Summary of Product Characteristics

1 NAME OF THE MEDICINAL PRODUCT

Remifentanil 2 mg powder for concentrate for solution for injection or infusion

2 QUALITATIVE AND QUANTITATIVE COMPOSITION

Remifentanil 2 mg powder for concentrate for solution for injection or infusion
1 vial contains 2 mg remifentanil (as remifentanil hydrochloride).

After reconstitution the solution contains 1 mg/ml, if prepared as recommended (see section 6.6).
For the full list of excipients, see section 6.1.

3 PHARMACEUTICAL FORM

Powder for concentrate for solution for injection or infusion.

White to off white, powder

4 CLINICAL PARTICULARS

4.1 Therapeutic Indications

Remifentanil is indicated as an analgesic agent for use during induction and/or maintenance of general anaesthesia.

Remifentanil is indicated for provision of analgesia in mechanically ventilated intensive care patients of 18 years of age and over.

This medicinal product is exclusive for hospital use.

4.2 Posology and method of administration

Remifentanil shall be administered only in a setting fully equipped for the monitoring and support of respiratory and cardiovascular function, and by persons specifically trained in the use of anaesthetic drugs and the recognition and management of the expected adverse effects of potent opioids, including respiratory and cardiac resuscitation. Such training must include the establishment and maintenance of a patent airway and assisted ventilation.

Continuous infusions of remifentanil must be administered by a calibrated infusion device into a fast flowing IV line or via a dedicated IV line. This infusion line should be connected at, or close to, the venous cannula and primed to minimise the potential dead space (see section 6.6 for additional information, including tables with examples of infusion rates by body weight to help titrate remifentanil to the patient's anaesthetic needs).

Remifentanil may be given by target controlled infusion (TCI) with an approved infusion device incorporating the Minto pharmacokinetic model with covariates for age and lean body mass (LBM)

Care should be taken to avoid obstruction or disconnection of infusion lines and to adequately clear the lines to remove residual remifentanil after use (see *section 4.4*).

Remifentanil is for intravenous use only and must not be administered by epidural or intrathecal injection (see *section 4.3*).
The content of one vial is for single use only.

Dilution

Remifentanil must be further diluted after reconstitution (see *section 6.3* and *6.6* for storage conditions of the reconstituted/diluted product and the recommended diluents).

For manually-controlled infusion remifentanil can be diluted to concentrations of 20 to 250 micrograms/ml (50 micrograms/ml is the recommended dilution for adults and 20 to 25 micrograms/ml for paediatric patients aged 1 year and over).

For TCI the recommended dilution of remifentanil is 20 to 50 micrograms/ml.

General Anaesthesia

The administration of remifentanil must be individualised based on the patient's response.

Adults

Administration by Manually-Controlled Infusion

The following table summarises the starting injection/infusion rates and dose range.

Dosing guidelines for adults:

Indication	Bolus Injection (micrograms/kg)	Continuous Infusion (micrograms/kg/min)	
		Starting Rate	Range
Induction of anaesthesia	1 (give over not less than 30 seconds)	0.5 to 1	-
Maintenance of anaesthesia in ventilated patients			
• Nitrous oxide (66%)	0.5 to 1	0.4	0.1 to 2
• Isoflurane (starting dose 0.5 MAC)	0.5 to 1	0.25	0.05 to 2
• Propofol (Starting dose 100 micrograms/kg/min)	0.5 to 1	0.25	0.05 to 2

When given by bolus injection remifentanil should be administered over not less than 30 seconds.
At the doses recommended above, remifentanil significantly reduces the amount of hypnotic agent required to maintain anaesthesia. Therefore, isoflurane and propofol should be administered as recommended above to avoid an increase of haemodynamic effects such as hypotension and bradycardia (see in section 4.2: *Concomitant medication* below).

Induction of anaesthesia:
Remifentanil should be administered with a standard dose of hypnotic agent, such as propofol, thiopental, or isoflurane, for the induction of anaesthesia. Remifentanil can be administered at an infusion rate of 0.5 to 1 micrograms/kg/min, with or without an initial bolus injection of 1 micrograms/kg given over not less than 30 seconds. If endotracheal intubation is to occur more than 8 to 10 minutes after the start of the infusion of remifentanil, then a bolus injection is not necessary.

Maintenance of anaesthesia in ventilated patients:
After endotracheal intubation, the infusion rate of remifentanil should be decreased, according to anaesthetic technique, as indicated in the above table. Due to the fast onset and short duration of action of remifentanil, the rate of administration during anaesthesia can be titrated upward in 25% to 100% increments or downward in 25% to 50% decrements, every 2 to 5 minutes to attain the desired level of micro-opioid response. In response to light anaesthesia, supplemental bolus injections may be administered every 2 to 5 minutes.

Anaesthesia in spontaneously breathing anaesthetised patients with a secured airway (e.g. laryngeal mask anaesthesia):
In spontaneously breathing anaesthetised patients with a secured airway respiratory depression is likely to occur. There is also a risk that muscle rigidity may occur. Special care is needed to adjust the dose to the patient requirements and ventilatory support and/or urgent intubation may be required. The recommended starting infusion rate for supplemental analgesia in spontaneously breathing anaesthetised patients is 0.04 micrograms/kg/min with titration to effect. A range of infusion rates from 0.025 to 0.1 micrograms/kg/min has been studied.

Bolus injections are not recommended in spontaneously breathing anaesthetised patients.

Remifentanil should not be used as an analgesic in procedures where patients remain conscious or do not receive any airway support during the procedure.

Concomitant medication:

Remifentanil decreases the amounts or doses of inhaled anaesthetics, hypnotics and benzodiazepines required for anaesthesia (see *section 4.5*).
Doses of the following agents used in anaesthesia: isoflurane, thiopentone, propofol and temazepam have been reduced by up to 75% when used concurrently with remifentanil.

Guidelines for discontinuation/ continuation into the immediate post-operative period:
Due to the very rapid offset of action of remifentanil no residual opioid activity will be present within 5 to 10 minutes after discontinuation. For those patients undergoing surgical procedures where post-operative pain is anticipated, analgesics should be administered prior to discontinuation of remifentanil. Sufficient time must be allowed to reach the maximum effect of the longer acting analgesic. The choice of analgesic should be appropriate for the patient's surgical procedure and the level of post-operative care.

Care should be taken to avoid inadvertent administration of remifentanil remaining in IV lines and cannulae (see section 4.4).

In the event that longer acting analgesia has not been established prior to the end of surgery, remifentanil may need to be continued to maintain analgesia during the immediate post-operative period until longer acting analgesia has reached its maximum effect.

Guidance on use in mechanically ventilated intensive care patients is provided in *section 4.2: Use in Intensive Care*.

In patients who are breathing spontaneously, the infusion rate of remifentanil should initially be decreased to a rate of 0.1 micrograms/kg/min. The infusion rate may then be increased or decreased by not greater than 0.025 micrograms/kg/min every five minutes, to balance the patient’s level of analgesia and respiratory rate.

Remifentanil should only be used in a setting fully equipped for the monitoring and support of respiratory and cardiovascular function, under the close supervision of persons specifically trained in the recognition and management of the respiratory effects of potent opioids.

The use of bolus injections of remifentanil to treat pain during the post-operative period is not recommended in patients who are breathing spontaneously.

Administration by Target-Controlled Infusion
Induction and maintenance of anaesthesia in ventilated patients:
Remifentanil TCI should be used in association with an intravenous or inhalational hypnotic agent during the induction and maintenance of anaesthesia in ventilated adult patients (see *Dosing Guidelines for Adults* in *section 4.2: General Anaesthesia / Adults - Administration by Manually-Controlled Infusion*). In association with these agents, adequate analgesia for induction of anaesthesia and surgery can generally be achieved with target blood remifentanil concentrations ranging from 3 to 8 nanograms/ml. Remifentanil should be titrated to individual patient response. For particularly stimulating surgical procedures target blood concentrations up to 15 nanograms/ml may be required.

At the doses recommended above, remifentanil significantly reduces the amount of hypnotic agent required to maintain anaesthesia. Therefore, isoflurane and propofol should be administered as recommended above to avoid an increase of haemodynamic effects such as hypotension and bradycardia (see *Dosing Guidelines for Adults* and *Concomitant Medication* in *section 4.2: General Anaesthesia/ Adults/ Administration by Manually-Controlled Infusion).*

For information on blood remifentanil concentrations achieved with manually-controlled infusion see *Table 6*.

As there are insufficient data, the administration of remifentanil by TCI for spontaneous ventilation anaesthesia is not recommended.

Guidelines for discontinuation/continuation into the immediate post-operative period:
At the end of surgery when the TCI infusion is stopped or the target concentration reduced, spontaneous respiration is likely to return at calculated remifentanil concentrations in the region of 1 to 2 nanograms/ml. As with manually-controlled infusion, post-operative analgesia should be established before the end of surgery with longer acting analgesics (see *Guidelines for discontinuation* in section *4.2: General Anaesthesia / Adults / Administration by Manually-Controlled Infusion*).

As there are insufficient data, the administration of remifentanil by TCI for the management of post-operative analgesia is not recommended.

Paediatric patients (1 to12 years of age)

Co-administration of remifentanil and an intravenous anaesthetic agent for induction of anaesthesia has not been studied in detail and is therefore not recommended.

Remifentanil TCI has not been studied in paediatric patients and therefore administration of remifentanil by TCI is not recommended in these patients.

When given by bolus injection, remifentanil should be administered **over not less than 30 seconds**. Surgery should not commence until at least 5 minutes after the start of remifentanil infusion, if a simultaneous bolus dose has not been given. For sole administration of nitrous oxide (70%) with remifentanil, typical maintenance infusion rates should be between 0.4 and 3 micrograms/kg/min, and although not specifically studied, adult data suggest that 0.4 micrograms/kg/min is an appropriate starting rate. Paediatric patients should be monitored and the dose titrated to the depth of analgesia appropriate for the surgical procedure.

Induction of anaesthesia: The use of remifentanil for induction of anaesthesia in patients aged 1 to 12 years is not recommended as there are no data available in this patient population.

Maintenance of anaesthesia: The following doses of remifentanil are recommended for maintenance of anaesthesia:

Dosing Guidelines for paediatric patients (1 to12 years of age):

*Concomitant Anaesthetic Agent	Bolus Injection (micrograms/kg)	Continuous Infusion (micrograms/kg/min)	
		Starting Rate	Range
Halothane (starting dose 0.3 MAC)	1	0.25	0.05 to 1.3
Sevoflurane (starting dose 0.3 MAC)	1	0.25	0.05 to 0.9
Isoflurane (starting dose 0.5 MAC)	1	0.25	0.06 to 0.9

*co-administered with nitrous oxide/oxygen in a ratio of 2:1

Concomitant medication:
At the doses recommended above, remifentanil significantly reduces the amount of hypnotic agent required to maintain anaesthesia. Therefore, isoflurane, halothane and sevoflurane should be administered as recommended above to avoid an increase of haemodynamic effects such as hypotension and bradycardia. No data are available for dosage recommendations for simultaneous use of other hypnotics other than those listed in the table with remifentanil (see in *section 4.2: General Anaesthesia / Adults - Concomitant medication).*

Guidelines for patient management in the immediate post-operative period:
Establishment of alternative analgesia prior to discontinuation of remifentanil:
Due to the very rapid offset of action of remifentanil, no residual activity will be present within 5 to 10 minutes after discontinuation. For those patients undergoing surgical procedures where post-operative pain is anticipated, analgesics should be administered prior to discontinuation of remifentanil. Sufficient time must be allowed to reach the therapeutic effect of the longer acting analgesic. The choice of agent(s), the dose and the time of administration should be planned in advance and individually tailored to be appropriate for the patient's surgical procedure and the level of post-operative care anticipated (see *section 4.4*).

Neonates/infants (aged less than 1 year)

There is limited clinical trial experience of remifentanil in neonates and infants (aged under 1 year old; see section 5.1). The pharmacokinetic profile of remifentanil in neonates/infants (aged less than 1 year) is comparable to that seen in adults after correction for body weight differences (see section 5.2). However, because there are insufficient clinical data, the administration of remifentanil is not recommended for this age group.

Use for Total Intravenous anaesthesia (TIVA): There is limited clinical trial experience of remifentanil of TIVA in infants (see section 5.1). However, there are insufficient clinical data to make dosage recommendations.

Cardiac anaesthesia

Administration by Manually-Controlled Infusion

Dosing Guidelines for Cardiac Anaesthesia:

Indication	Bolus Injection (microgram/kg)	Continuous Infusion (microgram/kg/min)	
		Starting Rate	Typical Infusion Rates
Induction of anaesthesia	Not recommended	1	-
Maintenance of anaesthesia			
• Isoflurane (starting dose 0.4 MAC)	0.5-1	1	0.003-4
• Propofol (starting dose 50 microgram/kg/min)	0.5-1	1	0.01 to 4.3
Continuation of post-operative analgesia, prior to extubation	Not recommended	1	0 to 1

Induction period of anaesthesia:
After administration of hypnotic to achieve loss of consciousness, remifentanil should be administered at an initial infusion rate of 1 microgram/kg/min. The use of bolus injections of remifentanil during induction in cardiac surgical patients is not recommended. Endotracheal intubation should not occur until at least 5 minutes after the start of the infusion.

Maintenance period of anaesthesia:
After endotracheal intubation the infusion rate of remifentanil should be titrated according to patient need. Supplemental slow bolus doses may also be given as required. High risk cardiac patients, such as those with poor ventricular function or undergoing valve surgery, should be administered a maximum bolus dose of 0.5 micrograms/kg.

These dosing recommendations also apply during hypothermic cardiopulmonary bypass (see s*ection 5.2*).

Concomitant medication:
At the doses recommended above, remifentanil significantly reduces the amount of hypnotic agent required to maintain anaesthesia. Therefore, isoflurane and propofol should be administered as recommended above to avoid an increase of haemodynamic effects such as hypotension and bradycardia. No data are available for dosage recommendations for simultaneous use of other hypnotics other than those listed in the table with remifentanil (see *section 4.2: General Anaethesia / Adults/ Concomitant medication).*

Guidelines for post-operative patient management

Continuation of remifentanil post-operatively to provide analgesia prior to weaning for extubation:
It is recommended that the infusion of remifentanil should be maintained at the final intra-operative rate during transfer of patients to the post-operative care area. Upon arrival into this area, the patient's level of analgesia and sedation should be closely monitored and the remifentanil infusion rate adjusted to meet the individual patient's requirements (see in s*ection 4.2:Use in Intensive Care* for further information on management of intensive care patients).

Establishment of alternative analgesia prior to discontinuation of remifentanil:
Due to the very rapid offset of action of remifentanil, no residual opioid activity will be present within 5 to 10 minutes after discontinuation. Prior to discontinuation of remifentanil, patients must be given alternative analgesic and sedative agents at a sufficient time in advance to allow the therapeutic effects of these agents to become established. It is therefore recommended that the choice of agent(s), the dose and the time of administration are planned, before weaning the patient from the ventilator.

Guidelines for discontinuation of remifentanil:

Due to the very rapid offset of action of remifentanil, hypertension, shivering and aches have been reported in cardiac patients immediately following discontinuation of remifentanil (see *section 4.8*). To minimise the risk of these occurring, adequate alternative analgesia must be established (as described above), before the remifentanil infusion is discontinued. The infusion rate should be reduced by 25% decrements in at least 10-minute intervals until the infusion is discontinued.

During weaning from the ventilator the remifentanil infusion should not be increased and only down titration should occur, supplemented as required with alternative analgesics. Haemodynamic changes such as hypertension and tachycardia should be treated with alternative agents as appropriate.

When other opioid agents are administered as part of the regimen for transition to alternative analgesia, the patient must be carefully monitored. The benefit of providing adequate post-operative analgesia must always be balanced against the potential risk of respiratory depression with these agents.

Administration by Target-Controlled Infusion

Induction and maintenance of anaesthesia:
Remifentanil TCI should be used in association with an intravenous or inhalational hypnotic agent during the induction and maintenance of anaesthesia in ventilated adult patients (see the *table in Dosing Guidelines for Cardiac Anaesthesia* in *section 4.2: Cardiac anaesthesia / Administration by Manually-Controlled Infusion*). In association with these agents, adequate analgesia for cardiac surgery is generally achieved at the higher end of the range of target blood remifentanil concentrations used for general surgical procedures. Following titration of remifentanil to individual patient response, blood concentrations as high as 20 nanograms/ml have been used in clinical studies. At the doses recommended above, remifentanil significantly reduces the amount of hypnotic agent required to maintain anaesthesia. Therefore, isoflurane and propofol should be administered as recommended above to avoid an increase of haemodynamic effects such as hypotension and bradycardia (see *table in Dosing Guidelines for Cardiac Anaesthesia and Concomitant medication paragraph* in section *4.2: Cardiac anaesthesia / Administration by Manually-Controlled Infusion*).

For information on blood remifentanil concentrations achieved with manually-controlled infusion see *Table 6*.

Guidelines for discontinuation/continuation into the immediate post-operative period:
At the end of surgery when the TCI infusion is stopped or the target concentration reduced, spontaneous respiration is likely to return at calculated remifentanil concentrations in the region of 1 to 2 nanograms/ml. As with manually-controlled infusion, post-operative analgesia should be established before the end of surgery with longer acting analgesics (see Guidelines for discontinuation in *section 4.2: Cardiac anaesthesia / Administration by Manually-Controlled Infusion*).

As there are insufficient data, the administration of remifentanil by TCI for the management of post-operative analgesia is not recommended.

Use in Intensive Care

Remifentanil can be used for the provision of analgesia in mechanically ventilated intensive care patients. Sedative agents should be added as appropriate.

Remifentanil has been studied in mechanically ventilated intensive care patients in well controlled clinical trials for up to three days. As patients were not studied beyond three days, no evidence of safety and efficacy for longer treatment has been established. Therefore, the use of Remifentanil is not recommended for a duration of treatment greater than 3 days.

Remifentanil TCI has not been studied in intensive care patients and therefore administration of remifentanil by TCI is not recommended in these patients.

In adults it is recommended that remifentanil is initiated at an infusion rate of 0.1 micrograms/kg/min (6 micrograms/kg/h) to 0.15 micrograms/kg/min (9 micrograms/kg/h). The infusion rate should be titrated in increments of 0.025 micrograms/kg/min (1.5 micrograms/kg/h) to achieve the desired level of sedation and analgesia. A period of at least 5 minutes should be allowed between dose adjustments. The level of sedation and analgesia should be carefully monitored, regularly assessed and the remifentanil infusion rate adjusted accordingly. If an infusion rate of 0.2 micrograms/kg/min (12 micrograms/kg/h) is reached and the desired level of sedation is not achieved, it is recommended that dosing with an appropriate sedative agent is initiated (see below). The dose of sedative agent should be titrated to obtain the desired level of sedation. Further increases to the remifentanil infusion rate in increments of 0.025 micrograms/kg/min (1.5 micrograms/kg/h) may be made if additional analgesia is required.

The following table summarises the starting infusion rates and typical dose range for provision of analgesia in individual patients:

Dosing Guidelines for use of remifentanil within the intensive care setting:

Continuous Infusion micrograms/kg/min (micrograms/kg/h)	
Starting Rate	Range
0.1 (6) to 0.15 (9)	0.006 (0.38) to 0.74 (44.6)

Bolus doses of remifentanil are not recommended in the intensive care setting.

The use of remifentanil will reduce the dosage requirement of any concomitant sedative agents. Typical starting doses for sedative agents, if required, are given below.

Recommended starting dose of sedative agents, if required:

Sedative Agents	Bolus (mg/kg)	Infusion (mg/kg/h)
Propofol	Up to 0.5	0.5
Midazolam	Up to 0.03	0.03

To allow separate titration of the respective agents, sedative agents should not be administered as anadmixture.

Additional analgesia for ventilated patients undergoing stimulating procedures:
An increase in the existing remifentanil infusion rate may be required to provide additional analgesic cover for ventilated patients undergoing stimulating and/or painful procedures such as endotracheal suctioning, wound dressing and physiotherapy. It is recommended that a remifentanil infusion rate of at least 0.1 micrograms/kg/min (6 micrograms/kg/h) should be maintained for at least 5 minutes prior to the start of the stimulating procedure. Further dose adjustments may be made every 2 to 5 minutes in increments of 25% to 50% in anticipation of, or in response to, additional requirement for analgesia. A mean infusion rate of 0.25 micrograms/kg/min (15 micrograms/kg/h), maximum 0.75 micrograms/kg/min (45 micrograms/kg/h), has been administered for provision of additional analgesia during stimulating procedures.

Establishment of alternative analgesia prior to discontinuation of remifentanil:
Due to the very rapid offset ofaction of remifentanil, no residual opioid activity will be present within 5 to 10 minutes after discontinuation regardless of the duration of infusion. Following administration of remifentanil, the possibility of tolerance and hyperalgesia should be considered. Therefore, prior to discontinuation of remifentanil, patients must be given alternative analgesic and sedative agents to prevent hyperalgesia and associated haemodynamic changes. These agents must be given at a sufficient time in advance to allow the therapeutic effects of these agents to become established. The range of options for analgesia includes long acting oral, intravenous, or regional analgesics controlled by the nurse or the patient. These techniques should always be titrated to individual patient needs as the infusion of remifentanil is reduced. It is therefore recommended that the choice of agent (s), the dose and the time of administration are planned prior to discontinuation of remifentanil.

There is a potential for the development of tolerance with time during prolonged administration of micro-opioid agonists.

Guidelines for extubation and discontinuation of remifentanil:
In order to ensure a smooth emergence from a remifentanil-based regimen it is recommended that the infusion rate of remifentanil is titrated in stages to 0.1 micrograms/kg/min (6 micrograms/kg/h) over a period up to 1 hour prior to extubation.

Following extubation, the infusion rate should be reduced by 25% decrements in at least 10-minute intervals until the infusion is discontinued. During weaning from the ventilator the remifentanil infusion should not be increased and only down titration should occur, supplemented as required with alternative analgesics.

Upon discontinuation of remifentanil, the IV cannula should be cleared or removed to prevent subsequent inadvertent administration.

When other opioid agents are administered as part of the regimen for transition to alternative analgesia, the patient must be carefully monitored. The benefit of providing adequate analgesia must always be balanced against the potential risk of respiratory depression with these agents.

Paediatric intensive care patients

The use of remifentanil in intensive care patients under the age of 18 years is not recommended as there are no data available on the use in paediatric patients.

Renally-impaired intensive care patients

No adjustments to the doses recommended above are necessary in renally-impaired patients including those undergoing renal replacement therapy, however the clearance of the carboxylic acid metabolite is reduced in patients with renal impairment (see *section 5.2*).

Special patient populations

Elderly (over 65 years of age)

General anaesthesia:
Caution should be exercised in the administration of remifentanil in this population. The initial starting dose of remifentanil administered to patients over 65 should be half the recommended adult dose and then shall be titrated to individual patient need as an increased sensitivity to the pharmacological effects of remifentanil has been seen in this patient population. This dose adjustment applies to use in all phases of anaesthesia including induction, maintenance, and immediate post-operative analgesia.
Because of the increased sensitivity of elderly patients to remifentanil, when administering remifentanil by TCI in this population the initial target concentration should be 1.5 to 4 nanograms/ml with subsequent titration to response.

Cardiac anaesthesia:
No initial dose reduction is required (see also in *section 4.2: Cardiac anaesthesia*).

Intensive Care:
No initial dose reduction is required (see also in *section 4.2: Use in Intensive Care*).

Obese patients

For manually-controlled infusion it is recommended that for obese patients the dosage of remifentanil should be reduced and based upon ideal body weight as the clearance and volume of distribution of remifentanil are better correlated with ideal body weight than actual body weight.

With the calculation of lean body mass (LBM) used in the Minto model, LBM is likely to be underestimated in female patients with a body mass index (BMI) greater than 35 kg/m^2 and in male patients with BMI greater than 40 kg/m^2. To avoid underdosing in these patients, remifentanil TCI should be titrated carefully to individual response.

Renal impairment

On the basis of investigations carried out to date, a dose adjustment in patients with impaired renal function, including intensive care patients, is not necessary.

Hepatic impairment

Studies carried out with a limited number of patients with impaired liver function, do not justify any special dosage recommendations. However, patients with severe hepatic impairment may be slightly more sensitive to the respiratory depressant effects of remifentanil (see *section 4.4).* These patients should be closely monitored and the dose of remifentanil shall be titrated to individual patient need.

Neurosurgery

Limited clinical experience in patients undergoing neurosurgery has shown that no special dosage recommendations are required.

ASA III/IV patients

General anaesthesia:
As the haemodynamic effects of potent opioids can be expected to be more pronounced in ASA III/IV patients, caution should be exercised in the administration of remifentanil in this population. Initial dosage reduction and subsequent titration to effect is therefore recommended. In paediatric patients, there are insufficient data to make a dosage recommendation.

For TCI, a lower initial target of 1.5 to 4 nanograms/ml should be used in ASA III or IV patients and subsequently titrated to response.

Cardiac anaesthesia:
No initial dose reduction is required (see also in *section 4.2: Cardiac anaesthesia*).

4.3 Contraindications

As glycine is present in the formulation, remifentanil is contra-indicated for epidural and intrathecal use (see also *section 5.3)*.

Remifentanil is contra-indicated in patients with hypersensitivity to the active substance or other fentanyl analogues or to any of the excipients listed in section 6.1.

Remifentanil is contra-indicated for use as the sole agent for induction of anaesthesia.

4.4 Special warnings and precautions for use

Remifentanil should be administered only in a setting fully equipped for the monitoring and support of respiratory and cardiovascular function, and by persons specifically trained in the use of anaesthetic drugs and the recognition and management of the expected adverse effects of potent opioids, including respiratory and cardiac resuscitation. Such training must include the establishment and maintenance of a patent airway and assisted ventilation.

The use of remifentanil in mechanically ventilated intensive care patients is not recommended for a duration of treatment greater than 3 days.

Patients with a known hypersensitivity to opioids of a different class may exhibit a hypersensitivity reaction following administration of remifentanil. Caution should be exercised before using Remifentanil in these patients.

Rapid offset of action/ Transition to alternative analgesia:

Due to the very rapid offset of action of remifentanil, no residual opioid activity will be present within 5-10 minutes after the discontinuation of remifentanil. For those patients undergoing surgical procedures where post-operative pain is anticipated, analgesics should be administered prior to discontinuation of remifentanil. The possibility of tolerance, hyperalgesia and associated haemodynamic changes should be considered when used in Intensive Care Unit. Prior to discontinuation of remifentanil, patients must be given alternative analgesic and sedative agents. Sufficient time must be allowed to reach the therapeutic effect of the longer acting analgesic. The choice of agent(s), the dose and the time of administration should be planned in advance and individually tailored to be appropriate for the patient's surgical procedure and the level of post-operative care anticipated. When other opioid agents are administered as part of the regimen for transition to alternative analgesia, the benefit of providing adequate post-operative analgesia must always be balanced against the potential risk of respiratory depression with these agents.

Risk from concomitant use of sedative medicines such as benzodiazepines or related drugs
Concomitant use of Remifentanil and sedative medicines such as benzodiazepines or related drugs may result in sedation, respiratory depression, coma and death. Because of these risks, concomitant prescribing with these sedative medicines should be reserved for patients for whom alternative treatment options are not possible. If a decision is made to prescribe Remifentanil concomitantly with sedative medicines, the lowest effective dose should be used, and the duration of treatment should be as short as possible.
The patients should be followed closely for signs and symptoms of respiratory depression and sedation. In this respect, it is strongly recommended to inform patients and their caregivers to be aware of these symptoms (see section 4.5).

Discontinuation of treatment and withdrawal syndrome:
Repeated administration at short term intervals for prolonged periods may result in the development of withdrawal syndrome after cessation of therapy. Symptoms following withdrawal of remifentanil including tachycardia, hypertension and agitation have been reported infrequently upon abrupt cessation, particularly after prolonged administration of more than 3 days.

Where reported, re-introduction and tapering of the infusion has been beneficial. The use of remifentanil in mechanically ventilated intensive care patients is not recommended for duration of treatment greater than 3 days.
Inadvertent administration:
A sufficient amount of remifentanil may be present in the dead space of the IV line and/or cannula to cause respiratory depression, apnoea and/or muscle rigidity if the line is flushed with IV fluids or other drugs. This may be avoided by administering remifentanil into a fast flowing IV line or via a dedicated IV line which is removed when remifentanil is discontinued.

Muscle rigidity - prevention and management:
At the doses recommended muscle rigidity may occur. As with other opioids, the incidence of muscle rigidity is related to the dose and rate of administration. Therefore, slow bolus injections should be administered over not less than 30 seconds.

Muscle rigidity induced by remifentanil must be treated in the context of the patient's clinical condition with appropriate supporting measures including ventilator support. Excessive muscle rigidity occurring during the induction of anaesthesia should be treated by the administration of a neuromuscular blocking agent and/or additional hypnotic agents. Muscle rigidity seen during the use of remifentanil as an analgesic may be treated by stopping or decreasing the rate of administration of remifentanil. Resolution of muscle rigidity after discontinuing the infusion of remifentanil occurs within minutes. Alternatively an opioid antagonist may be administered; however this may reverse or attenuate the analgesic effect of remifentanil.

Respiratory depression – prevention and management:
As with all potent opioids, profound analgesia is accompanied by marked respiratory depression. Therefore, remifentanil should only be used in areas where facilities for monitoring and dealing with respiratory depression are available.
The appearance of respiratory depression shall be managed appropriately, including decreasing the rate of infusion by 50%, or by a temporary discontinuation of the infusion. Unlike other fentanyl analogues, remifentanil has not been shown to cause recurrent respiratory depression, even after prolonged administration. However, as many factors may affect post-operative recovery it is important to ensure that full consciousness and adequate spontaneous ventilation are achieved before the patient is discharged from the recovery area.

Cardiovascular effects:
The risk of cardiovascular effects such as hypotension and bradycardia, which may rarely lead to asystole/cardiac arrest (see sections 4.5 and 4.8) may be reduced by lowering the rate of infusion of remifentanil or the dose of concurrent anaesthetics or by using IV fluids, vasopressor or anticholinergic agents as appropriate.

Debilitated, hypovolaemic, hypotensive and elderly patients may be more sensitive to the cardiovascular effects of remifentanil.

Neonates/infants (aged less than 1 year):
There is limited data available on use in neonates/infants under 1 year of age (see sections 4.2 and 5.1).

Tolerance and opioid use disorder (abuse and dependence)
Tolerance, physical and psychological dependence, and opioid use disorder (OUD) may develop upon repeated administration of opioids. Abuse or intentional misuse of opioids may result in overdose and/or death. The risk of developing OUD is increased in patients with a personal or a family history (parents or siblings) of substance use disorders (including alcohol use disorder), in current tobacco users or in patients with a personal history of other mental health disorders (e.g. major depression, anxiety and personality disorders).

4.5 Interaction with other medicinal products and other forms of interactions

Remifentanil is not metabolised by plasmacholinesterase, therefore, interactions with drugs metabolised by this enzyme are not anticipated.

As with other opioids remifentanil, whether given by manually-controlled infusion or TCI, decreases the amounts or doses of inhaled and IV anaesthetics, and benzodiazepines required for anaesthesia (see *section 4.2*). If doses of concomitantly administered CNS depressant drugs are not reduced patients may experience an increased incidence of adverse effects associated with these agents.

Sedative medicines such as benzodiazepines or related drugs
The concomitant use of opioids with sedative medicines such as benzodiazepines or related drugs increases the risk of sedation, respiratory depression, coma and death because of additive CNS depressant effect. The dose and duration of

concomitant use should be limited (see section 4.4). The concomitant use of opioids and gabapentinoids (gabapentin and pregabalin) increases the risk of opioid overdose, respiratory depression and death.

Co-administration of remifentanil with a serotonergic agent, such as Selective Serotonin Reuptake Inhibitors (SSRIs), Serotonin Norepinephrine Reuptake Inhibitors (SNRIs) or Monoamine Oxidase Inhibitors (MAOIs) may increase the risk of serotonin syndrome, a potentially life-threatening condition. Caution should be exercised with concomitant use of MAOIs. Irreversible MAOIs should be discontinued at least 2 weeks prior to remifentanil use.

The cardiovascular effects of remifentanil (hypotension and bradycardia – *see sections 4.4 and 4.8*), may be exacerbated in patients receiving concomitant cardiac depressant drugs, such as beta-blockers and calcium channel blocking agents.

4.6 Fertility, pregnancy and lactation

Pregnancy:
There are no adequate and well-controlled studies in pregnant women. Remifentanil should be used during pregnancy only if the potential benefit justifies the potential risk to the foetus.

Lactation:
It is not known whether remifentanil is excreted in human milk. However, because fentanyl analogues are excreted in human milk and remifentanilrelated material was found in rat milk after dosing with remifentanil, nursing mothers should be advised to discontinue breast feeding for 24 hours following administration of remifentanil.

Fertility:
For a summary of the reproductive toxicity study findings please refer to Section 5.3 Preclinical safety data.

Labour and delivery:
The safety profile of remifentanil during labour or delivery has not been demonstrated. There are insufficient data to recommend remifentanil for use during labour and Caesarean section. It is known that remifentanil crosses the placental barrier and fentanyl analogues can cause respiratory depression in the child. In case remifentanil is administered nevertheless, the patient and the neonate must be monitored for signs of excess sedation or respiratory depression (see section 4.4).

4.7 Effects on ability to drive and use machines

After anaesthesia with remifentanil the patient should not drive or operate machinery. The physician should decide when these activities may be resumed. It is advisable that the patient is accompanied when returning home and that alcoholic drink is avoided.

This medicine can impair cognitive function and can affect a patient's ability to drive safely. When prescribing this medicine, patients should be told:

- The medicine is likely to affect your ability to drive
- Do not drive until you know how the medicine affects you
- It may be an offence to drive while under the influence of this medicine.

4.8 Undesirable effects

The most common undesirable effects associated with remifentanil are direct extensions of micro-opioid agonist pharmacology. These adverse events resolve within minutes of discontinuing or decreasing the rate of remifentanil administration.

Frequencies below are defined as very common (³1/10), common (³1/100 to <1/10), uncommon (³1/1,000 and <1/100), are rare (³1/10,000 to <1/1000), very rare (<1/10,000) and not known (cannot be estimated from the available data).

Immune system disorders
Rare: Allergic reactions including anaphylaxis have been reported in patients receiving remifentanil in conjunction with one or more anaesthetic agents.

Psychiatric disorders

Not known: Drug dependence, Withdrawal syndrome

Nervous system disorders
Very common: Skeletal muscle rigidity
Rare: Sedation (during recovery from general anaesthesia)
Not known: Convulsions

Cardiac disorders
Common: Bradycardia
Rare: Asystole/cardiac arrest, usually preceded by bradycadia, has been reported in patients receiving remifentanil in conjunction with other anaesthetic agents.
Not known: Atrioventricular block, Arrhythmia

Vascular disorders
Very common: Hypotension
Common: Post-operative hypertension

Respiratory, thoracic and mediastinal disorders
Common: Acute respiratory depression, apnoea, Cough
Uncommon: Hypoxia

Gastrointestinal disorders
Very common: Nausea, vomiting
Uncommon: Constipation

Skin and subcutaneous tissue disorders
Common: Pruritus

General disorders and administration site conditions
Common: Post-operative shivering
Uncommon: Post-operative aches
Not known: Drug tolerance

Discontinuation of treatment
Symptoms following withdrawal of remifentanil including tachycardia, hypertension and agitation have been reported infrequently upon abrupt cessation, particularly after prolonged administration of more than 3 days (see section 4.4).

Reporting of suspected adverse reactions
Reporting suspected adverse reactions after authorisation of the medicinal product is important. It allows continued monitoring of the benefit/risk balance of the medicinal product. Healthcare professionals are asked to report any suspected adverse reactions via HPRA Pharmacovigilance, Website: www.hpra.ie.

4.9 Overdose

As with all potent opioid analgesics, overdose would be manifested by an extension of the pharmacologically predictable actions of remifentanil. Due to the very short duration of action of remifentanil, the potential for deleterious effects due to overdose are limited to the immediate time period following drug administration. Response to discontinuation of the drug is rapid, with return to baseline within ten minutes.

In the event of overdose or suspected overdose, take the following actions: discontinue administration of remifentanil, maintain a patent airway, initiate assisted or controlled ventilation with oxygen and maintain adequate cardiovascular function. If depressed respiration is associated with muscle rigidity, a neuromuscular blocking agent may be required to facilitate assisted or controlled respiration.
Intravenous fluids and vasopressor for the treatment of hypotension and other supportive measures may be employed.

Intravenous administration of an opioid antagonist such as naloxone may be given as a specific antidote to manage severe respiratory depression and muscle rigidity. The duration of respiratory depression following overdose with remifentanil is unlikely to exceed the duration of action of the opioid antagonist.

5 PHARMACOLOGICAL PROPERTIES

5.1 Pharmacodynamic properties

Pharmacotherapeutic group: Nervous system; anesthetics, Opioid anesthetics,
ATC code: N01AH06

Remifentanil is a selective mu-opioid agonist with a rapid onset and very short duration of action. The mu-opioid activity of remifentanil is antagonized by narcotic antagonists, such as naloxone.

Assays of histamine in patients and normal volunteers have shown no elevation in histamine levels after administration of remifentanil in bolus doses up to 30 micrograms/kg.

Neonates/infants (aged less than 1 year)
In a randomised (ratio of 2:1, remifentanil:halothane), open label, parallel group, multicentre study in 60 young infants and neonates 8 weeks of age (mean 5.5 weeks) with an ASA physical status of I-II who were undergoing pyloromyotomy, the efficacy and safety of remifentanil (given as a 0.4 micrograms/kg/min initial continuous infusion plus supplemental doses or infusion rate changes as needed) was compared with halothane (given at 0.4% with supplemental increases as needed). Maintenance of anaesthesia was achieved by the additional administration of 70% nitrous oxide (N20) plus 30% oxygen. Recovery times were superior in the remifentanil relative to the halothane groups (not significant).

Use for Total Intravenous anaesthesia (TIVA) - children aged 6 months to 16 years
TIVA with remifenanil in paediatric surgery was compared to inhalation anaesthesia in three randomised, open- label studies. The results are summarised in the table below.

Surgical intervention	**Age (y), (N)**	**Study condition (maintenance)**	**Extubation (min)** **(mean (SD))**
Lower abdominal/urological surgery	0.5 – 16 (120)	TIVA: propofol (5-10 mg/kg/h) + remifentanil (0.125 – 1.0 micrograms/kg/min)	11.8 (4.2)
		Inhalation anaesthesia: sevoflurane (1.0 – 1.5 MAC) and remifentanil (0.125 – 1.0 micrograms/kg/min)	15.0 (5.6) ($p<0.05$)
ENT-surgery	4-11 (50)	TIVA: propofol (3 mg/kg/h) + remifentanil (0.5 micrograms/kg/min)	11 (3.7)
		Inhalation anaesthesia: desflurane (1.3 MAC) and N_2O mixture	9.4 (2.9) Not significant
General or ENT surgery	2-12 (153)	TIVA: remifentanil (0.2 – 0.5 micrograms/kg/min) + propofol (100 – 200 micrograms/kg/min)	Comparable extubation times (based on limited data)
		Inhalation anaesthesia: sevoflurane (1-1.5 MAC) + N_2O mixture	

In the study in lower abdominal/urological surgery comparing remifentanil/propofol with remifentanil/sevoflurane, hypotension occurred significantly more often under remifentanil/sevoflurane, and bradycardia occurred significantly more often under remifentanil/propofol. In the study in ENT surgery comparing remifentanil/propofol with desflurane/nitrous oxide, a significantly higher heart rate was seen in subjects receiving desflurane/nitrous oxide compared with remifentanil/propofol and with baseline values.

5.2 Pharmacokinetic properties

Following administration of the recommended doses of remifentanil, the effective half-life is 3-10 minutes. The average clearance of remifentanil in adolescents is 40ml/min/kg, the central volume of distribution is 100 ml/kg and the steady-state

volume of distribution is 350 ml/kg. Blood concentrations of remifentanil are proportional to the dose administered throughout the recommended dose range. For every 0.1micrograms/kg/min increase in infusion rate, the blood concentration of remifentanil will rise 2.5ng/ml.
Remifentanil is approximately 70% bound to plasma proteins.

Metabolism:
Remifentanil is an esterase metabolised opioid that is susceptible to metabolism by non-specific blood and tissue esterases. The metabolism of remifentanil results in the formation of a carboxylic acid metabolite which in dogs is 1/4600th as potent as remifentanil. Studies in man indicate that all pharmacological activity is associated with the parent compound. The activity of this metabolite is therefore not of any clinical consequence. The half life of the metabolite in healthy adults is 2 hours.

In patients with normal renal function, the time for 95% elimination of the primary metabolite of remifentanil by the kidneys, is approximately 7 to 10 hours. Remifentanil is not a substrate for plasma cholinesterase.

Placental and milk transfer:
Placental transfer studies in rats and rabbits showed that pups are exposed to remifentanil and/or its metabolites during growth and development. Remifentanil-related material is transferred to the milk of lactating rats. In a human clinical trial, the concentration of remifentanil in foetal blood was approximately 50% of that in maternal blood. The foetal arterio-venous ratio of remifentanil concentrations was approximately 30%, suggesting metabolism of remifentanil in the neonate.

Cardiac Anaesthesia:
The clearance of remifentanil is reduced by approximately 20% during hypothermic (28°C) cardiopulmonary bypass. A decrease in body temperature lowers elimination clearance by 3% per degree centigrade.

Renal impairment:
In the clinical studies conducted to date, the rapid recovery from remifentanil-based analgesia appears unaffected by renal status.

The pharmacokinetics of remifentanil are not significantly changed in patients with varying degrees of renal impairment even after administration for up to 3 days in the intensive care setting.

The clearance of the carboxylic acid metabolite is reduced in patients with renal impairment.
In intensive care patients with moderate/severe renal impairment, the concentration of the carboxylic acid metabolite is expected to reach approximately 100-fold the level of remifentanil at steady-state. Clinical data demonstrates that accumulation of the metabolite does not result in clinically relevant micro-opioid effects even after administration of remifentanil infusions for up to 3 days in these patients. There are no data available on the safety and pharmacokinetic profile of the metabolite following infusions of remifentanil for durations greater than 3 days.
There is no evidence that remifentanil is extracted during renal replacement therapy.

The carboxylic acid metabolite is extracted during haemodialysis by at least 30%.

Hepatic impairment:
The pharmacokinetics of remifentanil are not changed in patients with severe hepatic impairment awaiting liver transplant, or during the anhepatic phase of liver transplant surgery. Patients with severe hepatic impairment may be slightly more sensitive to the respiratory depressant effects of remifentanil. These patients should be closely monitored and the dose of remifentanil should be titrated to the individual patient need.

Paediatric patients:
The average clearance and steady state of volume of distribution of remifentanil are increased in younger children and decline to adolescents values by age 17.

The elimination half-life of remifentanil in neonates is not significantly different from that of adolescents. Changes in analgesic effect after changes in infusion rate of remifentanil should be rapid and similar to those seen in adolescents. The pharmacokinetics of the carboxylic acid metabolite in paediatric patients 2-17 years of age are similar to those seen in adults after correcting for differences in body weight.

Elderly:
The clearance of remifentanil is slightly reduced (approximately 25%) in elderly patients>65 years) compared to young patients. The pharmacodynamic activity of remifentanil increases with increasing age. Elderly patients have a remifentanil EC_{50} for

formation of delta waves on the electroencephalogram (EEG) that is 50% lower than young patients; therefore, the initial dose of remifentanil should be reduced by 50% in elderly patients and then carefully titrated to meet the individual patient need.

5.3 Preclinical safety data

Remifentanil, like some other fentanyl analogues, produced increases in action potential duration (APD) in dog isolated Purkinje fibres. There were no effects at a concentration of 0.1 micromolar (38ng/ml). Effects were seen at a concentration of 1 micromolar (377ng/ml), and were statistically significant at a concentration of 10 micromolar (3770ng/mL). These concentrations are 12-fold and 119-fold respectively the highest likely free concentrations (or 3-fold and 36- fold respectively, the highest likely whole blood concentrations) following the maximum recommended therapeutic dose.

Acute toxicity:
Expected signs of mu-opioid intoxication were observed in non-ventilated mice, rats, and dogs after large single bolus intravenous doses of remifentanil. In these studies, the most sensitive species, the male rat, survived following administration of 5mg/kg.

Hypoxia-induced brain microhaemorrhages observed in dogs were reversed within 14 days after completion of dosing.

Repeat dose toxicity:
Bolus doses of remifentanil administered to non-ventilated rats and dogs resulted in respiratory depression in all dose groups, and in reversible brain microhaemorrhages in dogs. Subsequent investigations showed that the microhaemorrhages resulted from hypoxia and were not specific to remifentanil. Brain microhaemorrhages were not observed in infusion studies in nonventilated rats and dogs because these studies were conducted at doses that did not cause severe respiratory depression.

It is to be derived from preclinical studies that respiratory depression and associated sequelae are the most likely cause of potentially serious adverse events in humans.

Intrathecal administration to dogs of the glycine formulation alone (i.e. without remifentanil) caused agitation, pain and hind limb dysfunction and incoordination. These effects are believed to be secondary to the glycine excipient. Because of the better buffering properties of blood, the more rapid dilution, and the low glycine concentration of the remifentanil formulation, this finding has no clinical relevance for intravenous administration of remifentanil.

Reproductive toxicity studies:
Remifentanil reduced fertility in male rats after daily injection for at least 70 days. A no-effect dose was not demonstrated. Fertility was not affected in female rats. Teratogenic effects were not seen in rats or rabbits. Administration of remifentanil to rats throughout late gestation and lactation did not significantly affect the survival, development, or reproductive performance of the F_1 generation.

Genotoxicity:
Remifentanil did not yield positive findings in a series of in vitro and in vivo genotoxicity tests, except in the in vitro mouse lymphoma tk assay, which gave a positive result with metabolic activation. Since the mouse lymphoma results could not be confirmed in further in vitro and in vivo tests, treatment with remifentanil is not considered to pose a genotoxic hazard to patients.

Carcinogenicity:
Long-term carcinogenicity studies were not performed.

6 PHARMACEUTICAL PARTICULARS

6.1 List of excipients

Glycine
Hydrochloric acid 37% (for pH-adjustment)

6.2 Incompatibilities

Remifentanil must not be mixed with other medicinal products except those mentioned in section 6.6.

It should not be mixed with Lactated Ringer's Solution for Injection or Lactated Ringer's and Glucose 50 mg/ml (5%) Solution for Injection.

Remifentanil should not be mixed with propofol in the same intravenous admixture solution.

Administration of remifentanil into the same intravenous line with blood/serum/plasma is not recommended. Non-specific esterases in blood products may lead to the hydrolysis of remifentanil to its inactive metabolite.

6.3 Shelf life

Vials:
Remifentanil 2 mg: 2 years

Shelf life after reconstitution:
Chemical and physical in-use stability has been demonstrated for 24 hours at 25°C.

From a microbiological point of view, the product should be used immediately. If not used immediately, in-use storage times and conditions prior to use are the responsibility of the user and would normally not be longer than 24 hours at 2 to 8°C, unless reconstitution has taken place in controlled and validated aseptic conditions.

Shelf life after dilution:
All mixtures with infusion fluids should be used immediately.

6.4 Special precautions for storage

Do not store above 25°C.

For storage conditions after reconstitution and dilution of the concentrate see *section 6.3*

6.5 Nature and contents of container

Glass vial (type I) with chlorobutyl rubber stopper and flip-off cap:
Pack size of 5 x 3 ml vials

Not all pack sizes may be marketed.

6.6 Special precautions for disposal and other handling

Remifentanil should be prepared for intravenous use by adding, as appropriate 1, 2 or 5ml of diluent to give a reconstituted solution with a concentration of approximately 1 mg/ml remifentanil.
The appearance of the solution is clear, colourless and practically free from particulate material.

After reconstitution the solution should be visually inspected on contaminations, colour or a defective container. The solution should be discarded, if any of these modifications should appear. The reconstituted solution should be used immediately. Residuals must be discarded.

Remifentanil should not be administered by manually-controlled infusion without further dilution to concentrations of 20 to 250 micrograms/ml (50 micrograms/ml is the recommended dilution for adults and 20 to 25 micrograms/ml in paediatric patients aged 1 year and over).

Remifentanil should not be administered by target-controlled infusion (TCI) without further dilution (20 to 50 micrograms/ml is the recommended dilution for TCI).
The dilution is dependent upon the technical capability of the infusion device and the anticipated requirements of the patient.

Remifentanil has been shown to be compatible with the following intravenous fluids when administered into a running IV catheter:

Water for Injections

Glucose 50 mg/ml (5%) solution for injection
Glucose 50 mg/ml (5%) and Sodium Chloride 9 mg/ml (0.9%) solution for injection
Sodium Chloride 9 mg/ml (0.9%) solution for injection
Sodium Chloride 4,5 mg/ml (0.45%) solution for injection

After dilution, the solution should be inspected visually to ensure it is clear, colourless, practically free from particulate matter and the container is undamaged. Any solution where such defects are observed must be discarded.

Remifentanil has been shown to be compatible with the following intravenous fluids when administered into a running IV catheter:

Lactated Ringer's solution for injection
Lactated Ringer's and Glucose 50 mg/ml (5%) solution for injection

Remifentanil has been shown to be compatible with propofol when administered into a running IV catheter.

The following tables give guidelines for infusion rates of remifentanil for manually-controlled infusion:

Table 1: Remifentanil – Infusion Rates (ml/kg/h)

Drug Delivery Rate (microgram/kg/min)	Infusion Rate (ml/kg/h) for Solution Concentrations of			
	20 microgram/ml 1mg/50ml	25 microgram/ml 1mg/40ml	50 microgram/ml 1mg/20ml	250 microgram/ml 10 mg/40ml
0.0125	0.038	0.03	0.015	Not recommended
0.025	0.075	0.06	0.03	Not recommended
0.05	0.15	0.12	0.06	0.012
0.075	0.23	0.18	0.09	0.018
0.1	0.3	0.24	0.12	0.024
0.15	0.45	0.36	0.18	0.036
0.2	0.6	0.48	0.24	0.048
0.25	0.75	0.6	0.3	0.06
0.5	1.5	1.2	0.6	0.12
0.75	2.25	1.8	0.9	0.18
1.0	3.0	2.4	1.2	0.24
1.25	3.75	3.0	1.5	0.3
1.5	4.5	3.6	1.8	0.36
1.75	5.25	4.2	2.1	0.42
2.0	6.0	4.8	2.4	0.48

Table 2: Remifentanil - Infusion Rates (ml/h) for a 20microgram/ml Solution

Infusion Rate (microgram/kg/min)	Patient Weight (kg)						
	5	10	20	30	40	50	60
0.0125	0.188	0.375	0.75	1.125	1.5	1.875	2.25
0.025	0.375	0.75	1.5	2.25	3.0	3.75	4.5
0.05	0.75	1.5	3.0	4.5	6.0	7.5	9.0
0.075	1.125	2.25	4.5	6.75	9.0	11.25	13.5
0.1	1.5	3.0	6.0	9.0	12.0	15.0	18.0
0.15	2.25	4.5	9.0	13.5	18.0	22.5	27.0
0.2	3.0	6.0	12.0	18.0	24.0	30.0	36.0
0.25	3.75	7.5	15.0	22.5	30.0	37.5	45.0
0.3	4.5	9.0	18.0	27.0	36.0	45.0	54.0
0.35	5.25	10.5	21.0	31.5	42.0	52.5	63.0
0.4	6.0	12.0	24.0	36.0	48.0	60.0	72.0

Table 3: Remifentanil – Infusion Rates (ml/h) for a 25 microgram/ml Solution

Infusion Rate (microgram/kg/min)	Patient Weight (kg)

	10	20	30	40	50	60	70	80	90	100
0.0125	0.3	0.6	0.9	1.2	1.5	1.8	2.1	2.4	2.7	3.0
0.025	0.6	1.2	1.8	2.4	3.0	3.6	4.2	4.8	5.4	6.0
0.05	1.2	2.4	3.6	4.8	6.0	7.2	8.4	9.6	10.8	12.0
0.075	1.8	3.6	5.4	7.2	9.0	10.8	12.6	14.4	16.2	18.0
0.1	2.4	4.8	7.2	9.6	12.0	14.4	16.8	19.2	21.6	24.0
0.15	3.6	7.2	10.8	14.4	18.0	21.6	25.2	28.8	32.4	36.0
0.2	4.8	9.6	14.4	19.2	24.0	28.8	33.6	38.4	43.2	48.0

Table 4: Remifentanil – Infusion Rates (ml/h) for a 50 microgram/ml Solution

Infusion Rate (microgram/kg/min)	Patient Weight (kg)							
	30	40	50	60	70	80	90	100
0.025	0.9	1.2	1.5	1.8	2.1	2.4	2.7	3.0
0.05	1.8	2.4	3.0	3.6	4.2	4.8	5.4	6.0
0.075	2.7	3.6	4.5	5.4	6.3	7.2	8.1	9.0
0.1	3.6	4.8	6.0	7.2	8.4	9.6	10.8	12.0
0.15	5.4	7.2	9.0	10.8	12.6	14.4	16.2	18.0
0.2	7.2	9.6	12.0	14.4	16.8	19.2	21.6	24.0
0.25	9.0	12.0	15.0	18.0	21.0	24.0	27.0	30.0
0.5	18.0	24.0	30.0	36.0	42.0	48.0	54.0	60.0
0.75	27.0	36.0	45.0	54.0	63.0	72.0	81.0	90.0
1.0	36.0	48.0	60.0	72.0	84.0	96.0	108.0	120.0
1.25	45.0	60.0	75.0	90.0	105.0	120.0	135.0	150.0
1.5	54.0	72.0	90.0	108.0	126.0	144.0	162.0	180.0
1.75	63.0	84.0	105.0	126.0	147.0	168.0	189.0	210.0
2.0	72.0	96.0	120.0	144.0	168.0	192.0	216.0	240.0

Table 5: Remifentanil - Infusion Rates (ml/h) for a 250 microgram/ml Solution

Infusion Rate (microgram/kg/min)	Patient Weight (kg)							
	30	40	50	60	70	80	90	100
0.1	0.72	0.96	1.20	1.44	1.68	1.92	2.16	2.40
0.15	1.08	1.44	1.80	2.16	2.52	2.88	3.24	3.60
0.2	1.44	1.92	2.40	2.88	3.36	3.84	4.32	4.80
0.25	1.80	2.40	3.00	3.60	4.20	4.80	5.40	6.00
0.5	3.60	4.80	6.00	7.20	8.40	9.60	10.80	12.00
0.75	5.40	7.20	9.00	10.80	12.60	14.40	16.20	18.00
1.0	7.20	9.60	12.00	14.40	16.80	19.20	21.60	24.00
1.25	9.00	12.00	15.00	18.00	21.00	24.00	27.00	30.00
1.5	10.80	14.40	18.00	21.60	25.20	28.80	32.40	36.00
1.75	12.60	16.80	21.00	25.20	29.40	33.60	37.80	42.00
2.0	14.40	19.20	24.00	28.80	33.60	38.40	43.20	48.00

The following table provides the equivalent blood remifentanil concentration using a TCI approach for various manually-controlled infusion rates at steady state:

Table 6: Remifentanil Blood Concentrations (nanograms/ml) estimated using the Minto (1997) Pharmacokinetic Model in a 70 kg, 170 cm, 40 Year Old Male Patient for Various Manually-Controlled Infusion rates (micrograms/kg/min) at Steady State.

Remifentanil Infusion Rate (micrograms/kg/min)	Remifentanil Blood Concentration (nanograms/ml)
0.05	1.3
0.10	2.6
0.25	6.3
0.40	10.4
0.50	12.6
1.0	25.2

2.0	50.5

7 MARKETING AUTHORISATION HOLDER

Pinewood Laboratories Ltd,
Ballymacarbry
Clonmel
Co. Tipperary
Ireland

8 MARKETING AUTHORISATION NUMBER

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