ABSTRACT

Aims: The aim of this study was to develop and implement guidelines for sedation and analgesia management in the paediatric intensive care unit (PICU) and evaluate the impact, feasibility and acceptability of these as part of a programme of research in this area and as a prelude to future trial work.

Method: This pilot study used a pre–post design using a historical control.

Setting: Two PICUs at different hospitals in an Australian metropolitan city.

Participants: Patients admitted to the PICU and ventilated for ≥24 h, aged more than 1 month and not admitted for seizure management or terminal care.

Intervention: Guidelines for sedation and analgesia management for critically ill children including algorithm and assessment tools.

Outcome variables: In addition to key outcome variables (ventilation time, medication dose and duration, length of stay), feasibility outcomes data (recruitment, data collection, safety) were evaluated. Guideline adherence was assessed through chart audit and staff were surveyed about merit and the use of guidelines.

Results: The guidelines were trialled for a total of 12 months on 63 patients and variables compared with the historical control group (n=75). Analysis revealed differences in median Morphine infusion duration between groups (pretest 3.63 days (87 h) vs post-test 2.83 days (68 h), p=0.05) and maximum doses (pretest 120 μg/kg/h vs post-test 97.5 μg/kg/h) with no apparent change to ventilation duration. Chart audit revealed varied use of tools, but staff were positive about the guidelines and their use in practice.

Conclusions: The sedation guidelines impacted on the duration and dosage of agents without any apparent impact on ventilation duration or length of stay. Furthermore, the guidelines appeared to be feasible and acceptable in clinical practice. The results of the study have laid the foundation for follow-up research.

INTRODUCTION

Sedation and analgesia are necessary components in the care of all critically ill patients, especially those requiring mechanical ventilation. The main indications for their use include: to reduce patient pain, anxiety and agitation, induce amnesia, facilitate mechanical ventilation, prevent the displacement of endotracheal tubes, and decrease cellular metabolism.1–3 The detrimental impact of poor sedation practices intensive care units (ICUs) has increasingly become a focus for researchers and clinicians. The impetus for this stem from concerns about under-sedation and over-sedation.4 Both under-sedation and over-sedation have the potential to lead to agitation in the ICU patient include central nervous system activation, gastrointestinal disturbances and sympathetic hyperactivity. These signs and symptoms have been related to tolerance and withdrawal phenomena and also hold implications for the patient’s physical and psychological well-being.
being as well as healthcare costs. These risks are potentially amplified in the critically ill child in the paediatric ICU (PICU) due to the developing brain. The aim of this study was to develop and implement guidelines for sedation and analgesia management in the PICU and evaluate the impact, feasibility and acceptability of these as a part of programme of research in this area and as a prelude to future trial work.

BACKGROUND
The 2006 consensus guidelines on sedation and analgesia in critically ill children established a standard for clinical practice in PICUs. The guidelines’ key recommendations include advice on a loading dose and administration for analgesia and sedation medication, the use of validated pain and sedation assessment tools, withdrawal assessment, and the inclusion of non-pharmacological interventions. Surveys of sedation and analgesia management in PICUs have identified a lack of specific protocols for sedation and analgesia management. This research has also highlighted wide variations in physician practice, nursing assessment, pharmacological agents, as well as administrative methods and doses. Limited use of assessment tools has also been reported, and there were no measurements or guidelines for withdrawal of drugs.

A number of studies have attempted to evaluate the impact of sedation and analgesia guidelines in PICU; however, the results have been varied. Each of the studies successively added to our knowledge and understanding of sedation and analgesia management in critically ill children. However, differences in guideline specifics, models of care and study design may have contributed to the varied outcomes observed in the studies and limited their ability to inform best clinical practice. The aim of this study was to develop sedation and analgesia management guidelines based on the 2006 consensus recommendation and test their impact on patient outcomes as well as feasibility and acceptability in practice as a prelude to rigorous trial evaluation of guidelines in practice.

METHODS
Aims and objectives of study
The aim of this study was to develop and implement guidelines for sedation and analgesia management in the PICU and, following this, evaluate the impact, and acceptability and feasibility of their use in the clinical setting.

Study design
This dual site study used a pragmatic pretest and post-test design to examine the feasibility and impact of the guidelines on patient and practice outcomes. A chart audit was used to assess the implementation fidelity and a (nursing) staff survey was conducted to ascertain staff perceptions of guideline utility and acceptability in practice. The requirement for consent was waived.

Setting
The study units were two eight-bed, mixed medical–surgical (not cardiac surgery) PICUs located at tertiary referral children’s hospitals admitting patients from 0 to 16 years of age. Postregistration qualifications in either pediatrics, ICU or PICU, were held by approximately 48% of the nursing staff.

Sample and participants
The target population was all patients ventilated for ≥24 h within the PICU, aged more than 1 month and not admitted for seizure management or terminal care. All eligible patients were consecutively enrolled into the study. As the main aim of the study was feasibility and acceptability of guidelines rather than hypothesis testing, the statistical power of the sample was of reduced importance at this stage. Charts of patients in the post-implementation phase were the focus of the audit. All nursing staff were invited to participate in the survey gauging staff perceptions and use of the guidelines in practice.

Guideline development
The sedation and analgesia guidelines for this study were developed around an algorithm for each of the identified phases of sedation (see online supplementary appendix 1). The key recommendations of the guidelines developed and tested in this study were based on the key recommendations in the 2006 consensus paper which are summarised in table 1.

A range of non-pharmacological strategies to minimise patient stress and pain and optimise comfort are supported by varying levels of evidence ranging from case studies to Cochrane systematic reviews. These were not new strategies, but it was important to incorporate them into the guidelines to promote a holistic approach to pain and sedation management and reflect the recommendations of the consensus guidelines. Strategies recommended were aimed at moderating the PICU environment where possible (ie, minimising high-intensity light and noise, ensuring rest periods); minimising discomfort of invasive devices; regular repositioning and limb support with pillows, pressure relieving devices or swaddling; monitoring and optimising hydration, nutrition and essential cares (eg, oral and eye care); supporting parental visitation and reassurance as well as therapeutic (non-technical) touch.

New assessment scales for behavioural state, pain and withdrawal assessment were integral to the guidelines. These included the State Behaviour Scale (SBS), the Multidisciplinary Assessment of Pain Scale (MAPS) and the Opioid Benzodiazepine Withdrawal Assessment Scale (WAS).

The three phases of sedation (acute, plateau and weaning) management were derived from patterns
observed in a retrospective audit conducted earlier by the research team and from the literature. The guidelines reflect the dynamic nature of a PICU patient’s admission and allow for movement between and within phases according to the patient’s need, response and condition.

As the main aim of the guidelines was to improve consistency in medication practices, it was vital to get a consensus on prescribing practices within the study units. Even the authors of the consensus guidelines noted that there was limited evidence to draw on and the recommendations were based on knowledge of drug pharmacokinetics, case study reports, expert opinion and also the understanding of pain management, drug tolerance and withdrawal medicine. Morphine and midazolam are the most common analgesic and sedative agents used in PICUs and the drugs of choice in the study units. They are typically used in combination as together they have a synergistic effect that often allows for use of lower doses. Midazolam doses can be reduced as much as 30–50% when combined with an opioid. Nonetheless, prolonged and/or heavy sedation persists in critical care units, and as a result tolerance and withdrawal syndrome complicate recovery.

In the acute phase, the guidelines proposed a significant loading dose to achieve the desired analgesia and sedation goals, followed by regular patient assessment and incremental medication changes to achieve and maintain these goals. If the maximum dose allowed was reached (ie, 300 μg/kg/h for the past 4 h), then use of adjunct or alternative drugs was recommended (ie, clonidine, fentanyl). ‘Drug cycling’ has been reported to be helpful in the UK, where 25% of PICUs surveyed reported rotation of sedatives to minimise tolerance. In another paper, consultant intensivists conducted biweekly chart reviews of each patient in the ICU and regularly changed their sedation regimens. Although these authors imply success with drug tolerance, no numerical data was offered in support.

Once in the plateau phase, the key change in practice was the recommended conversion from intravenous to long-acting enteral agents. This approach is based on the principles of narcotic withdrawal where withdrawal syndrome is managed by conversion to an orally active drug with a longer half-life (such as methadone or diazepam) that has a more steady state serum concentration, more readily facilitating a slow tapering of the drug and minimising the severity of withdrawal symptoms or

| Table 1 | Summary of 2006 consensus paper recommendations for sedation management of critically ill children |
|---|---|
| 1. Non-pharmacological interventions | i. Any correctable environmental and physical factors causing discomfort should be addressed alongside the introduction of pharmacological agents.  
ii. A normal pattern of sleep should be encouraged. Attention should be paid to lighting, environmental noise and temporal orientation of patients.  
iii. All critically ill children have the right to adequate relief of their pain. Local and regional anaesthetic techniques should be considered. A patient controlled analgesia (PCA) device may be useful in older children.  
| 2. Pain assessment and analgesic management | Pain assessment should be performed regularly by using a scale appropriate to the age of the patient and routinely documented. The level of pain reported by the patient must be considered the current standard of analgesia. Patients who cannot communicate should be assessed for the presence of pain-related behaviours and physiological indicators of pain. A therapeutic plan for analgesia should be established for each patient and regularly reviewed.  
iii. Recommended pharmacological agents for analgesia include opioids (eg, morphine, fentanyl) for the relief of severe pain, non-steroidal anti-inflammatory drugs (NSAIDs) for moderately severe pain, and paracetamol for mild to moderate pain.  |
| 3. Sedation assessment and recommended or commonly used sedative agents | i. Adequate analgesia should be provided to all critically ill children regardless of the need for sedation. The use of clinical guidelines for sedation is recommended.  
ii. The level of sedation should be regularly assessed and documented using a validated and age-appropriate sedation assessment scale. The desired level of sedation should be identified for each patient and regularly reassessed. Doses of sedative agents should be titrated to produce the desired level of sedation.  
iii. Recommended pharmacological agents for sedation include midazolam or clonidine. Early use of enteral sedative agents (eg, chloral hydrate, promethazine) is recommended. Propofol should not be used to provide continuous sedation in critically ill children.  |
| 4. Withdrawal syndrome assessment, prevention and management | i. The potential for opioid and benzodiazepine withdrawal syndrome should be considered after 7 days of continuous therapy.  
ii. When subsequently discontinued, the doses of these agents may need to be routinely tapered.  |
even development of the withdrawal syndrome. The advantages of methadone are an oral bioavailability of 75–80%, allowing for oral administration, and a prolonged half-life of 12–24 h, allowing twice daily administration (ibid). There is a general reluctance to use diazepam for critically ill patients because of its long elimination and concerns about excessive and prolonged sedation. However, similar to methadone, diazepam’s long-acting active metabolites theoretically should result in small changes in serum drug concentrations and may decrease fluctuations in sedation state and therefore be a more appropriate agent for long-term sedated patients.

The formal acknowledgement of a sedation weaning phase with a dedicated assessment tool and tapering regime was new practice for the study units. No validated opioid or benzodiazepine weaning schedule was found; however, a consensus of opinion across the literature supports a daily reduction of 5–10% or an initial reduction of 20–40%, followed by a 10% reduction or twice daily, depending on the patient response. The protocol for sedation weaning incorporated into these guidelines approximated these recommendations.

Guideline implementation
The guidelines encompassed many changes in practice: new assessment scales, standardisation of practice, conversion to oral agents, algorithms and a discreet weaning pathway. In the interest of maximising staff understanding and uptake of the tools, a phased implementation process was adopted with the gradual introduction of each tool into the units, followed by orientation and implementation of the algorithm phases and medication administration. Staff in-services introducing the study and guidelines were held over an initial fortnight with administration. Staff in-services introducing the study and guidelines were held over an initial fortnight with implementation of the algorithm phases and medication administration. Staff in-services introducing the study and guidelines were held over an initial fortnight with administration. Staff in-services introducing the study and guidelines were held over an initial fortnight with administration.

In practice, the PICU team set sedation and analgesia goals as part of the daily patient review and staff at the bedside (usually nurses) used the guidelines to achieve the set goals.

Outcome variables
Data were collected from all eligible patients over 24 months (12 months historical control and 12 months post-implementation), plus a break to allow for the implementation period. In addition to the main study outcomes, the pilot study collected outcomes to establish feasibility of the protocol and processes. The main study outcomes measured included total ventilation time (TVT), sedation doses and duration, LOS in the PICU, plus quality indicators, such as accidental extubation and readmission rates. It was important to establish that the outcomes were not adversely affected by the guidelines before considering larger and more extensive trial work. Feasibility data outcomes included the success of screening and recruitment strategies; data collection and entry processes; confirmation of Research Nurse time and cost, and produced further estimates of ventilation times and medication dosing, which can be used to finalise sample size requirements for the larger trial, and inform funding applications for same. Potentially confounding variables collected included patient age, gender, diagnosis and the Paediatric Index of Mortality (PIM2) as a measure of acuity. Nurses in the study setting routinely collect and record standard demographic and biophysiological patient measurements on the local computerised information system. The revised PIM2 is a simple model of mortality in PICU based on admission data and uses 10 explanatory variables. Post-implementation compliance/fidelity was assessed by chart review using an audit tool based on the 19 key components of the guidelines. Adherence to 75% of the key components overall and then within each phase was nominally chosen as the minimum acceptable value for fidelity at this stage. However, the results whatever they were would inform any future implementation processes and trial work. Nursing staff perceptions of the guidelines were ascertained through administration of a researcher-developed survey with questions on ease of use, impact on practice, perceived benefit, facilitation of team management and promotion of nurse autonomy at the bedside. Staff members were also given the opportunity to comment on strengths and limitations of the guidelines.

Statistical analysis
Data were analysed using PASW V.18.0 (SPSS Inc.). Descriptive statistics were used for demographic data. Continuous values reported were medians and ranges due to the large spread of the data. Categorical variables were reported as counts and percentages. Non-parametric Mann-Whitney or Cross tabulation and Pearson’s \( \chi^2 \) were performed to compare groups. The probability of remaining ventilated between groups was analysed using survival analysis. Adherence to guidelines was reported in counts and percentages. The influence of diagnostic group on guideline adherence was analysed using Pearson’s correlation and comparison of means using Student t test. Survey responses were reported in counts and percentages as well as significant themes derived from qualitative data.

RESULTS
During the two study periods (12 months each), 173 and 235 patients were ventilated in the respective preguideline and postguideline implementation periods. After screening for eligibility, 75 and 70 patients were enrolled into the pre and post groups. Seven patients were lost to the study in the post-test group because of deviation from research protocol (n=5), one group of parents did not consent to use the drugs, and one was transferred to
another hospital. Ultimately, there were 75 in the control group and 63 in the post-implementation group. Data were analysed on a *per-protocol* basis. Figure 1 demonstrates the sampling framework and exclusion criteria.

Table 2 shows the main characteristics measured for each sample. Both groups were comparable with no significant differences between age, weight, sex or reason for admission. There were also no differences identified between the TVT and LOS for each group. There were no incidents of accidental extubation or readmission within 48 h for participants in either group for the study.

Table 3 shows the different drug characteristics between groups, demonstrating a greater variance in drug usage. The decrease of 19 h in the median infusion time of morphine between groups approached significance (87 vs 68 h, p=0.059). There were changes in the median minimum and maximum morphine doses, though not significantly. A reduction of 11 h was identified with median infusion of midazolam between groups; however, this difference was not significant. Significant changes in the median minimum and maximum doses of midazolam were observed (minimum 10 vs 17 μg/kg/h, p<0.001 and maximum 120 vs 180 μg/kg/h, p<0.001).

Applying the Kaplan-Meier curve of risk to the probability of remaining ventilated to each group demonstrated that the post-test group did not have an increased risk of remaining ventilated (see figure 2).

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**Table 2** Baseline characteristics in the study groups

|                      | Pre, n=75   | Post, n=63  | Statistic     |
|----------------------|-------------|-------------|---------------|
| Age (years), median (IQR) | 2.08 (5.6)  | 1.75 (4.5)  | NS Mann-Whitney|
| Weight (kg), median (IQR) | 11.5 (15.62) | 12 (11)     | NS Mann-Whitney|
| Sex, N (%)           | Male, 45 (60%) | Male, 38 (60%) | NS χ²         |
| Primary diagnosis, N (%) | Resp, 29 (39%) | Resp, 21 (33%) | NS χ²         |
| PIM, median (IQR)    | 5.00 (9)    | 5.20 (5.3)  | NS Mann-Whitney|
| TVT (days), median (IQR) | 4.02 (5.36) | 3.12 (7.68) | NS Mann-Whitney|
| LOS (days), median (IQR) | 6.3 (6.76)  | 5.8 (7.90)  | NS Mann-Whitney|

NS=not statistically significant, that is, p≥0.05.

LOS, length of stay; PIM, Paediatric Index of Mortality; TVT, total ventilation time.
The probability of remaining ventilated was reduced in the post-test group (by just less than a day at 21 h); however, this was not statistically significant.

Other observed changes in practice were the greater use of adjunctive and alternative medication, in particular methadone. Results showed that, prior to the guideline implementation, there was limited use of alternative medications (1–2 alternative medications or even none). Post-guideline implementation the numbers of alternative medications used increased. A more detailed analysis revealed a significant difference with the use of methadone pre 3%—post 33%, $p<0.001$; diazepam pre 5%—post 25%, $p=0.001$; chloral hydrate pre 32%—post 58%, $p=0.002$; propofol pre 60%—post 20%, $p<0.001$; and neuromuscular blockade agents pre 60%—post 47.6%, not significant.

**Implementation fidelity (chart audit)**

Sixty-three charts from the post-implementation period were reviewed to identify the level of staff adherence to the 19 key components of the guidelines and quantify the level of assessment and scoring. Overall adoption was achieved in 23 (36%) of the charts audited. Separate analysis within each of the phases demonstrated that adoption was achieved in 30 (47.6%) in the acute phase, 25 (36.5%) in the plateau phase and 25 (39.7%) in the weaning phase. Pain and sedation scores were assessed and documented in 95% (n=60) of charts in the acute and plateau phases, and in 85% (n=54) of charts in the weaning phase. The withdrawal score was assessed and documented appropriately in 75% (n=47) of charts.

**Staff survey**

The response rate was 49% (n=54). Participants’ responses were divided into four categories: awareness/use, strengths, limitations and suggestions for improvement. Fifty-two (96%) respondents stated they regularly referred to the guideline to assist with decision-making and to provide prompts and cues. There appeared to be some confusion as to who was primarily responsible for the initiation of the guidelines, with 12 (23%) suggesting that it was the consultant’s responsibility and 32 (60%) stating that it was the responsibility of the bedside nurse. Table 4 outlines further responses.

The perceived strengths of the tool included the structured nature of the guidelines, promotion of consistency in practice and the resulting increased awareness regarding sedation management. Conversely, the perceived limitations included the perceived complexity of algorithm, confusion with delineation and movement between phases, and the lack of accommodation of increased drug tolerance with long-term patients. Staff suggested simplifying the algorithm and using larger print, incorporating recommendations for short-term patients and providing clinical example as guides. Box 1 provides a sample of staff comments on the perceived strengths and weaknesses of the guidelines. Overall, four major themes were expressed by study participants (see box 1): (1) a knowledge deficit about some aspects of the

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**Table 3** Outcome variable comparison between study groups

|                      | Pre, n=75 | Post, n=63 | Difference and statistic |
|----------------------|-----------|------------|--------------------------|
| **Morphine**         |           |            |                          |
| Infusion duration (h)| 87 (136.5)| 68 (78)    | $-19 \text{ h } p=0.059$ |
| Minimum dose (µg/kg/h)| 10 (11)  | 17 (10)    | $+7 \mu\text{g}/\text{kg/h } \text{NS}$ |
| Maximum dose (µg/kg/h)| 120 (102.25)| 97.5 (52.75)| $-22.5 \mu\text{g}/\text{kg/h } \text{NS}$ |
| **Midazolam**        |           |            |                          |
| Infusion duration (h)| 71 (154)  | 60 (90)    | $-11 \text{ h } \text{NS}$  |
| Minimum dose (µg/kg/h)| 10 (12)  | 24 (20)    | $+14 \mu\text{g/kg/h } p<0.001$ |
| Maximum dose (µg/kg/h)| 120 (101.75)| 180 (143.25)| $+60 \mu\text{g/kg/h } p<0.001$ |

NS=not statistically significant, that is, $p\geq0.05$.  

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**Figure 2** Kaplan-Meier curve of risk of remaining ventilated between groups.
guidelines, (2) high value placed on individualised patient care, (3) perceived ineffectiveness of the guidelines for some patients and (4) disagreement between doctors and nurses on responsibilities.

### Table 4 Staff perceptions of sedation guidelines in practice

| Questions                                                                 | Yes response n=54 (%) |
|---------------------------------------------------------------------------|-----------------------|
| The sedation guidelines and flow chart are easy to follow                 | 58.5                  |
| The flow chart facilitates the sedation management process                | 87                    |
| Patients benefit from having a constructive escalation programme          | 96.3                  |
| Patients benefit from having a constructive titration programme           | 94.3                  |
| Patients benefit from having a constructive weaning programme             | 96.2                  |
| A multidisciplinary approach enhances sedation management                | 96.3                  |
| The guidelines give me more autonomy in managing sedation                | 68.5                  |
| The guidelines improve overall sedation management                       | 88.5                  |

### Box 1 Staff perceptions of strengths and limitations of sedation guidelines

**Strengths**
- The bedside nurse ‘knows’ the patient and their requirements, can initiate changes, use objective data on the screen, see changes and ask for a review if needed
- It is a clinical tool to justify an increase or decrease in sedation. Allows for uniform/consistent decision-making
- Empowers and rationalises nursing changes in sedation
- Everyone using the same guide should translate to more consistent care. There is more autonomy for nurses, particularly with less experienced registrars. It potentially iron out variations in individual consultant preferences
- It has increased the awareness among staff and prompts discussion
- It places importance on sedation and assists nurses to provide better sedation. Patients more comfortable equals parents more comfortable

**Limitations**
- Can be complicated because of the amount of detail
- Needs definitions and differential diagnoses for each of the phases
- Not all patients fit the guidelines or respond as predicted
- Requires full concentration with attention to detail and practice to become familiar
- Lack of medical leadership/ownership shared
- Difficult to continue in ward, particularly with weaning
- Have trouble with some long-term patients following the guidelines and keeping them comfortable

### DISCUSSION

This pragmatic pilot study demonstrated the use of guideline-directed sedation and analgesia management was not associated with increased ventilation times or PICU LOS. The results of the study also showed that the guidelines were generally feasible and acceptable in clinical practice with predominantly positive feedback from nursing staff using them. Full adoption of all aspects of guidelines was not realised, but results demonstrated improved levels of patient assessment and increased use of enteral agents (in line with guideline recommendations).

The observed increases in median minimum and maximum doses of morphine and midazolam do not appear to be associated with an increase in patient TVT or LOS, and in fact the duration of each infusion was reduced. Similar changes in medication administration have been observed in other PICU guideline studies.16–20

The results of the Kaplan-Meier Risk analysis indicate that there was potentially a reduced risk of remaining ventilated in the post-test group (though this was not statistically significant). However, a median difference of 21 h between groups may be viewed as ‘clinically significant’ as this time difference in the clinical setting could translate to earlier extubation and/or discharge. Larger randomised trial studies are warranted to allow firm conclusions to be made.

Only a small proportion of participants were ultimately eligible for the study (43% and 31%, respectively), which has implications for the projected timeline, research assistant time and costs and data collection for a larger multisite trial. The results also revealed the huge spread of the clinical data and the challenge this posed for researchers. Follow-on studies would possibly need to consider subcategories of patients, that is, short-term, medium-term and long-term ventilated, and analyse them within these categories.

The guidelines and implementation process in this study also appear to have increased the awareness and usage of alternative medications to complement or replace morphine/midazolam. This was particularly evident with the use of methadone and diazepam. Use of methadone rose from 3% pretest to 33% post-test. Use of diazepam rose from 5% pretest to 25% post-test. One of the key recommendations to emerge from the literature, and therefore included in the guidelines, was the transition from continuous intravenous analgesia and sedation to regular oral agents. Prolonged administration of opioids and benzodiazepines may result in the development of drug tolerance and then withdrawal syndrome if these agents are abruptly discontinued.9 38 49 50

Research has shown that this can be prevented by slowly tapering the intravenous administration of the drug or switching from intravenous morphine and midazolam to orally active drugs with a longer half-life, such as methadone and diazepam.44 46 In general, the increased use of adjunct medication was evidence of the clinician’s use of guideline recommendations.

Sedation, Pain and Withdrawal scores were all captured but difficult to summarise meaningfully as a
research variable. We recommended that a useful variable for follow-up in studies would be to calculate the percentage of time each patient spent in a designated ‘zone’ and determining the appropriateness and success/failure of management accordingly.

The audit of implementation fidelity demonstrated that the assessment and documentation of patient’s pain and sedation was well recorded, reflecting sound staff understanding and uptake of the new assessment tools. The adoption score for the withdrawal phase was the lowest of the three phases, which may have resulted from less familiarity and knowledge with the tool and phase. This is consistent with findings found in a review of similar studies. Suggested reasons for non-adherence included complexity of the guideline or algorithm, staff not valuing or understanding the goal of the guideline and perceived redundancy of the guideline if the staff were already competent practitioners in this area (ibid).

Potential solutions to these issues included ongoing staff education and timely feedback related to the guideline to continuously reinforce importance, ease of use and troubleshoot issues. In addition to surveying staff opinion, it is also important to conduct periodic chart audits to quantify guideline fidelity. This will help minimise self-report bias as was reflected somewhat in this study. Staff perceptions of guideline principles and use were positive, although the level of adherence was variable. So the full impact of the guidelines was not realised.

In conjunction with the audit, a survey of nursing staff perceptions and attitudes was undertaken to establish if these influenced adoption of the guidelines. In line with other similar studies, nurses were largely positive and constructive in their feedback. All feedback has been utilised to improve the guidelines. Involving staff and providing feedback during the process of procedural change is a vital step in optimising follow trial success and ultimately translation to practice. Follow-on trials should also build in mechanisms to capture multi-disciplinary staff experience and feedback.

The importance of the findings of this study is that they indicate that collaborative guidelines can be used to manage the PICU patient’s comfort and pain without compromising quality of care (TVT, LOS, quality indicators). The results are similar to those in the adult population where guideline or protocol-driven sedation has been linked to a reduction in duration of continuous intravenous sedation, ventilation time and associated healthcare costs. Evaluation of feasibility outcomes has aided in the development of a realistic plan regarding participant recruitment, staff education to optimise guideline fidelity, safety of guidelines in clinical practice and collection of key outcome variables.

**IMPLICATIONS AND RECOMMENDATIONS**

No definitive causal effect can be attributed to the guidelines on outcomes due to the pre–post study design and small sample size. Full adoption of all phases and tools in the guidelines was not realised and this has implications for ongoing implementation and larger trial work. Additionally, the small response rate and selective population for the survey may introduce some bias in the current understanding of staff acceptance of the guidelines. A more inclusive (medical and nursing) survey population is recommended for follow-up research.

Conducting the study in two units assists with the generalisability of the study and its results. Some specifics of the guidelines and algorithm, however, might need modification to reflect local practice, for example, use of different drugs (fentanyl instead of morphine) and different patient populations (post cardiothoracic surgery).

The study results are most useful in informing the structure and outcome measures for a follow-on clinical trial in this area.

Results from the study, audit and survey have informed changes and modifications to optimise staff understanding and use of sedation guidelines in practice. Weaning from sedation agents and the concept of withdrawal appear to be areas of practice that need more attention. The researchers went on to trial and evaluate a revised withdrawal assessment tool and a study comparing the outcomes of dexmedetomidine versus midazolam is about to start. The study units plan to continue to use the guidelines and tools in their modified form pending the results of a larger trial work recently completed in the USA. The modern ICU is an important focus for quality improvement efforts. Guidelines cannot automatically guarantee improved quality of care; however, they do direct the clinician in the pursuit of this objective, particularly when supported by high-level evidence.

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**Competing interests** None.

**Ethics approval** Royal Children’s Hospitals Human Research and Ethics Committee (HREC/05/QRCH/19).

**Provenance and peer review** Not commissioned; externally peer reviewed.

**Data sharing statement** A copy of the guidelines is supplied as an appendix or can be made available by emailing Debbie.Long2@health.qld.gov.au.

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**REFERENCES**

1. Bavdekar SB, Mahajan MD, Chandu KV. Analgesia and sedation in paediatric intensive care unit. J Postgrad Med 1999;45:95–102.

2. Mehta S, McCullagh I, Bury L. Current sedation practices: lessons learned from international surveys. Crit Care Clin 2009;25:471–88, vii–viii.

3. Playford SD, Thomas DA, Choona R. Sedation and neuromuscular blockade in paediatric intensive care: a review of current practice in the UK. Paediatr Anaesth 2003;13:147–51.

4. Shehabi Y, Bellomo R, Reade MC, et al. Early intensive care sedation predicts long-term mortality in ventilated critically ill patients. Am J Respir Crit Care Med 2012;186:724–31.
GUIDELINES FOR THE ADMINISTRATION OF SEDATION AND ANALGESIA IN MECHANICALLY VENTILATED CHILDREN

PURPOSE:
To outline the management of sedation and analgesia in critically ill children receiving mechanical ventilation.

BACKGROUND / SUPPORTIVE DATA:
Sedation and analgesia are necessary components of the care of all critically ill children, especially those requiring mechanical ventilation. The main indications for the use of sedation and analgesia include: to reduce pain and discomfort, to reduce anxiety and agitation, to induce amnesia, to facilitate mechanical ventilation, to prevent the displacement of endotracheal tubes, and to decrease cellular metabolism. The consequences of prolonged use of sedative and analgesic agents in the PICU patient include central nervous system activation, gastrointestinal disturbances, and sympathetic hyperactivity. These signs and symptoms have been related to tolerance and withdrawal phenomena and hold implications for the patient’s physical and psychological well being as well as health care costs.

Tolerance is one of the major reported adverse effects associated with continuous benzodiazepine infusions. Tolerance may be defined as a decrease in the effectiveness of a drug after prolonged use or as the requirement of larger doses to achieve the same effect. This phenomenon is due to an adaptation of neuronal cells and not a change of metabolism of the drug. One method of addressing this adverse effect, drug tolerance, is to recognise its occurrence and introduce alternative sedation agents titrated to an accepted sedation level.

A second adverse effect of the prolonged use of analgesic and sedation agents is withdrawal or abstinence syndrome. In paediatric patients, withdrawal syndrome is due to the development of tolerance to sedation and analgesic drugs not dependence or addiction. Studies have shown a strong positive correlation between large total doses of midazolam and the occurrence of withdrawal symptoms. Local, national and international audits have all shown that drug tapering is conducted in very few patients and that most patients have their sedation and analgesic agents abruptly discontinued. Thus, the incidence of withdrawal symptoms may be related to the infrequent tapering of sedation and analgesic agents.

There exists a plethora of literature discussing the adverse effects of sedation and analgesia in the critical care environment, particularly its prolonged use. There appears to be a consensus about the need and benefits of a systematic and coordinated approach to sedation administration, tapering and titration in the PICU.

SUMMARY OF SEDATION ALGORITHM:

Patient acutely unwell requiring I & V

**ACUTE PHASE**
Maintain: SBS -2 to +1
MAPS 0 to 3
by titrating sedation & analgesia
primarily M & Ms (20 to 300mcg/kg/hr) then adjuncts
(see adjunctive table)

When patient stable

**PLATEAU PHASE**
Find Optimal dose of sedation & analgesia with
SBS -1 to +1
MAPS 0 to 3

Good gut function:
Convert to Methadone & Diazepam (see conversion box)

Poor gut function or clinically inappropriate:
Continue M&Ms

When patient ready for weaning

**WEANING PHASE**
See Sedation & Analgesia Weaning Guideline
Maintain WAS ≤ 10.
EVIDENTIARY TABLE:

| Strategy                  | Evidence                                                                 |
|---------------------------|--------------------------------------------------------------------------|
| Use of protocol           | The use of protocol directed sedation can reduce the duration of mechanical ventilation, ICU and hospital stay and can result in safe, cost-effective improvements. | 1-5 |
| SBS – Sedation Scale      | Reliable and valid scale for use in paediatric critical care.            | 6-8 |
| PICU MAPS – Pain Scale    | Reliable and valid scale for use in paediatric critical care, particularly pre-verbal children. | 9-12 |
| Withdrawal Assessment Scale| Combination of validated tool and Great Ormond Street Hospital protocol  | 13, 14 |
| Accumulative dose         | Up to 300 mcg/kg/hr for Midazolam                                        | 15, 16 |
| Weaning timeframes        |                                                                           | 17, 18 |
| Mandatory review          |                                                                           | 19, 20 |
| Conversion to oral drugs  | Diazepam, Methadone                                                      | 21, 22, 23 |

SUGGESTED PHARMACOLOGICAL TREATMENT OF PROCEDURAL PAIN AND DISCOMFORT:

| Drug Group                  | Drug                  | Indications                                                                 |
|-----------------------------|-----------------------|-----------------------------------------------------------------------------|
| Topical Local Anaesthetic   | Angel Cream EMLA      | PIV/IAl insertion, Venepuncture, Arterial Stab, Portacath access, Lumbar puncture, CVL/ICC insertion | 1-5 |
|                             |                       | Lignocaine 2% & Chlorhexidine 0.05%                                          | 6-7 |
|                             |                       | Lignocaine 4%                                                               | 8-9 |
|                             |                       | Sub-cutaneous injection Lignocaine 1%                                       | 10-11 |
|                             |                       | Disassociative Agent Ketamine                                               | 12, 13, 14 |
|                             |                       | Short acting anaesthetic agent Propofol                                       | 15, 16, 17 |
|                             |                       | Short acting sedative & analgesic agent Morphine & Midazolam                 | 18, 19 |

* used in conjunction with other drugs

SUGGESTED NON-PHARMACOLOGICAL MEASURES FOR OPTIMISING PATIENT COMFORT

| Treatment                                    | Evidence |
|----------------------------------------------|----------|
| Positioning & body support                   | 12-15, 20, 21 |
| Reassurance by staff and/or parents          | 14, 22, 23 |
| Minimise discomfort of invasive devices (e.g. ETT, CVLs, and drainage tubes) | 14, 24, 25 |
| Optimise hydration, nutrition, essential cares (e.g. mouth, eye) | 16-17, 26, 27 |
| Massage, or rocking                           | 28, 29, 30 |
| Swaddling                                    | 31-33 |
| Non-nutritive sucking                        | 34, 35, 36 |
| Decrease external stimuli (noise, light, movement or handling) | 37, 38, 39 |
| Music therapy                                | 40, 41, 42 |

SUGGESTED ADJUNCTIVE PHARMACOLOGICAL THERAPIES FOR MAXIMISING PATIENT COMFORT

| Drug                  | Approach                                                                 |
|-----------------------|--------------------------------------------------------------------------|
| Propofol              | 2.5-3.5mg/kg stat then 7.5-15mg/kg/hr\(^{13}\); 4-6mg/kg/hr\(^{14}\)       | 50, 51, 52 |
| Morphine              | 20mcg/kg prn                                                             | 53 |
| Midazolam             | 20mcg/kg prn                                                             | 53 |
| Ketamine              | 1mg/kg/hr                                                                | 54, 55, 56, 57 |
| Chlorohydrate         | 25mg/kg q6h\(^{18}\) max 5g                                               | 58, 59, 60, 61 |
| Fentanyl              | If allergic or renal failure 5-10mcg/kg/hr                                | 62, 63, 64, 65, 66 |
| Promethazine          | Oral 0.5mg/kg q6h Maximum 1mg/kg                                          | 67 |
| Chlorpromazine        | 0.25-1mg/kg/q6-8h                                                        | 68, 69, 70, 71, 72 |
| Clonidine             | 3-5mcg/kg q8h                                                            | 73, 74, 75, 76, 77, 78 |
| Haloperidol           | 0.1mg/kg- 0.1mg/kg q12h                                                  | 79 |
| Phenobarb             | 5mg/kg/day                                                               | 80 |
| Paracetamol           | 90mg/kg/24hrs- accumulation in hepatotoxic in pts with impaired LF-      | 81, 82, 83, 84, 85 |
| Codeine               | Max 1mg/kg/dose                                                          | 86 |
| Ibuprofen             | 10mg/kg q6h Precautions- asthma, renal impairment, under 6mths           | 87, 88, 89, 90 |
REFERENCES - PROTOCOL

1. Alexander E, Carnevale FA, Razack S. Evaluation of a sedation protocol for intubated critically ill children. Intensive and Critical Care Nursing 2002;18(5):292-301.
2. Brook AD, Ahmed TS, Schaff R, Prentice D, Sherman G, Shannon W, et al. Effect of a nursing-implemented sedation protocol on the duration of mechanical ventilation. Crit Care Med 1999;27(12):2609-15.
3. Bratttebo G, Hofoss D, Flaattem H, Muri AK, Gjerse S, Pisek PE. Effect of a scoring system and protocol for sedation on duration of patients’ need for ventilator support in a surgical intensive care unit. Quality & Safety In Health Care 2004;13(3):203-205.
4. Mascia MF, Koch M, Medicis JJ. Pharmacoeconomic impact of rational use guidelines on the provision of analgesia, sedation, and neuromuscular blockade in critical care. Crit Care Med 2000;28(7):2300-6.
5. McKinley S. A nursing-implemented sedation protocol and the duration of mechanical ventilation. Australian Critical Care: Official Journal Of The Confederation Of Australian Critical Care Nurses 2000;13(2):72-74.
6. Cimmer TP, Wallace JC, Spuhler VJ, Bailey PP, Devin JW. Origins of the Motor Activity Assessment Scale score: a multi-institutional process. Critical Care Medicine 2000;28(8):3124.
7. Curley MAQ, Harris SK. State Behavioural Scale: A Sedation Instrument for Ventilated Infants and Young Children. In: American Thoracic Society Scientific Meeting Conference Proceedings; 2005 23 May; San Diego; 2005. p. A557.
8. Devin JW, Boleksi G, Mynarek M, Nerenz DR, Peterson E, Jankowski M, et al. Motor Activity Assessment Scale: a valid and reliable sedation scale for use with mechanically ventilated patients in an adult surgical intensive care unit. Critical Care Medicine 1999;27(7):1271-1275.
9. Ramelet AS. Assessment of pain and agitation in critically ill infants. Australian Critical Care: Official Journal Of The Confederation Of Australian Critical Care Nurses 1999;12(3):92-96.
10. Ramelet AS, Bulsara M, Abu-Saad HH, McDonald S, Rees N. Development of a clinical-based pain measure for the critically ill infant. In: 8th World Congress of Intensive and Critical Care Medicine; 2001; Sydney; 2001.
11. Ramelet AS, Abu-Saad HH, Bulsara M, Rees N, McDonald S. The Multidimensional Assessment of Pain Scale (Part II): Clinical validation in preverbal children. Unpublished manuscript: submitted.
12. Ramelet AS, Abu-Saad HH, Bulsara M, Rees N, McDonald S. The Multidimensional Assessment of Pain Scale (Part I): Development and preliminary psychometric testing in preverbal children. Unpublished manuscript: submitted.
13. Directorate C, Service PC, Studies CoNR. Protocol for weaning Opioids and Benzodiazepines. London: Great Ormond Street Hospital; 2000.
14. Finnegan LP, Connaughton JF, Jr, Kron RE, Emich JP. Neonatal abstinence syndrome: assessment and management. Addictive Diseases 1975;2(1-2):141-158.
15. Kahn EJ, Neumann LL, Polk GA. The course of the heroin withdrawal syndrome in newborn infants treated with phenobarbital or chlorpromazine. The Journal Of Pediatrics 1969;75(3):495-500.
16. Naughton J. Opioid Weaning Flowsheet. Oakland: Children's Hospital Oakland; 2000.
17. Franch L, Vizardi J. Assessment and management of opioid withdrawal in ill neonates. Neonatal Network: NN 1995;14(2):39-48.
18. Franch LS, Vilardi J, Durand D, Powers R. Opioid withdrawal in neonates after continuous infusions of morphine or fentanyl during extracorporeal membrane oxygenation. American Journal Of Critical Care: An Official Publication, American Association Of Critical-Care Nurses 1998;7(5):364-369.
19. Dhawan S, Dudda A, Duggan M, Sinclair M, Vanhuyse J, Wong K. The Prevention and Treatment of Opioid and Benzodiazepine Withdrawal. Philadelphia: Philadelphia Children's Hospital; 2002.
20. Dodson B, Curley MAQ. Designing a nurse-implemented sedation algorithm for use in a pediatric intensive care unit - A preliminary report. In: 4th World Congress on Pediatric Intensive Care; 2003 12 June; Boston, Massachusetts, USA; 2003. p. 125.
21. Tobias JD. Tolerance, withdrawal, and physical dependency after long-term sedation and analgesia of children in the pediatric intensive care unit. Crit Care Med 2000;28(6):2122-32.
22. Lugo RA, Chester EA, Cash J, Grant MC, Vernon DD. A cost analysis of enterally administered lorazepam in the paediatric intensive care unit. Critical Care Medicine. 1999;27(2):417-421.
23. Cigada M, Pezzi A, Di Mauro P, Marzorati S, Noto A, Valdambrini F, et al. Sedation in the critically ill ventilated patient: possible role of enteral drugs. Intensive Care Medicine 2005;31:482-486.
24. Yaster M, Kost-Byerly S, Berde C, Billet C. The management of opioid and benzodiazepine dependence in infants, children, and adolescents. Pediatrics 1996;98(1):135-140.
25. DRUGDEX. In: Thomson, editor. MICROMEDEX. Vol. 124 ed; 1974-2005.
26. Tobias JD. Sedation and analgesia in paediatric intensive care units: a guide to drug selection and use. Paediatric Drugs 1999;1(2):109-126.
REFERENCES - SEDATION

1. Bishai R, Taddio A, Bar-Oz B, Freedman MH, Koren G. Relative efficacy of amethocaine gel and lidocaine-prilocaine cream for Port-a-Cath puncture in children. Pediatrics 1999;104(3):e31.

2. Gunter JB. Benefit and risks of local anesthetics in infants and children. Paediatric Drugs 2002;4(10):649-672.

3. Miser AW, Goh TS, Dose AM, O’Fallon JR, Niedringhaus RD, Betcher DL, et al. Trial of a topically administered local anesthetic (EMLA cream) for pain relief during central venous port accesses in children with cancer. Journal Of Pain And Symptom Management 1994;9(4):259-264.

4. O’Brien L, Taddio A, Lysykiewicz DA, Koren G. A critical review of the topical local anesthetic amethocaine (Adetop) for pediatric pain. Paediatric Drugs 2005;7(1):41-54.

5. Taddio A, Gurguis M, Koren G. Lidocaine-prilocaine cream versus tetracaine gel for procedural pain in children. The Annals of Pharmacotherapy 2002;36(9):972-977.

6. Tanabe P, Steinmann R, Anderson J, Johnson D, Metcalfe S, Ring-Hunn E. Factors affecting pain scores during female urethral catheterization. Academic Emergency Medicine: Official Journal Of The Society For Academic Emergency Medicine 2004;11(6):699-702.

7. Gerard LL, Cooper CS, Duetsman KS, Ordleley BM, Kleiber CM. Effectiveness of lidocaine lubricant for discomfort during pediatric urethral catheterization. The Journal Of Urology 2003;170(2, Part 1):564-567.

8. Stolz D, Chhajed PN, Leuppi JP, Brutsche M, Pfimlin E, Tamm M. Cough suppression during flexible bronchoscopy using combined sedation with midazolam and hydrocortone: a randomised, double blind, placebo controlled trial. Thorax 2004;59(9):773-776.

9. Millman N, Laub M, Munch EP, Angelo HR. Serum concentrations of lignocaine and its metabolite monoethylglycinexylidide during fibre-optic bronchoscopy in local anaesthesia. Respiratory Medicine 1998;92(1):40-43.

10. Vard A, Salem Y, Padeh S, Paret G, Barzilay Z. Is propofol safe for procedural sedation in children? A prospective evaluation of propofol versus ketamine in pediatric critical care. Critical Care Medicine 2002;30(6):1231-1236.

11. Green SM, Denmark TK, Cline J, Roghair C, Abd Allah S, Rothrock SG. Ketamine sedation for pediatric critical care procedures. Pediatric Emergency Care 2001;17(4):244-248.

12. Bari E, Gerarduzzi T, Marchetti F, Neri E, Verucci E, Bruno I, et al. Deep sedation with propofol by nonanesthesiologists: a prospective pediatric experience. Archives Of Pediatrics & Adolescent Medicine 2003;157(11):1097-1103.

13. Oehler JM, Hannon T, Catlett A. Maternal views of preterm infants’ responsiveness to social interaction. Neonatal Network; NN 1993;12(6):67-74.

14. Stephens BK, Barkey ME, Hall HR. Techniques to comfort children during stressful procedures. Accident and Emergency Nursing 1999;7(4):226-36.

15. Jorgensen KM. Developmental Care of the Premature Infant: A Concise Overview. Weymouth: Developmental Care Division of Children’s Medical Ventures; 1993.

16. Young J. Developmental Care of the Premature Baby. London: Bailliere Tindall; 1996.

17. Burns SM. Weaning from long-term mechanical ventilation. AACN Clinical Issues in Critical Care Nursing 1991;2(3):359-473.

18. Burns SM, Burns JE, Truwit JD. Comparison of five clinical weaning indices. American Journal of Critical Care 1994;3(5):342-352.

19. Burns SM, Clohesy JM, Hanneman SKG. Weaning from long-term mechanical ventilation. American Journal of Critical Care 1995;4(1):4-22.

20. Keegan L. Therapies to reduce stress and anxiety. Critical Care Nursing Clinics Of North America 2005;17(1):34-48.

21. Forsyth J, Jordan C. Therapies to reduce the stress response and promote comfort in preterm infants. Journal Of Obstetric, Gynecologic, and Neonatal Nursing 1995;24(2):143-151.

22. Ogilvie S, Akiyama T, Arisawa K, Shimogori K. Randomised controlled trial of swaddling versus massage in the management of excessive crying in infants with colic. Archives Of Disease In Childhood Fetal Neonatal Edition 2000;83(3):212-216.

23. Pickler RH, Reyna BA. Effects of non-nutritive sucking on nutritive sucking, breathing, and behaviour during bottle feedings of preterm infants. Advances in Neonatal Care 2004;4(4):226-34.

24. Wright KJ, Jemmott-Wright J, Symington A. Non-nutritive sucking for promoting physiologic stability and comfort in preterm infants. The Cochrane Database of Systematic Reviews 2001.

25. Stevens B, Yamada J, Ohlsson A. Sucrose for analgesia in newborn infants undergoing painful procedures. The Cochrane Database of Systematic Reviews 2004.

26. Oehler JM. Developmental care of low birth weight infants. Nursing Clinics of North America 1993;28(2):289-301.

27. Walden M, Suda-Robinson T, Carrier CT. Comfort care of infants in the neonatal intensive care unit at end of life. Newborn and Infant Nursing Reviews 2001;1(2):97-105.

28. Sharron F. Drug Doses. 12th ed. Victoria: Collective Pty Ltd; 2003.

29. Rigby J, Jemmott-Wright J, Symington A. Non-nutritive sucking for promoting physiologic stability and comfort in preterm infants. The Cochrane Database of Systematic Reviews 2001.

30. Robinson T, Carrier CT. Comfort care of infants in the neonatal intensive care unit at end of life. Newborn and Infant Nursing Reviews 2001;1(2):97-105.

31. Sharron F. Drug Doses. 12th ed. Victoria: Collective Pty Ltd; 2003.

32. Rigby-Jones AE, Nolan JA, Priston MJ, Wright PMC, Sneyd JR, Wolf AR. Pharmacokinetics of propofol infusions in critically ill neonates, infants, and children in an intensive care unit. Anesthesiology 2002;97(6):1393-1400.

33. Tobias JD, Martin LD, Wetzel RC. Ketamine by continuous infusion for sedation in the pediatric intensive care unit. Critical Care Medicine 1990;18(8):819-821.

34. Seigler R, Avant M, Gwyn M, Lynch A, Golding E, Blackhurst D, et al. A comparison of propofol and ketamine/midazolam for intravenous sedation of children. Pediatric Critical Care Medicine 2001;2(1):20-23.

35. Burns AM, Shelly MP, Park GR. The use of sedative agents in critically ill patients. Drugs 1992;43(4):507-515.

36. Tobias JD. Sedation and analgesia in paediatric intensive care units: a guide to drug selection and use. Paediatric Drugs 1999;1(2):109-126.

37. Dhanani S, Dodds A, Duggan M, Sinclair M. The prevention and treatment of opioid and benzodiazepine withdrawal: Princess Margaret Hospital for Children; 2002.

38. Parkison L, Hughes J, Gill A, Billingham I, Ratcliffe J, Choonara I. A randomized controlled trial of sedation in the critically ill. Paediatric Anaesthesia 1997;7:405-410.

39. Arenas-Lopez S, Ripshagen S, Tibby SM, Dunward A, Tomlin S, Davies G, et al. Use of oral chloridane for sedation in ventilated paediatric intensive care patients. Intensive Care Medicine 2004;30(9):1625-1629.

40. Brown R, Henke A, Greenhalgh D, Warden G. The use of haloperidol in the agitated, critically ill pediatric burn patient. Journal of Burn Care and Rehabilitation 1996;17(1):34-38.
Acute Phase

**DEFINITION:**
Acutely unwell, new admission, expectation that illness/injury will worsen, potentially unstable where poor levels of sedation would be detrimental to patient.
Eg. Raised ICP, onset of oscillation, return from OT.

**GOALS:**
- Sedation: SBS -2 to -1
- Pain: MAPS 0 to 3

**DO NOT USE GUIDELINE IF PATIENT IS:**
- Admitted for management of seizure activity
- < 1 year of age
- has underlying renal impairment
- has a metabolic condition

**FLOWCHART:**

1. **START HERE**
   - Patient intubated and ventilated

2. Prepare Morphine and Midazolam infusion as per standard concentration guidelines
   - Commence infusion at 20mcg/kg/hr
   - following a 20-60mcg/kg bolus of same solution

3. Is the patient’s MAPS or SBS score greater than their set goal?
   - **Yes**
     - Patient eligible for **Plateau phase**
   - **No**

4. Has the patient received a previous bolus in each of the last 3 hours?
   - **No**
     - Has the patient received a bolus in the last 4 hours?
       - **No**
         - Continue to monitor and assess SBS and MAPS hourly
       - **Yes**
         - Is the total midazolam dose >300mcg/kg every hour of the last 4 hours?
           - **No**
             - Consider adjunctive pharmacological therapies.
           - **Yes**
             - Continue to monitor and assess SBS and MAPS hourly

5. Has the patient received a previous bolus this hour?
   - **No**
     - Give patient 20mcg/kg bolus and increase the background rate by 20mcg/kg/hr.
   - **Yes**
     - Give patient 20mcg/kg bolus.
**Weaning Phase**

**DEFINITION:**
When weaning from sedative and analgesic agents is required.
Eg. Imminent PICU discharge, no longer ventilated.

**GOALS:**
- Sedation: SBS 0 to +3
- Pain: MAPS 0 to 3
- Withdrawal: <10

10% of original dose means 10% of dose when first reduction made.

---

**START HERE**

**What has the duration of medication usage been?**

- **< 5 days**
  - Commence **rapid wean.**
  - Reduce original oral total daily dose by 50% for 24 hrs then discontinue.
  - Please notify PICU Pharmacist

- **5 - 10 days**
  - Commence **5 day wean.**
  - Reduce original oral total daily dose by 20% every 24 hrs.
  - Please notify PICU Pharmacist

- **> 10 days**
  - Commence **10 day wean.**
  - Reduce original oral total daily dose by 20% every 48 hours.
  - Please notify PICU Pharmacist

**Withdrawal assessment score < 10?**

- **Yes**
  - Continue to monitor and assess SBS, MAPS and WAS at least q4h

- **No**
  - * Return to previous dose and hold wean for 24 hrs.
  - * Monitor and assess WAS q2h.
  - * After 24 hrs, wean medication by 10% q24h when score < 10.

**Weaning Tips**
- The above strategies offer approximate timeframes for weaning.
- A total daily dose can be reduced by changing the dose AND/or the frequency
- The minimum dose of Methadone at any time SHOULD NOT be below 0.5mg (0.1mls)

**Example of 5 day wean:**
- (TDD = Total daily dose)
  - Day 1: TDD 50mg - 12.5mg q6h
  - Day 2: TDD 40mg - 10mg q6h
  - Day 3: TDD 30mg - 10mg b.d.
  - Day 4: TDD 20mg - 10mg b.d.
  - Day 5: TDD 10mg - 5mg b.d OR 10mg daily

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* Consider adjunctive drugs and non pharmacological therapy.