinely employed. Capnography provides early detection of respiratory change by monitoring capnogram waveform, and exhaled CO2. Essential as pulse oximetry is, it is an insensitive and late phase monitor but does complement the capnography. Capnography provides a continuous real-time measure of respiratory rate and CO2 exchange and provides early detection of adverse effects often associated with procedural sedation.
Other monitoring includes NIBP, BPM, RR, and ECG if indicated.

In Conclusion
TCI gives one the control to determine with some certainty just where on the continuum of sedation you want to be. TCI produces stable drug-brain concentrations while providing the ability to manipulate these concentrations rapidly, safely, and accurately in a way that intermittent bolus techniques or infusions just can't.

The reality is that TCI uses more suitable drugs and provides a more logical and accurate method of administration. With this stable, steady drug concentration, titration to effect is more accurate, thus resulting in an overall safer sedation, higher patient satisfaction, and improved patient care.

TCI enables safety, stability, control, and accuracy as well as predictability, flexibility with a faster recovery and earlier home-readiness.

Don Macalister BDS (Otago), FDS, RCS (Eng)

*BIS™ (Bispectral Index monitor) is a form of brain function monitoring involving the use of a processed electroencephalogram – pEEG that assists in monitoring of patient awareness during TCI-PS (Target-Controlled Infusion-Procedural Sedation).
As a clinician, what I want from sedation first and foremost is safety and stability. That is, the stability of physiology, and stability of operating conditions to enable surgery to be undertaken safely and comfortably.

I need a technique that can deliver operating conditions akin to the stability of general anaesthesia (GA) yet produce a responsive, compliant patient during treatment coupled with a rapid, and pleasant recovery. The rapidity of recovery is a significant factor in patient safety.

I want a technique capable of accommodating a wide range of different patient covariates. These include body type, age, height, weight or even medical complexity or cross tolerances from other agents, and I need that for operative times that are either very short, or can accommodate unforeseen circumstances and be extended, yet still with a rapid recovery independent of the length of sedation.

The following TCI sedation attributes are essential in my oral surgery practice:

- Accurate titration with fine control over both drugs, especially when balancing the sedative and analgesic effects together
- Provide profound analgesia when necessary, or use the synergistic action of remifentanil as a sedative sparing action when reducing unwanted propofol side-effects such as haemodynamic instability
- My ability as a sedationist to alter the quality of the sedation by titrating changes in drug levels to meet patient needs or surgical stimulus
- Drug properties that allow profound amnesia, euphoric and anti-emetic qualities
- A rapid, pleasant recovery and early home-readiness for the patient and escort
- Titration enhances safety by allowing quick adjustments to meet individual patient variability

BIS Guided TCI with propofol and remifentanil procedural sedation delivers on all of the above.

Manual intermittent bolus techniques, as currently used using midazolam and fentanyl, cannot offer anywhere near the same levels of control, safety, accuracy and predictability.

TCI is made possible by utilising pharmacokinetic algorithms embedded in the pump administering the drug, the accuracy of effect is enabled by the swift onset and offset of
propofol and remifentanil.

In specialist oral surgical practice the advantage is that we have the ability to produce very high-quality sedation for a short case or a longer more demanding case that would typically be carried out under general anaesthesia, but with TCI we have the ability to extend time as required yet still recover the patient from the chair as the recovery is so crisp and rapid.

TCI improves patient safety principally due to the high level of control one has over the depth and stability of the sedation.
In manual intermittent sedation with long-acting agents, there is no ability to withhold drug effect other than supporting physiology for an indeterminate time until the effect levels have dropped or the use of antagonists that render continued treatment impossible.
There is no real provision for plan B at all.

With TCI we can stop, restart, wait, or continue treatment, all with excellent control of titration, more rapidly than the use of antagonists would allow and still maintain treatment options.
Studies on the safety of manual midazolam/fentanyl sedation have used the frequency of intervention with antagonists as an indicator of inferior process and less safe practice. No one would oppose the use of antagonists to regain the safety of patient management, but it does speak to the inability of present systems to provide adequate and sustained control of depth of sedation and just how difficult that is to achieve by manual technique.

There is no antagonist for propofol, and there does not need to be as its pharmacokinetics are so much more suited to accurate sedation that recovery is seen faster than the delivery of an antagonist could deliver. Remifentanil with a half-life of 3.5 minutes defeats using a narcotic antagonist as its removal of effect is stellar.

The reliance and insistence on having antagonists for these agents of TCI is mired in the past as a once-needed provision to enable the use of less appropriate drugs being administered manually and crudely.

The safer smarter way to administer propofol is by TCI. Manual intermittent bolus technique is inappropriate and capable of the same difficulties experienced with the many varied midazolam and fentanyl protocols.

The technique of BIS guided TCI with propofol, and remifentanil is solely focused on using the most suitable drugs for sedation and administering them by the safest and most suitable method of delivery.

The requirement for this is a trained team, in my opinion consisting of the operator, an assistant and a suitably trained third person dedicated to monitoring the patient and communicating with the other members of the team.
Management of the sedation is best described and supported as using the RAVOC ™
approach as promoted by Safe Sedation Training (SST)™ online programme.
(www.safesedationtraining.com)

R.A.V.O.C. is an acronym meaning:

R – Responsive. Does the patient respond to loud voice or light touch? A – Airway. Is the airway patent, partially patent, or full obstructed?
V – Ventilation. Is the patient breathing normally (respiration rate and depth) or not (hypoventilation, hyperventilation or apnoea)?
O – Oxygenation. Is the patient maintaining adequate blood-oxygen levels or not (hypoxemia)?
C – Circulation. Does the patient have adequate heart rate and blood pressure to maintain perfusion?
Target Controlled Infusion Sedation in General Dentistry

Dr. Graham Shaw - Dentist
Auckland, New Zealand

I have been doing intravenous sedation as a general dentist in New Zealand since 1986. I started by administering Midazolam and Pentazocine, and then later Midazolam and Fentanyl. My colleague, Dr. Don Macalister (Oral Surgeon), introduced and mentored me in the use of TCI as an alternative technique for sedation. I have experienced first-hand how TCI technology has improved both the effectiveness of sedation and patient safety.

Using TCI syringe pumps to administer the drugs allows me to adjust the drug concentrations to an optimum sedation level. This avoids the roller coaster of high and low levels of drugs that often occurs with a manual intermittent bolus administration. Adding brain function monitoring (BIS) enables me to have an objective digital reading, and EEG waveform of the level of hypnosis achieved for the patient. BIS is like having a ‘window to the brain’.

TCI pumps use pharmacokinetic algorithms specific for each drug they administer, and enable adjusting for patient variables of age, gender, weight, and height. I select the ‘effect site’ target concentration I feel appropriate for the patient and the dental procedure. The algorithm calculates the initial bolus, and then controls the amount of drug infused throughout the procedure to maintain the chosen level of drug available at the effect site, thus precisely controlling the sedation. TCI pumps differ significantly from normal infusion pumps. The TCI pump is always adjusting the flow rate according to the pharmacokinetic algorithm, maintaining the correct amount of drug concentration at the effect-site or brain receptors.

This technique is still titration to effect, only slightly different, and due to the very stable brain concentrations titration is more accurate and I can increase or decrease the amount of drug necessary by adjusting the target concentration and the pump then takes over. Once the chosen level is determined, this allows for stable and steady sedation throughout the procedure.

I use two separate pumps, one dedicated for Propofol and the other for Remifentanil. Both have their own unique algorithms: Schnider for Propofol, and Minto for Remifentanil. Due to the rapid onset and offset of these drugs, changes to the level of sedation are apparent very quickly, usually within one minute or less. The synergism of these two drugs is similar to that of Midazolam and Fentanyl. Using Propofol alone is sometimes all that is needed, as with Midazolam on its own, but the sedation is much more predictable, reliable and of a better quality when using the two drugs combined. The recovery time at the end of a session is also very fast. At the end of a short recovery period it’s common for the patient to demonstrate a very rapid, crisp recovery, put their shoes on, and be ready to walk off normally. They are also very lucid, and often gently euphoric.

My colleagues and I have experienced a common reaction from Anaesthetists when we tell them what we are using. Unless they have seen the way we use the drugs for sedation and
what we achieve with this technique, they tend to associate the drugs as causing General Anaesthesia or deep sedation, as that is what they associate the use of these drugs as producing. Understandably these drugs represent a different picture to them as they have usually never used them the way we do. Because of this, we experience some push back that we shouldn’t be using these drugs and that they are dangerous. Fortunately we have found that if they are prepared to listen and process that what we are doing is not what they do, they have become supportive in New Zealand. Those with open minds to new knowledge are usually then enlightened as they didn’t realise what else can be achieved with TCI technology using these agents for moderate levels of sedation.

I guess it is just human nature to jump to incorrect assumptions before we may have all the relevant information.

As a poor attempted comparison I feel it’s a bit like fluoride. It is highly toxic at high levels, but extremely therapeutic at 1-2ppm. The anti-fluoridationists base their objections on the high dose evidence.

My goal is to provide safe light to moderate sedation only. I find I have no need for deep sedation, and I find this technique so much safer as I can stay within the light to moderate parameters with far more control. On the occasion if I do find I have slipped a little deeper than I want, I simply stop the TCI pumps, and wait while maintaining airway patency as the drugs drop off within a minute or two, and then re-establish the sedation at a lower chosen effect site concentration before continuing.

I have never had to call for assistance or use bag mask on patients while using this technique.

Remifentanil has excellent analgesia properties, patients rarely notice palatal injections. On its own Remifentanil produces a sedative effect but no amnesia. It has less cardiovascular effect than Propofol, which can cause hypotension. Sometimes I will titrate in very little Propofol and use a higher dose of remifentanil to avoid these issues for higher risk patients. The downside is that they may remember some of the procedure, but they still experience a very pleasant sedated state.

Propofol provides more predictable amnesia at concentration levels 1.0 µg ml⁻¹ and higher.

The TCI pumps display a numerical number in the display indicating current drug concentrations at the patient’s effect-site or receptors. This is displayed as Ce. I commonly administer a 1.0:1.0 (Propofol:Remifentanil) concentration ratio, and sometimes a bit less, say 1.0:0.8, or 0.8:0.8 towards the end of a long session. My anaesthetist colleague describes this this as “homeopathic dosing”. Other times I do use higher concentrations depending on the procedure, according to the individual patient’s tolerance, or anxiety, say 2.4:1.6. It’s easy to move the levels of each drug up and down until the desired effect is found, and then stay stable at those levels for the necessary procedure. I find with the longer restorative appointments that the patients progressively need less drug as the session goes on. Over 3-5 hours the last few hours often run at very low doses.

For monitoring I use NIBP, pulse oximetry, and side stream capnography. Supplemental oxygen is administered routinely between 2-4 L/minute using an oxygen concentrator.

For those of you who haven’t used side stream capnography, detection of respiratory depression or obstruction occurs 1 – 2 minutes (or longer) ahead of pulse oximetry changes. This allows early intervention to occur well before oxygen saturation begins to drop.

I manage many anxious patients, and the euphoria and disconnect that is produced by these drugs allows me to maintain much lighter sedation levels with much less respiratory depression.
There are no tears or sobbing which was often an unpleasant side-effect of Midazolam sedation.
Gag reflexes are inhibited.
Some patients attend and have sedation every 6 months for routine hygiene visits.
Short visits are much easier due to the rapid offset and a safe fast recovery.
It is superb for orthodontic extractions.
Special needs patients become much easier to manage.

TCI has multiple advantages. Due to the rapid onset and offset, I can have the patient be ‘into or out of the zone’ very quickly, and due to the rapid offset, they can almost be back to normal within a few minutes too.

If the patient needs a bathroom break, I can stop the drug administration, and disconnect the intravenous line. After a few minutes when the patient is ready, they can visit the bathroom (not locking the door and with a staff member standing guard). I can then easily reconnect them and they can be sedated back to the required level. These short breaks during long appointments also allow me the opportunity to obtain some refreshment though obviously two staff are always present with and monitoring the patient.

As a CEREC user, I can reduce the Ce_target (effect site target) when I am doing the design/mill/furnace stages and then adjust quickly back to previous levels of sedation once we recommence clinically. This allows me to sedate patients for a lot longer. I commonly will do treatment sessions of 5 – 6 hours. I could go longer, but personally 5 – 6 hours is enough for one session! Note that ICU’s run Propofol induced coma’s for weeks at a time. (I don’t put them in a coma).

In the event TCI sedation becomes deeper than desired, I can simply stop the pumps, and wait a minute or so for the patient to become lighter, then reset at a lower effect site target. As the drug concentration falls, the pump algorithm calculates and displays the lower effect-site level on the screen, so I am able to reset the target concentration to this lower level. This probably sounds complicated, but it is very simple to do once you’re familiar with the pumps and the way the algorithm works.

My staff are well qualified Dental Assistants trained in the same New Zealand IV sedation course that dentists take, including the advanced resuscitation training program (2 yearly cycle). We sedate as a dedicated team of three. We have done more than 1000 cases with this technique.

My Oral Surgeon colleagues have successfully administered > 40,000 cases collectively.

In conclusion, TCI Sedation gives superior control. The patient is safer, more stable, easier to keep at the desired sedation level, and recovers faster with less cognitive impairment than hand bolus administration of other drugs.

Graham Shaw BDS (Otago); President – New Zealand Society for Sedation in Dentistry