

Editorial

Time for prefilled syringes – everywhere

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Medication harm is the greatest cause of preventable harm: about 6% of patients suffer preventable harm and incidents related to drugs are the greatest cause, representing 25% of events [1]. This has been recognised by the World Health Organization (WHO) in the third Global Patient Safety Challenge: *Medication without harm* [2]. Great improvements in patient safety have been made in anaesthesia, particularly in monitoring and airway management. However, apart from the successful implementation of international standardised user-applied syringe labels in 2004 [3], there has been little progress in reducing harm from injectable medicines, about 10 of which anaesthetists administer to every patient [4]. Medication errors occur when there has been a mistake in the process of procuring; prescribing; preparing; dispensing; administering; and/or monitoring of medicines [5]. Most of these processes are not currently amenable to the use of safety-engineered devices in the way that the preparation of injectable medicines is.

A prefilled syringe is a ready-to-administer syringe that is filled and then labelled before it enters the final clinical area where it can be immediately administered without further manipulation. Some prefilled syringes are pharmacy-prepared in 'clean rooms' with a shelf life of a few weeks and others are industry-manufactured with up to three years of shelf life. The risk of a medication error during preparation has been reported as 17 times greater when syringes are prepared by hand [6] and while the use of prefilled syringes cannot prevent all medication errors

(wrong syringe selection, administering the incorrect dose), their engineered safety benefits make a strong argument for routine use. In this editorial we consider these and other advantages that appear not to be widely appreciated.

Human factors

The preparation and administration of injectable medicines is the most commonly performed task by any anaesthetist. It is also the process that involves more human factors steps than any other in anaesthesia. Human errors are involved in 80% of patient safety incidents [7], so any way of eliminating steps in the preparation and administration of injectable medications is likely to improve patient safety and reduce preventable harm.

A study by Reason describes individual unsafe acts as being hard to predict and control, but the organisational and contextual factors that give rise to them are present before the occurrence of an incident [8]. As such, they are prime candidates for treatment. The most successful way to reduce the number of human factors steps is to remove them completely. Indeed, there is no longer any need to go through many of the preparation steps for injectable medication preparation such as: removing an ampoule from its packaging; checking the contents label; opening it; opening a syringe packet; attaching a needle; aseptically drawing the injection from the ampoule into the syringe; and then correctly labelling it [9]. All these processes can be eliminated if the injectable medicines are procured and

supplied in safety-engineered prefilled, prelabelled syringes. It is estimated that at least 60% of the human factors-related steps can be eliminated this way [10].

Surprisingly, the NHS Specialist Pharmacy Service, whose job is to advise hospitals on purchasing medicines, makes no reference to human factors in its procurement overview [11]. However, the Royal Pharmaceutical Society advises that manipulation of medicines in clinical areas should be minimised and recommends the use of prefilled syringes wherever possible [12]. Such is the risk of preparing our drugs at the bedside that “*wrongly prepared high-risk medication*” was included in the original NHS England Never Events publication [13]. Just about all anaesthesia drugs are classified as ‘high risk’ but for various reasons the profession and others seemed to overlook reporting any of these Never Events. Many will have happened and the 5th National Audit Project (NAP5) identified six cases of accidental awareness in which patients were harmed because syringes had been prepared with the wrong labels, none of which were ever reported formally [14]. Despite strong representations, NHS England removed this Never Event in 2015, saying that it was doing so because “*the strong systemic protective barriers required, i.e. the national availability of, and the use in all clinical areas, of ready to administer injectable medication products requires a national plan that was beyond the timescales of this review*” [15]. NHS England looked to undertake an impact assessment to see if this Never Event might be a candidate for re-inclusion in the future but there is no evidence that this has ever taken place. Eight years later, prefilled syringes of anaesthetic medicines are becoming increasingly available and will be even more so if we – the end users – demand their use. Having prefilled syringes prelabelled correctly can also guarantee that minimum labelling standards are met and support additional labelling requirements that are unlikely to be consistently complied with when relying on manual labelling by clinicians in a busy workplace.

Workforce

Experts agree that the largest healthcare problem now is the workforce shortage and in 2023 the UK Government proposed a 15-year plan to increase the number of healthcare staff [16]. Lord Carter reported that providing just prefilled antibiotics alone would release 4000 whole-time equivalent nursing staff [17]. The labour-saving intervention of supplying prefilled syringes to clinical areas can contribute to reliably achieving a reduction in staffing pressures in a short timescale.

Correct concentrations

As well as prefilled syringes having the correct contents, any medicines that need diluting can also be certain to have the correct concentration. Simulation studies have shown that there can be large variations in the contents of manually filled syringes, with some actually having no active ingredient at all [6]. Using prefilled syringes can also help the standardisation of medicine concentrations, which in turn can help prevent medication harm. Simulation studies in critical care settings have shown that prefilled syringes allow medication to be administered to patients more quickly than using manual preparation techniques [4]. A recent patient safety report noted that “*a noradrenaline infusion syringe ran out, without a replacement being ready very shortly after the transfer from theatre, resulting in hypotension and death*” [18]. This would have been much less likely to occur if the hospital’s pharmacy had supplied prefilled noradrenaline syringes to the intensive care unit.

Infection control

Prefilled syringes can ensure that the injection contents are sterile: 6% of the syringes drawn up in operating theatres and 16% of those drawn up on the ward are contaminated [19], whereas the figure for a clean room or manufacturing facility is 0%. Sterile prefilled saline flush syringes can halve bloodstream infection rates when compared with those filled manually [20]. It is astonishing that such evidence has not been given more priority by infection control authorities to change practice.

Sustainability

Anaesthesia has embraced the concept of sustainability, and one way to protect the environment is to reduce the use of disposable equipment. Having injectable medicines supplied in ready-to-administer containers removes large quantities of glass ampoules, packaging, needles and the transport of all these items to the hospital. There are also additional cost savings in not having to pay for the expensive disposal of these items [21].

Cognitive load

A notable advantage of prefilled syringes to the anaesthetist is that they have been shown to reduce cognitive load, particularly in time-critical situations. This improves the working environment for staff, thus enabling them to concentrate on other patient care issues [22]. One study looking at the impact of prefilled syringes and equipment preparation in pre-hospital emergency anaesthesia simulation showed no lapses or errors in medicine

preparation and consequently the cognitive load of team members was significantly reduced [23].

Economics

One of the often-mentioned barriers to prefilled syringes is their higher purchase price compared with individual ampoules of many now out-of-patent, low-cost anaesthetic drugs. However, 15% of healthcare budgets are spent on managing adverse events [24], which can be decreased with the use of prefilled syringes. One of the highest ever NHS medical negligence payouts of £24 million (US \$29.3 million, €27.8 million) was caused by a mix-up of two unlabelled 10 ml syringes [25]. This benefit decreases the environmental harm of all the extra drugs and equipment needed to manage these additional adverse events, providing both a patient safety and sustainability dividend.

From the compelling arguments above it is difficult to understand why prefilled syringes are not already in widespread use. Over 28% of the 10 billion doses of injectable medicines sold globally every year are in prefilled syringes but only 4% of these are used in the acute sector [26]. The higher purchase price is often used to override, stall or fail to consider any deeper rationale of their undoubted patient safety and other benefits. This spurious economic argument is easily countered by a consideration of the wider systemic financial benefits: elimination of costs of manual preparation items and time; bacteraemia treatment; wastage; errors; and legal bills [27, 28]. Anaesthetists are fiscally responsible in general, but some seem to take great pride in illogically providing all their services on a shoestring. This contrasts with our surgical colleagues who 60 years ago stopped preparing their own sutures by cutting lengths of silk and threading them through the eyes of needles to now speedily opening sterile prefilled prelabelled packets of expensive state-of-the-art polymers with needles already attached. More recently they have brilliantly developed laparoscopic surgery with equipment, technology and disposables with no apparent concern for the cost or value. This pattern continues with the advancement of robotic surgery while the anaesthetist continues to draw up drugs in the face of convincing patient safety evidence. Surprisingly, sterile prefilled syringes of lidocaine have been purchased by hospitals in urinary catheter kits for over 20 years. This seems to show an illogical and unjustifiable difference in standards for urethral catheterisation and direct intravenous injection.

In the past, the profession has shown that prompt culture change is possible. The introduction of patient monitoring during anaesthesia was a huge advance in

patient safety, with most hospitals purchasing sets of very expensive equipment within 5 years of its national recommendation. Prefilled syringes represent one of the few occasions in clinical practice where investment in technology completely buys out many human factors-related error steps. Ultrasound equipment for the insertion of central venous access was initially thought to be particularly expensive when first introduced but now has widespread adoption. The routine use of ultrasound for regional anaesthesia has become a cultural norm now that its safety benefit of reduced harm and cognitive load is evident [29]. More recently, growing support for universal videolaryngoscopy has shown it is possible for the profession to successfully make the case for the procurement of new safety innovations.

In conclusion, the elimination of the multiple steps in preparing an intravenous medication, drawing it into a syringe aseptically and then correctly labelling the syringe is one of the few genuine hard-engineering opportunities to improve the safety of medication administration during anaesthesia [30]. The speciality of anaesthesia has been left far behind in the implementation of prefilled syringes. Surely anaesthetists, as the specialists in, and most frequent exponents of, intravenous practice should now be demanding them. Where these demands are unheeded, we believe there is such an abundance of benefit and safety evidence that organisations should record this decision in their risk register and address it through their safety management system [31]. It is time for prefilled syringes – everywhere.

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References

1. Panagioti M, Khan K, Keers RN, et al. Prevalence, severity, and nature of preventable patient harm across medical care settings: systematic review and meta-analysis. *British Medical Journal* 2019; **366**: l4185.
2. World Health Organization. Medication Without Harm - Global Patient Safety Challenge on Medication Safety. 2017. <https://www.who.int/publications/i/item/WHO-HIS-SDS-2017.6> (accessed 03/10/2023).

3. Birks RJS, Simpson PJ. Syringe labelling – an international standard. *Anaesthesia* 2003; **58**: 518–9.
4. Merry AF, Webster CS, Hannam J, et al. Multimodal system designed to reduce errors in recording and administration of drugs in anaesthesia: prospective randomised clinical evaluation. *British Medical Journal* 2011; **343**: d5543.
5. NHS Resolution. Did you know? Insights into medication errors. 2022. <https://resolution.nhs.uk/resources/did-you-know-insights-into-medication-errors/> (accessed 03/10/2023).
6. Adapa RM, Mani V, Murray LJ, et al. Errors during the preparation of drug infusions: a randomized controlled trial. *British Journal of Anaesthesia* 2012; **109**: 729–34.
7. Cooper JB, Newbower RS, Long CD, McPeck B. Preventable anesthesia mishaps: a study of human factors. *Anesthesiology* 1978; **49**: 399–406.
8. Reason J. Safety in the operating theatre – part 2: human error and organisational failure. *Quality and Safety in Health Care* 2005; **14**: 56–60.
9. National Patient Safety Agency. Promoting safer use of injectable medicines: A template standard operating procedure for prescribing, preparing and administering injectable medicines in clinical areas. 2007. https://webarchive.nationalarchives.gov.uk/ukgwa/20180501163752mp_/http://www.nrls.npsa.nhs.uk/resources/type/alerts/?entryid45=59812%26p=3 (accessed 12/10/2023).
10. Whitaker MCA, Whitaker DK. The impact of using prefilled syringes on a standard operating procedure for preparing injectable medicines in clinical areas. *Anaesthesia* 2023 Epub. <https://doi.org/10.1111/anae.16166>.
11. Healthcare Safety Investigation Branch. Investigation report: Inadvertent administration of an oral liquid medicine into a vein. 2019. <https://www.hssib.org.uk/patient-safety-investigations/inadvertent-administration-of-an-oral-liquid-into-a-vein/investigation-report/> (accessed 03/10/2023).
12. Royal Pharmaceutical Society of Great Britain. Professional guidance on the safe and secure handling of medicines. 2018. <https://www.rpharms.com/recognition/setting-professional-standards/safe-and-secure-handling-of-medicines/professional-guidance-on-the-safe-and-secure-handling-of-medicines> (accessed 12/10/2023).
13. Department of Health/Patient Safety. The never events policy framework: An update to the never events policy. 2012. <https://assets.publishing.service.gov.uk/media/5a7cc409e5274a2f304efef1/never-events-policy-framework-update-to-policy.pdf> (accessed 30/10/2023).
14. Mackay J, O'Connor K, Cook TM. Table 13.4. Drugs involved and psychological impact of six ampoule-labelling and one drug-omission error. In: Pandit JJ, Cook TM. *NAP5: Accidental Awareness during General Anaesthesia in the United Kingdom and Ireland: Report and Findings*. 2014. <https://www.nationalauditprojects.org.uk/downloads/NAP5Chapter13.pdf> (accessed 25/10/2023).
15. NHS England Patient Safety Domain. Revised Never Events Policy and Framework. 2015. <https://www.england.nhs.uk/wp-content/uploads/2015/04/never-evnts-pol-framwrk-apr.pdf> (accessed 12/10/2023).
16. NHS England. NHS Long Term Workforce Plan. <https://www.england.nhs.uk/wp-content/uploads/2023/06/nhs-long-term-workforce-plan-v1.2.pdf> (accessed 12/10/2023).
17. Department of Health and Social Care. Transforming NHS pharmacy aseptic services in England. 2020. <https://www.gov.uk/government/publications/transforming-nhs-pharmacy-aseptic-services-in-england/transforming-nhs-pharmacy-aseptic-services-in-england> (accessed 12/10/2023).
18. Faculty of Intensive Care Medicine. Safety Incidents in Critical Care. 2023. <https://www.ficm.ac.uk/sites/ficm/files/documents/2023-01/Safety-Bulletin-JAN-23.pdf> (accessed 12/10/2023).
19. Gargiulo DA, Mitchell SJ, Sheridan J, et al. Microbiological contamination of drugs during their administration for anaesthesia in the operating room. *Anesthesiology* 2016; **124**: 785–94.
20. Bertoglio S, Rezzo R, Merlo FD, et al. Pre-filled normal saline syringes to reduce totally implantable venous access device-associated bloodstream infection: a single institution pilot study. *Journal of Hospital Infection* 2013; **84**: 85–8.
21. Royal College of Nursing. Freedom of Information Follow up Report on Management of Waste in the NHS. 2018. <https://www.rcn.org.uk/Professional-Development/publications/pdf-006683> (accessed 09/10/2023).
22. Yang Y, Rivera AJ, Fortier CR, Abernathy JH. A human factors engineering study of the medication delivery process during an anesthetic. *Anesthesiology* 2016; **124**: 795–803.
23. Swinton P, Corfield AR, Moultrie C, Percival D, Proctor J, Sinclair N, Perkins ZB. Impact of drug and equipment preparation on pre-hospital emergency Anaesthesia (PHEA) procedural time, error rate and cognitive load. *Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine* 2018; **26**: 82.
24. Slawomirski L, Auraaen A, Klazinga NS. The economics of patient safety. 2017. <https://www.oecd-ilibrary.org/content/paper/5a9858cd-en> (accessed 12/10/2023).
25. Dyer C. Syringe mix-up led to brain damage and a possible £24m payout. *British Medical Journal* 2014; **348**: g1202.
26. Whitaker D. Standardisation, syringe labelling and prefilled syringes. *Anaesthesia News* 2021. <https://anaesthetists.org/Home/Resources-publications/Anaesthesia-News-magazine/Anaesthesia-News-Digital-February-2021/Standardisation-syringe-labelling-and-prefilled-syringes> (accessed 09/10/2023).
27. Benhamou D, Piriou V, Vaumas C d, et al. Ready-to-use prefilled syringes of atropine for anaesthesia care in French hospitals - a budget impact analysis. *Anaesthesia, Critical Care and Pain Medicine* 2017; **36**: 115–21.
28. Larmené-Beld KHM, Spronk JT, Lutjebroer J, Taxis K, Postma MJ. A cost minimization analysis of ready-to-administer prefilled sterilized syringes in a Dutch Hospital. *Clinical Therapeutics* 2019; **41**: 1139–50.
29. Chin KJ, Mariano ER, El-Boghdady K. Advancing towards the next frontier in regional anaesthesia. *Anaesthesia* 2021; **76**: 3–7.
30. Merry A, Wahr J, eds. Introduction to medication safety in anaesthesia and the perioperative period. *Medication Safety during Anesthesia and the Perioperative Period*. Cambridge: Cambridge University Press, 2021: 1–17.
31. Health Services Safety Investigations Body. Investigation report: Safety management systems - an introduction for healthcare. 2023. <https://www.hssib.org.uk/patient-safety-investigations/safety-management-systems/investigation-report/> (accessed 23/10/2023).