Editorial

Painless Procedures in Pediatrics: Pipe Dream or a Possibility?

In this issue of the Journal, Borker, *et al.*(1) report the experience of non-anesthesiologists providing procedural sedation for invasive procedures in children with cancer. This is an area that has seen rapid evolution in the past decade due to the increasing awareness among healthcare providers and parents that even the smallest infant may perceive pain and anxiety. The trend of parental presence during procedure in many countries has further raised the expectations of a relatively anxiety free experience for the child and the family.

Pain perception in young infants and newborns did not receive much attention until some recent studies(2) . There have been valid concerns regarding the safety of administering potent opiates and sedatives to children due to the potential of resultant airway compromise and respiratory depression. However, inadequate sedation and analgesia for painful procedures in children is also aided by the fact that the adult healthcare providers can often physically overpower children. Moreover, we often consider that it is natural for children to cry in these situations. Children are often unable to refuse consent or even express their fears and apprehension. As a result, even recently, less than 25% of children under-going bone marrow aspiration in US received deep sedation or anesthesia(3). This notwithstanding the fact that the children with cancer rate inflicted pain related to diagnostic and therapeutic procedures much more severe than the pain due to cancer itself(4). The American Academy of Pediatrics has stated long ago that the success of procedural pain management is to be measured by a child who is not afraid of subsequent procedures and not merely by the fact that a child can be held still for the procedure(5).

The development of newer pharmacologic agents and non invasive monitoring techniques have made it possible to administer effective short acting sedatives without compromising patient safety. It is no longer ethical to deprive a child of effective sedatives and analgesics under the often erroneously held belief "a crying child is safer than a sedated child!"

This changing trend along with the increasing number of invasive and non-invasive procedures being performed in children has led to a phenomenal demand for safe, predictable, efficacious and cost effective sedation in varied settings(6). Many institutions around the world are grappling with this ever-increasing demand. In most situations, there are not enough trained anesthesiologists available to provide these services. This issue often raises challenging questions: Does every child who needs sedation for a procedure need an anesthesiologist? Can non-anesthesiologists with adequate training in airway management, resuscitation and pharmacology of the sedatives and analgesics offer these services safely? What is the optimal physical infrastructure and monitoring capability to provide safe procedural sedation? Should some of the more potent and effective sedative agents, yet eminently titratable agents be restricted to be used only by anesthesiologist?

There are no perfect answers or solutions to these questions and each healthcare facility has

to conceive and implement solutions that work the best under their own unique constraints. However, a few guiding principles and concepts should be followed.

Goals of procedural sedation

The goals may vary depending on the specific situation. Nevertheless, an ideal procedural sedation plan often attempts to achieve the following goals(7):

1. Allay anxiety and fear
2. Obtain cooperation to perform procedure
3. Achieve immobilization
4. Produce unawareness and amnesia
5. Reduce or eliminate pain
6. Keep the child safe during and immediately after sedation
7. Minimizing the residual effects of sedation after the procedure is over.

Levels of Sedation

There has been a lot of debate and confusion in the past over the various levels of sedation. In 1992, the term of "conscious sedation" was introduced by American Academy of Pediatrics to reflect a state where the child is sedated but still responds to verbal commands(8). Soon it became clear that this conceptual state of sedation is often not adequate for children and they often need deeper sedation(9). Many feel that the term "conscious sedation" is indeed oxymoronic in children(10). Consequently, there has been a revised levels of sedation proposed by American Society of Anesthesiologists and adopted by the American Academy of Pediatrics in 1999(11) (*Table I*).

Training and skill level of providers

Training and skill level for providing safe procedural sedation has been another controversial area. As mentioned earlier, it is not possible in most circumstances to have trained anesthesiologist perform all the procedural sedation. There are guidelines available from various regulatory organizations in US for the non anesthesiologist performing such function (11,12).

The person providing sedation and monitoring should not be the person performing the procedure. Further, the person monitoring the sedated child should not have

TABLE I–*Levels of Sedation*(11)

	Minimal sedation	Moderate sedation/analgesia (Conscious sedation)	Deep sedation	General anesthesia
Responsiveness	Normal response to verbal stimulation	Purposeful response to verbal or tactile stimulation	Purposeful response following repeated or painful stimulation	Unarousable, even with painful stimulus
Airway	Unaffected	No intervention required	Intervention may be required	Intervention often required
Spontaneous ventilation	Unaffected	Adequate	May be inadequate	Frequently inadequate
Cardiovascular function	Unaffected	Usually maintained	Usually maintained	May be impaired

any other responsibilities that will interfere in his or her ability to monitor and intervene in a timely fashion(11). This individual should be skilled in recognizing and intervening in partial or total airway obstruction and apnea and should be able to maintain airway patency and provide assisted ventilation. In addition, familiarity with the pharmacology of the drugs used including the antagonists is desirable(7).

Pre-sedation assessment and screening

For ensuring safe sedation, appropriate patient selection is essential. A child undergoing sedation should be evaluated immediately before the administration of sedatives for any risk factors that may increase the possibility of adverse outcome. The preoperative assessment guidelines by American Society of Anesthesiologists (ASA) is often used as a standard tool to assess the risk (11). Any child classified to have a ASA physical status of class IV or higher should be referred to an anesthesiologist(7).

One should obtain a focused history including any allergies, major medical illnesses involving the cardiovascular and pulmonary system and history of sleep apnea, snoring or hypoventilation.

Physical examination should assess the airways: any macroglossia, micrognathia, trismus, facial dysmorphism, obesity, tonsillar hypertrophy should be of concern. It is often advisable to obtain anesthesiology advice in such patients(7).

An appropriate duration of fasting reduces the risk of vomiting and possible aspiration. Although there are few evidence based guidelines, ASA guidelines are widely followed: a fasting period of 2 hours for clear liquids, 4 hours for breast milk and 6-8 hours for light solids(11). In cases where the optimal period of fasting is not possible, one has to make a judgment based on the relative risks of aspiration versus that resulting from a delay in procedure.

Monitoring

It is essential to have the appropriate monitoring capability as well as equipment and supplies to be able to help a child who gets in trouble during sedation. These include emergency resuscitation drugs, appropriate airway equipments(8). The child should be monitored continuously from the time of administration of sedatives till complete recovery using a continuous pulse oximeter with audible and visible signal. In addition, ventilatory monitoring by direct observation, auscultation or continuous nasal capnography is desirable. Continuous heart rate and fre-quent blood pressure checks are recommended (11). Special MRI compatible monitors are required for use in MRI suites.

A time-based running record of vital signs and monitored parameters are helpful in documentation and analysis of any events.

The post-procedure time is often the most vulnerable but often neglected period. The delayed absorption of drugs, slow metabolism, absence of procedural stimulation along with reduced vigilance may cause unexpected and undetected respiratory depression. The child should be back to the pre-procedural state prior to discharge from the observed surroundings. A standardized criteria for discharge often helps in reducing practice variation and guesswork(7).

Choice of sedative / analgesic agent

Newer short acting sedatives have been used in the recent years to produce more predictable and easily titrable effects. In addition, they do not lead to prolonged sedation after the procedure is over, obviating the need for prolonged observation. Older popular

combinations like "lytic cocktail" (pethidine / chlorpromazine / promethazine combination) are no longer preferred due to the excessively prolonged sedation they produce(13).

Multiple routes of administration including intranasal, transmucosal, rectal and intramuscular routes can be utilized in absence of intravenous access. The choice of a specific agent or a combination should be dictated by the specific clinical situation, goals of sedation and the expertise of the practitioner in the chosen agents.

Midazolam, a short acting benzodiazepine, has become a very commonly used agent in pediatric procedural sedation. It offers eminent amnesia and anxiolysis but has no analgesic properties(14). It can be administered through oral, intranasal, rectal, intramuscular or intravenous routes(7,15).

Traditionally, chloral hydrate and pentobarbital have been used to help achieve sedation and immobilization for non-painful radiological procedures like CT scan and MRI scans(16). However, chloral hydrate has been associated with prolonged sedation and adverse effects(17).

Opioids are often used to achieve adequate level of analgesia for painful procedures; with increasing use of shorter acting agents like fentanyl. In fact, combination of fentanyl and midazolam is quite popular in many settings, although can often produce profound respiratory depression(18). Nausea, emesis, pruritus are common with the use of opioids. Chest wall rigidity is a rare complication associated with rapid intravenous administration of fentanyl(19).

Ketamine, as used in the study in this issue of Journal, is a dissociative anesthetic and produces excellent analgesia, amnesia and sedation for painful procedures in children. It has been regarded by many to offer a better safety profile due to less pronounced depressant effect on respiratory drive and airway protective reflexes. However, it could produce excessive salivation and emergence dysphoria and hallucinations.

Propofol has been used by non-anesthesiologists who are aware of its pharmacology and side effects profile. Being a potent agent, proper training and adequate monitoring tools are required prior to its use by non-anesthesiologist. Many reports of its safe and effective use have been published(20,21). It has the advantage of rapid onset and offset and very predictable therapeutic effect. However, it lacks analgesic properties and is more suited for painless procedures in radiology suite.

Topical application and local infiltration of lidocaine or other agents is recommended as a supplement with drugs that do not offer inherent analgesia (benzodiazepines, barbiturates or propofol) to provide a pain-free experience to children undergoing invasive procedures.

There are no good studies documenting the incidence of adverse effects due to procedural sedation in children. As mentioned already, majority of the complications are associated with respiratory depression or airway obstruction leading to hypoxemia and hypoventilation. The cardiac events are usually secondary to persistent hypoxemia. Almost any agent, administered via any route can produce adverse effects. The adverse effects are more related to the depth of sedation achieved rather than the agent used (10).

Conclusion

The need for pediatric procedural sedation for both painful and non-painful procedures will continue to grow in the near future. These needs will arise in various settings including outpatient, inpatient, radiology, catheteriza-

tion and endoscopy suites and emergency rooms. It is unrealistic to expect anesthesiologist to be available for all of these children. However, non-availability of anesthesiologist is not a valid reason to deny children and their family a pain-free and anxiety free experience. The non-anesthesiologists will be increasingly expected to provide safe, effective and cost effective sedation to thousands of children undergoing procedures. Physical restraints and forcing a child to undergo procedure seems no longer morally or ethically justifiable in this era of availability of safe and effective sedative and analgesic agents. Despite the economic and logistical constraints of providing care to children in the developing world, procedural sedation can be incorporated in the treatment plan of children. It should no longer be an option but a requirement for anyone considering a procedure that may invoke anxiety or pain in children.

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