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# Improving safety in regional anaesthesia – adopting the NRFit™ system

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**Abstract**

Errors of medication administration in intrathecal, epidural or regional anaesthesia have the potential to confer severe morbidity or mortality. In response, the UK's National Health Service (NHS) has mandated a transition to the NRFit™ connection system for regional and neuraxial anaesthesia, with the transition aimed to be complete by January 31st, 2025. NRFit™ connections are narrow bore and incompatible with the ubiquitous Luer connections. Commonly coded with yellow as an additional warning sign, it is virtually impossible to accidentally attach to a standard Luer connector. NRFit™ connections are to be reserved for regional or neuraxial anaesthesia and intrathecal chemotherapy.

Such a transition has not yet been implemented in Ireland. As the anaesthesia community looks forward to the publication of the National Audit Project 8 led by the Royal College of Anaesthetists (RCoA) in the UK, the topic of complications of regional anaesthesia will likely soon come under increased scrutiny.

## The nature and scope of the issue

Standard anaesthetic practice involves the administration of multiple different medications in rapid succession, often via differing routes, within a time critical period. The working environment is often rife with distractions, and the potential for error is very real.[1] The reasons for this are varied, but typically revolve around a relative deficit of anaesthetic staff in theatre (sole anaesthetists being common), coupled with certain periods requiring multiple drugs being administered in quick succession (such as during the induction process, which is swiftly followed by administration of mandatory antibiotic prophylaxis before incision, etc).

As a result, unfortunately mistakes in the administration of medications do occur. Sometimes serious morbidity or even mortality follows in the wake of these errors.

Where medication errors in anaesthesia are reported, up to 7.8% of these are classified as 'wrong site' administrations.[2] As a result of a desire to better understand these errors, and to better guard against them in the future, human factors analysis of anaesthetic practice has been implemented. Even as far back as 1978, drug-syringe errors were noted as being a frequent source of human error.[3]

Inadvertent administration of medications intended for the intravenous route into the intrathecal space has historically been recognised as being at particular risk of severe harm[4]. These concerns were validated once more with the National Audit Project 3 (NAP3) audit in 2009[5] – which counted 9 episodes of such an inadvertent injection into a neuraxial space, resulting in one death, with a further death reported just before the commencement of the audit and therefore not included in the official statistics.

**Mitigating against the risk of inadvertent injection in regional/neuraxial anaesthesia**

As mentioned previously, human factors analysis has been implemented in an effort to improve safety in anaesthesia in general. Excellent guidance on implementing this is available, such as Anaesthesia's 2023 article which collated advice from the Difficult Airways Society and the Association of Anaesthetists.[6] Some recommendations include optimising theatre list planning, utilising cognitive aids and checklists, and providing adequate time for a comprehensive team brief prior to commencing a list.

To paraphrase a particularly pertinent point from this article – the design of medical devices and workspaces is the most important factor in improving human factors in anaesthesia, and therefore reducing medication and performance errors. This is followed by creating barriers to prevent errors happening - such as cross-checking drugs, followed by mitigating harm when errors do occur, and finally by delivering further education and training regarding potential high-risk scenarios. Investing effort in education and training – while important – is thought to be a less high-yield approach than designing a system in which an error cannot easily occur, if it can occur at all. This model of understanding the human factors that lead to error is known as the 'heirarchy of controls' model.

The authors of this guidance comment that in the NHS (and ostensibly the HSE) we devote a considerable amount of effort towards training and educating healthcare professionals in an effort to prevent harm from occurring. The issue with this approach is that it ultimately relies on fallible humans never to fail – and we know that human performance can deteriorate with fatigue, stress and distraction. Thus, 'engineering out' a potential problem from the workflow can be a more reliable means to reduce errors, and this is the approach that the NRFit™ system seeks to implement.[7]

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**The NRFit™ System**

The NRFit™ syringe/connector system is officially referred to as ISO 80369-6 standard. These are narrow bore connectors that are designed to be physically incompatible with the standard Luer connectors that are ubiquitous throughout the healthcare system. NRFit™ connectors are envisioned as being reserved for "neuraxial sites, wound infiltration anaesthesia delivery, and other regional anaesthesia procedures or to monitor or remove cerebrospinal fluid for therapeutic or diagnostic purposes."[8]

The NRFit™ connections are 20% smaller than Luer connections, with respect to diameter. In addition, the NRFit™ tip is level with the collar of the connector, while the Luer tip extends beyond the collar. These discrepancies make it virtually impossible to fit the differing connection systems together. As an additional safety measure, NRFit™ connectors are coloured yellow to aid visual clarity of the differing systems.[9] A comparison between standard Luer syringes and NRFit™ syringes can be seen in figure 1. Of note, these connectors come in both 'slip' and 'lock' configurations.


*Fig 1: NRFit™ (yellow, left) vs Luer syringe (clear, right).*

NRFit™ connectors are to be reserved for particular procedures, such as spinal or epidural anaesthesia/analgesia, and for regional anaesthetic techniques. When this is the case, it is exceptionally difficult to attach a standard Luer syringe to an NRFit™ connector – like might erroneously happen when a medication intended for IV administration is given intrathecally.[10] It also functions in the opposite manner – preventing medications intended for neuraxial or regional routes from being given in an intravenous manner. The latter may be particularly important regarding regional anaesthesia – where large volumes of local anaesthetic are frequently used in nerve blockades, and intravenous injection of this agent would carry a significant risk of local anaesthetic toxicity.

While still a relatively new technology, some centres have reported the complete elimination of wrong-site injections in the two years since introducing NRFit™ connectors, a potential indicator of their efficacy.[9]

**NRFit™, the NHS and the HSE**

Non-Luer connectors have long been considered as being useful for these procedures, with the NHS advocating a transition to NRFit™ as long ago as 2011.[10] The rollout has fallen victim to multiple delays, with the most recent recommendation in January 2024 recommending all NHS funded trusts to complete a switch to NRFit™ connectors by the end of January 2025.[11]

In contrast, the HSE seem to have issued very little guidance on the implementation of NRFit™ connectors in Ireland, save for an advisory that they be used in the administration of intrathecal chemotherapy.[12] Currently, it would seem that it remains up to the individual hospital group in question as to whether it is worth pursuing the NRFit™ system for these indications.

An obvious issue those involved in procurement would have to consider would be the cost involved of such a transition to non-Luer connections such as NRFit™ . While the precise costs vary by manufacturer of the NRFit™ devices, it is important to realise that what is being proposed is a substitution of a certain amount of Luer devices for NRFit™ ones, mitigating the cost.[9] By way of example, however, one UK supplier quotes a single 10ml NRFit lock syringe at 92 pence[13], vs 62 pence for a standard 10ml luer lock syringe.[14]

**NAP 8 and patient safety in regional anaesthesia**

The 8th National Audit Project (NAP 8) has been announced in the UK, and this time will focus on the complications of regional anaesthesia.[15] The National Audit Projects have been of immense interest to anaesthesiologists around the world, as they study rare but potentially

serious complications related to anaesthesia. By involving all of the NHS, they have the potential to capture these relatively rare occurrences.

Whatever the results of NAP 8, it will undoubtedly shine a light once again on the safety of regional anaesthesia, and prompt discussions around how best we mitigate against patient harm when using these techniques. This is especially relevant given that 1:4 anaesthetics involve a regional technique at some point.[15] What will be particularly interesting to see will be the incidence of medication errors with wrong site injections, as the NHS is in the late stages of transitioning to the NRFit™ system. One would assume that if NRFit™ works as intended, the incidence of such errors would be minimal, and certainly lower than that reported in the previous NAP 3, which looked at complications of neuraxial techniques and took place before the NRFit™ rollout had properly begun. [5]

**Closing thoughts**

Ultimately, non-Luer connectors such as the NRFit™ system represent a potential advance in patient safety. Beyond increased cost, the system seems to have very few downsides that are readily apparent. With the NHS transitioning to the NRFit™ system wholesale, and with the upcoming NAP 8 publication, it may be time to consider whether the HSE should follow suit, or whether the technology is ultimately unnecessary. We hope that the NAP 8 publication will provide further data regarding the efficacy of NRFit™ that could guide policy and procurement.

**Declarations of Conflicts of Interest:**

None declared.

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