**THIS IS A PROPOSED ANAESTHETIC TECHNIQUE ONLY. It is NOT a recommendation. The suggestions below are personal ones. They are not endorsed by my employers or any other institution with which I am associated.**

**Proposal for a ‘COVID general anaesthetic’ (COVID-GA)**

***A method for GA without AGP in spontaneously breathing patients***

**Background:** After intravenous induction, general anaesthetics traditionally entail insertion and subsequent postoperative removal of a supraglottic airway or an endotracheal tube (hereafter, ‘intubation’ and ‘extubation’ – regardless of device).

Under COVID-era protocols (CEPs), all these four procedures are deemed aerosol-generating (AGPs). A twenty-minute safety period is advised after each, during which time only personnel with full personal protective equipment (PPE) should be present in the room.

In classic CEPs, this means a 20-min delay after the anaesthetist has intubated in theatre, before surgeons can enter and prepare for surgery. To expedite matters, some surgeons don full PPE in advance, enter theatres with the patient and start preparing for surgery immediately after intubation - without a formal 20-min interval. After wound closure, though, CEPS stipulate a second 20 min delay after extubation, before the theatre doors can be opened and the patient (or anyone else) can leave.

Regional anaesthesia avoids the need for CEPs and increases theatre productivity but is unsuitable in some cases. A technique for surgical anaesthesia without AGPs would offer similar advantages.

**Rationale:** Ketamine and propofol have both been available for more than thirty years. A recent review of their combined use (hereafter ‘ketofol’) refers to ‘sedation’. Nevertheless, procedures to which the review and other articles refer include ECT, bone marrow aspiration and puerperal sterilisation – all traditionally conducted under general anaesthesia. High levels of patient satisfaction have apparently been reported and - where recorded - interventions to support ventilation rarely appear to be necessary. [1]

Many of the relevant studies have been conducted in, or been published in journals from, lower and middle income countries. Many are also written by non-anaesthetists working outside the operating theatre

An intraoperative pharmacological technique that maintains spontaneous ventilation while providing reliable amnesia, immobility and cardiovascular stability with some postoperative analgesia as well could arguably be defined as a general anaesthetic - irrespective of classical definitions or the presence/absence of an artificial airway.

Below is a description of a proposed ‘COVID-GA’, a ketofol technique re-purposed for COVID-positive or COVID-suspected patients (hereafter ‘COVID patients’). It does not entail AGPs. For clinicians unfamiliar with ketamine who may consider using COVID-GA, appropriate reviews are available [2, 3]

**Suggested indications:** The technique may be suitable for COVID patients undergoing surgical or diagnostic procedures below the neck, lasting less than two hours and requiring general anaesthesia, where a laryngeal mask/ spontaneous breathing technique is appropriate.

Anaesthetists using COVD-GA would require immediate access to the patient’s airway at all times.

**Suggested contraindications:** These include any contraindication to a laryngeal mask/ spontaneous breathing technique (e.g. likely regurgitation, airway compromise, respiratory impairment and others). Patients with any contraindication to ketamine should not receive COVID-GA (see reviews – e.g. psychosis, epilepsy, angina, poorly controlled hypertension, raised intracranial pressure, dementia and others). The technique is also likely to be unsuitable where profound muscle relaxation is a surgical requirement.

**SUGGESTED CONDUCT OF ANAESTHESIA**

**(A) General approach:**

The usual institutional CEPs apply for preoperative theatre preparation and staffing. The approach is similar to the one for COVID patients having surgery under regional anaesthesia and/or sedation, in that there is the potential for urgent intraoperative conversion to a technique involving AGP. Surgeons and nursing/recovery staff should be briefed about what to expect with the COVID-GA technique.

All staff in theatre at induction – or entering afterwards – should therefore be in COVID PPE. Should COVID-GA fail at any point after induction or intraoperatively, requiring bag-mask ventilation or supraglottic airway/endotracheal tube insertion, all usual protocols for AGP apply from then on.

Anaesthetist and assistant should remain in theatre at all times between arrival of patient and discharge to recovery. All equipment/drugs, prepared as below, should be ready in theatres. The patient should be brought from the ward wearing a paper mask, straight into theatres.

**(B) Equipment prepared preoperatively in theatre:**

(1) Anaesthetic machine, checked and ready for immediate use, with COVID compatible circle circuit (fillers etc) and with supplementary oxygen flowmeter/supply

(2) Two intravenous infusion pumps – at least one of them capable of target-controlled infusion. The TCI pump to be loaded with a 50 ml syringe containing 1% propofol (i.e.10 mg/ml), the other with a 50 ml syringe containing 100mg ketamine in 50ml NaCl 0.9% (i.e. 2mg/ml).

Each syringe to have a three way tap at outlet. Connect both to dual intravenous infusion tubing with one-way valves as supplied and terminal adapter (\*\*) at the patient end, to allow simultaneous administration of intravenous maintenance fluids.

(3) Facemask with reservoir bag, or - if not available - ordinary Hudson mask. Adapter for end-tidal gas sample tubing in each case.

(4) Emergency airway equipment (first reserve – use does not constitute AGP): Guedel’s airway, appropriate size for patient. Nasal airway, size 6.0. Waters circuit with proximal adapter for wall-mounted oxygen supply. Catheter mount, filter, anaesthetic facemask.

(6) Emergency airway equipment (second reserve – use constitutes AGP): Use local protocol equipment list for COVID AGPs including laryngeal mask and endotracheal tube appropriately sized for patient.

(7) Equipment for intravenous cannulation, dressings, tape etc

**(C) Drugs drawn up preoperatively in theatre:**

[ Propofol and ketamine in pumps - as above]. Also

(1) Reserve syringe each of ketamine and propofol

(2) Glycopyrrolate 0.6mg in 3ml, with spare ampoule available

(3) Midazolam 5mg in 5ml

(4) Fentanyl 200 micrograms in 20ml NaCl 0.9% (i.e. 5 micrograms/ml)

(5) Rocuronium 100mg in 10ml

(6) Paracetamol 1g in 100ml

(7) Ondansetron 4mg in 2 ml

(8) Antibiotics, vasopressors, tranexamic acid etc - as per surgical/anaesthetic preference

(9) Labetalol (if no contraindication) 100mg in 20ml

(10) Hartmann’s 1l attached to giving set with three way tap and long extension. Second three way tap close to patient if terminal adapter (see 2 above) unavailable.

**(D) Other preparations**

The patient should be positioned on operating table. The usual mandatory checks and monitors should be applied. Surgeons may prepare themselves while this is going on.

**( E) Induction:** (the doses suggested are appropriate for a 70kg adult)

(1) Apply rebreathing/Hudson mask over patient’s paper mask and connect to anaesthetic machine supplementary flowmeter. Start O2 at 5-10 l/min. Connect end-tidal CO2 monitor

(2) Programme TCI pump with patient weight etc.

(3) Insert cannula, ideally in large forearm vein. Avoid hand (pain on propofol infusion compromises sedation) and antecubital fossa (infusion will occlude if patient flexes elbow 2y inadequate sedation). Apply blood pressure cuff on opposite arm (inflation will occlude ipsilateral propofol infusion and cause pain, compromising sedation). Connect dual infusion tubing and iv maintenance fluids

(4) Administer intravenous midazolam 0.5mg. Wait for effect. Administer intravenous glycopyrrolate 0.6mg as prophylactic antisialogogue (alternatively, wait to see if this is clinically indicated). Administer intravenous antibiotics as surgically indicated.

(5) Start propofol TCI with initial target plasma concentration 1-2mcg/ml. Wait for effect and then adjust target until patient unresponsive to voice.

If airway obstruction occurs at any point during induction or maintenance phase, adjust head/neck/chin position and/or lift paper mask to insert Guedel’s airway. Replace outer gloves immediately after this procedure and dispose of soiled ones securely. Further rescue procedures are described in the next section.

(6) Start intravenous ketamine. Administer initial bolus of 10mg (5ml), then infuse at 1.5mk/kg/hr initially, i.e. 50ml/h. Wait for effect

(7) Surgeons now infiltrate surgical site with local anaesthesia (where no contraindication) and make incision

**(F) Intraoperative maintenance**

(1) Continue oxygen administration throughout, as above. Monitor spontaneous breathing by observing chest and end-tidal CO2. Intraoperative rescue procedures (in italics) are as follows:

*(a) If oxygen desaturation occurs at any point intraoperatively, correct airway obstruction if present. Insert Guedel’s airway if not already in use (see above).*

*(b) If saturation fails to recover, exchange Hudson/rebreathing mask and tubing for Waters bag/anaesthetic facemask to ensure 100% oxygen administration. Instruct staff to prepare for possible imminent AGP.*

*(c) Avoid positive pressure ventilation via mask if possible (this constitutes an AGP). If spontaneous breathing resumes, continue 100% oxygen administration with Waters bag/ anaesthetic facemask until saturation recovers, replace this with Hudson/rebreathing mask as before.*

*(d) If patient remains hypoxic secondary to hypopnoea, obstruction or other factors - despite 100% oxygen as above -* ***declare AGP.*** *Commence positive pressure ventilation with 100% O2 via facemask. Increase propofol target concentration and prepare for insertion of supraglottic airway. If endotracheal intubation is indicated or preferred instead, administer rocuronium. Continue thereafter with local protocols for COVID AGPs including postoperative phase.*

(2) Continue propofol infusion, adjusting target between as required between 2-3 micg/ml

(3) Ketamine infusion rate may be reduced as surgery proceeds (intraoperative rates between 10 – 50 ml/h appear appropriate).

(4) Clinically significant tachycardia and hypertension can be treated with intravenous labetalol 5-10mg if no contraindication

(5) Intravenous paracetamol Ig and ondansetron 4mg can be administered intraoperatively as required

(6) Administer fentanyl cautiously in 5 micg increments during latter half of surgery. Avoid dosage sufficient to cause apnoea. Aim for a total intraoperative fentanyl dose approximately one half of the dose that would usually be appropriate for the procedure and patient in a standard (i.e. ketamine free), spontaneously breathing anaesthetic.

(7) Discontinue ketamine ten minutes before wound closure complete

(8) Request surgeons to administer local anaesthetic to wounds/drains if not already done

(9) Discontinue propofol on completion of wound closure

**(G) Recovery**

(1) Sit patient up unless surgical contraindication. Continue oxygen administration

(2) Prescribe appropriate analgesia as usual, including incremental fentanyl for recovery room use

**PRACTICAL EXPERIENCE OF COVID-GA:**

I used this technique on two middle-aged female patients last week. The first was undergoing a wide local excision of wire-located breast lesion with axillary node clearance (about 1.5 hrs). Smoker. Normal BMI. ASA2 (treated hypertension). The second patient had a wide local excision of breast lesion with dye/sentinel node biopsy (about 1 hr). Normal BMI. ASA1. Both patients had had previous general anaesthetics

I explained to the patients preoperatively that COVID had led to a number of changes in the way that surgical cases were conducted and that some of these would be evident when they arrived in theatres (staff in PPE, induction in theatres). I explained that I had also altered my anaesthetic technique for reasons connected with COVID. I said I would be giving them a combination of two general anaesthetic drugs during the procedure.

I warned the that the drugs might produce dreaming. I did not mention hallucinations as these are rare when ketamine is combined with propofol and/or fentanyl. I did not mention awareness. NAP5 showed that the incidence of spontaneously reported awareness in self-ventilating patients under surgical anaesthesia is almost unknown.

Here are some notes on the practical aspects of the two anaesthetics I gave:

(1) Both patients remained immobile throughout the surgery

(2) Respiratory rate and tidal volume appeared to be sustained and adequate intraoperatively, and unreactive to the degree of surgical stimulus. They did respond to changes in propofol infusion rate and fentanyl boluses (see below)

(3) My second (non-hypertensive) patient got a bit hypertensive and tachycardic with the ketamine and glycopyrrolate combined.

(4) I turned off the ketamine about ten minutes before the end of surgery. In my second patient I had reduced the infusion rate from 50ml/hr to 10ml/hr over the course of the operation.

(5) At no stage was manual ventilation required in either patient. The first patient – a smoker - had some early desaturations, despite chin-lift and jaw thrust, until I inserted a Guedel’s airway. Thereafter – for the remaining hour of surgery – no other airway intervention was required.

(6) Neither patient appeared especially ‘ketaminized’ (eyes open, unresponsive) immediately after wound closure. Both continued to breathe spontaneously but were unrousable at this stage. The first was unable to maintain her airway unassisted once the Guedel’s airway was removed. Both patients were normotensive at the end of the procedure. I took both to recovery a few minutes after the dressings were applied

(7) For the first patient, the receiving recovery nurse was unhappy about the fact she had to perform jaw thrust. (While this may be within the skill set of a trained recovery nurse, I think she had grown used to receiving COVID patients wide awake, 20 minutes after extubation.)

To expedite emergence, then, I gave the first patient 50mg doxapram in recovery, about ten minutes after stopping propofol. She became responsive within seconds. A few minutes later, she said she was pain free. She subsequently required increments of intravenous fentanyl in recovery (total dose 100 micg). She never appeared especially ketaminized.

The second patient opened her eyes spontaneously in recovery and required two or three 20 micg fentanyl boluses. She looked more ketaminized but recovered, I was told, within fifteen or twenty minutes

(8) Recovery in both patients was otherwise uneventful. I visited the first patient postoperatively on the ward about three hours after wound closure. She was entirely happy with her experience. She had no explicit recollection of anything between the intravenous cannulation and regaining consciousness in recovery. She thought she may have had a dream at some stage but couldn’t remember what it was about.

I called the ward about the second patient later that evening (about three hours after wound closure). Her allocated nurse said that the patient appeared content, pain-free, had eaten and not complained of dreaming or any specific recollections.

(9) At the end of the operating list, I received the following feedback:

*‘That’s amazing. I’ve never seen anything like that before’ (ODA)*

*‘I had my doubts beforehand, but you can definitely come again’ (surgeon – unknown to me beforehand)*

[1] Amornyotin S (2014) Ketofol: A Combination of Ketamine and Propofol. J Anesth Crit Care Open Access 2014;1(5): 00031. DOI: 10.15406/

[2] Pai A, Heining M. Ketamine. Continuing Education in Anaesthesia, Critical Care & Pain 2007;7(2):59-63

[3] Kurdi MS et al. Ketamine: Current applications in anesthesia, pain, and critical care. Anesth Essays Res. 2014 Sep-Dec;8(3):283-90

**BONA FIDES**

I regularly administer intravenous ketamine intraoperatively for postoperative analgesia. Over a thirty-year career, I have given ketamine to many patients in other contexts e.g. surgical anaesthesia in the developing world, analgesia/anaesthesia in the prehospital environment.

I also conducted clinical research some years ago on target-controlled intravenous ketamine infusions, using original and modified versions of a drug-specific pharmacokinetic model devised by Jürgen Schüttler.

**The Good Soldier (18/05/20)**