Prevention of neurotoxicity due to accidental caudal injection of 'Non-Preservative-Free' Ketamine – A Medication Safety Initiative

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Project Background

Caudal anaesthesia is commonly used to provide analgesia for infra-umbilical surgical procedures in children, using local anaesthetics along with additives such as ketamine and clonidine. Research into neurotoxicity of ketamine confirms preservatives such as benzethonium and chlorobutanol as the agents contributing to toxicity [1,2]. Hence only "preservative free" preparations of ketamine and other medications are used as an additive for caudal or epidural anaesthesia.

A near miss incident where 'non-preservative-free' ketamine was almost injected into caudal space, in our department, highlighted the need to deal with root causes of such an adverse incident. A safety programme was initiated with an overall goal of preventing adverse events due to caudal injection of 'Non preservative free' preparations.

Structured improvement methodology used:

Model for improvement.

Plan:

1.To review factors that led to the near miss incident.
2.To identify areas of improvement.
3.To plan implementation of improvement strategies.

Do:

1. Review of factors that led to near miss incidents

- National survey of Resident Anaesthetists in Singapore was conducted to review knowledge gaps about advantages and drawbacks of different preparations of Ketamine available for caudal epidural use.

2. Core quality and safety group meeting were conducted to identify improvement potentials in our systems and processes.

Consequently we identified the following deficiencies in our system.

Survey Response rate: 71%

Knowledge gaps and deficits:

Two preparations of ketamine are available in our institution. One is the racemic mixture that is not preservative free and the other is "preservative free" S ketamine. It is the S ketamine that is suitable for caudal epidural usage.

- A staggering 37% (n=35) were not aware of the fact that only 'preservative free' ketamine should be used for caudal injections (Figure 1) because the 'non preservative free' preparation has a neurotoxicity potential.
- 43(45%) of the residents considered the use of preservative free ketamine for caudal , without knowing that this was to avoid neurotoxicity due to preservatives. (Figure 2)

In Singapore, the only hospital to use AWS in operating theatre is KK Hospital. Hence Keying in the drug name into the automated drug dispensing Anaesthesia Work Station (AWS) enables anaesthetists to obtain various high alert drugs including ketamine.

- If the anaesthetist keys in 'Ketamine' then the preparation that is non preservative free and neurotoxic will be obtained.
- To obtain "preservative free" S-ketamine for use in caudal blocks, one should key in "S KETAMINE" and not "Ketamine".

- 52% of anaesthesia residents were unfamiliar with AWS (Figure 3)
- 64(67%) of the residents were not sure of the right way of obtaining the correct non toxic ketamine preparation from AWS. (Figure 4)

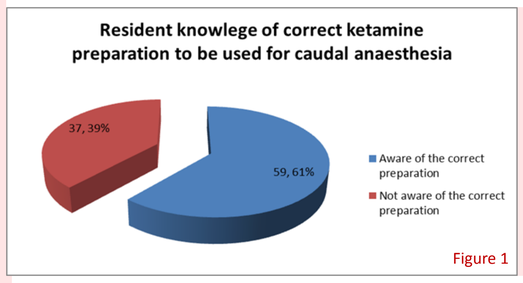


Figure 1

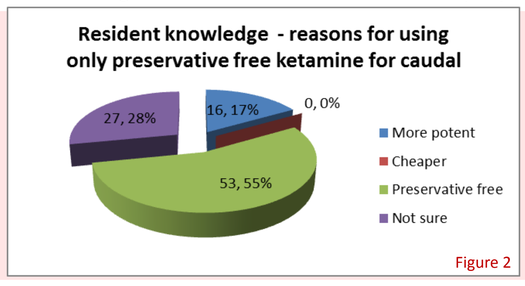


Figure 2

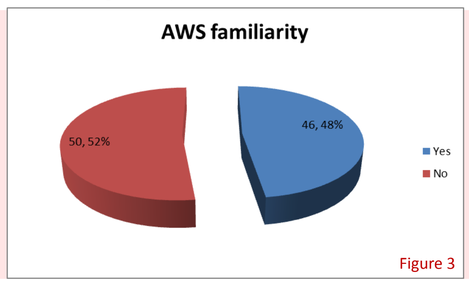


Figure 3

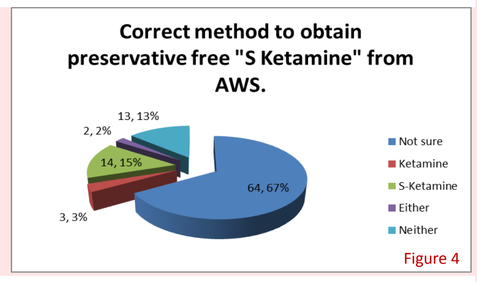


Figure 4

Interventions

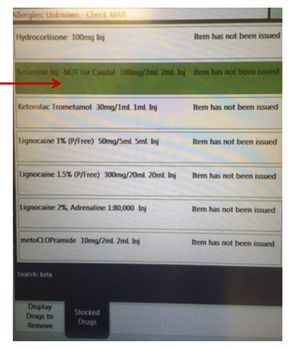
Improving knowledge about use of correct drug for caudal injections:

1. An email was sent out to all the anaesthesia residents across Singapore warning them about
   - Potential neurotoxicity of caudal 'non-preservative-free' ketamine and
   - The correct method of retrieving "preservative-free S-Ketamine" from AWS, for caudal use.
2. The information is reiterated in the 'medication safety' orientation core lecture series to the new residents rotating to KK Paediatric anaesthesia.
3. A survey is conducted on all newly rotating resident anaesthetists to ensure dissemination of information about the correct ketamine preparation to be used for caudal injection and the reasons behind it.

Two level warning system.

1. A warning message "Not for Caudal use" appears on the AWS screen, on keying in 'ketamine'. (Picture 1)

2. Dedicated bins are used for the 2 different preparations of ketamine.
The bins containing preparation with potential for neurotoxicity are labelled "NOT FOR CAUDAL USE" (Picture 2)



Picture 1

Picture 2

Check:

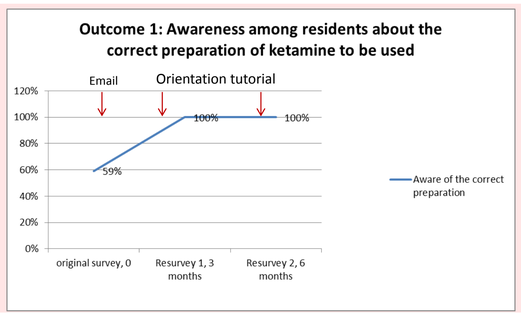
Outcome measures:

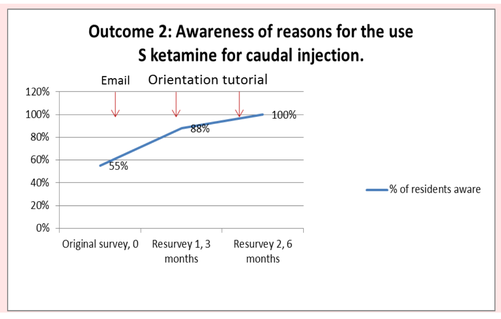
1. Knowledge among residents
   - Neurotoxicity potential of 'non preservative free' ketamine preparation
   - Correct ketamine preparation to be used for caudal epidural injection
   - Correct method of obtaining 'S ketamine' which is preservative free from AWS
2. Near miss or actual adverse incidents where in the wrong ketamine preparation was retrieved and/ or administered caudally.

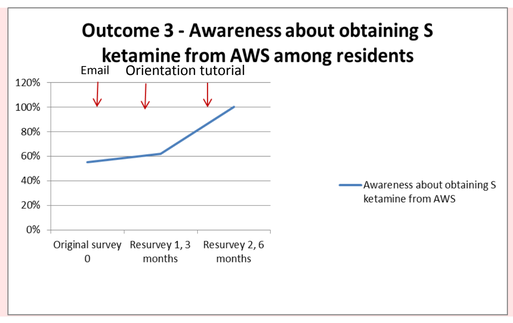
Results:

To date we have found huge improvements in the awareness of residents about

- Correct ketamine preparation to be used for caudal/epidural injections (Chart 1)
- Neurotoxic potential of non-preservative-free ketamine (Chart 2)
- Use of AWS to retrieve correct ketamine preparation for caudal use (Chart 3)
- Zero near miss/adverse incidents of injection of wrong preparation of drug into caudal space.







Conclusions

Our project has demonstrated that gaps in the knowledge among residents and deficiencies in the drug listing and dispensing system can together lead to a very serious adverse event such as caudal injection of wrong preparations. Our interventions have clearly demonstrated a significant improvement in the awareness among residents about neurotoxic potential of 'non preservative free' preparations and also prevented further near misses or adverse incidents due to injection of inappropriate ketamine preparation caudally.

Act:

The resident update and survey and improvements to AWS will continue to be a part of our medication safety initiative. These initiatives could also be used in other settings in Singapore. Other such potential areas will be explored and improvements put in place to enhance medication safety in our department.

References:

1.Benzethonium increases the cytotoxicity of S (+)-ketamine in lymphoma, neuronal, and glial cells. Anesthesia Analgesia . 2010 Dec;111(6):1389-93
2.Is ketamine or its preservative responsible for neurotoxicity in the rabbit? Anesthesiology. 1993 Jan; 78(1):109-15