

CLINICAL PRACTICE



## Confirming the drugs administered during anaesthesia: a feasibility study in the pilot National Health Service sites, UK

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### Key points

- The use of double-checking for all drugs used during anaesthesia has been proposed.
- Two-person checking and electronic checking were evaluated for feasibility.
- Both systems were perceived to improve safety.
- The electronic system appeared to be more feasible.
- Technical aspects and a cultural change need more attention.

**Background.** To help prevent drug errors, it is recommended that drugs should be confirmed/checked with a second person before administration. We aimed to assess the feasibility of introducing second-person or electronic bar-code confirmation of drugs, administered during anaesthesia, in the National Health Service (NHS) settings in the UK.

**Methods.** Seven NHS sites took part in a pilot study over a 3 month period. Five used a second-person and two used bar-code electronic confirmation of drugs given during anaesthesia. A total of 36 consultant anaesthetists and three trainees, 15 operating department practitioners (ODPs), and seven anaesthetic nurses participated. A group of anaesthetists, ODPs, and nurse practitioners ( $n=11$ ) from different NHS sites independently observed both methodologies. In addition, each site was visited and observed by one of the study investigators. At the end of the study period, four focus groups (two with participants from pilot sites and two with observers) were held. The discussions were taped, transcribed, and qualitatively analysed. Data were triangulated using observer's notes and investigator's reflective diaries, and processed using line-by-line coding. The codes were then synthesized into themes.

**Results.** Both methods were perceived to contribute to the prevention of drug errors. For the two-person confirmation to be carried out correctly, there should be no distraction or time pressure. The main limitation to the feasibility was that the continuous presence of the second person was not always possible. The process also met with resistance from the staff at some pilot sites. Electronic confirmation was always feasible, as it did not require the presence of a second person. It was found to be intuitive to the anaesthetist's current working practice. However, there were some practical issues related to introduction of new technology and an initial learning curve.

**Conclusions.** The introduction of two-person confirmation to the NHS would have a significant impact on the existing working practices. Issues related to resources and a cultural change will need to be addressed. Electronic confirmation was more feasible, but the technological aspects of its integration into the operating theatre environment, and learning, will require further attention.

**Keywords:** double-checking; drug administration; drug errors; patient safety

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Drug errors during anaesthesia remain a serious cause of iatrogenic harm.<sup>1,2</sup> The reported incidence of errors range from 1:131 to 1:5475 anaesthetics.<sup>3–7</sup> Despite the wide range of reported incidence, and perceived lack of consensus regarding the magnitude of the problem, it is unacceptable that any patients suffer harm, no matter how minor, while undergoing anaesthesia.<sup>8</sup>

The white paper 'Building a safer NHS for patients'<sup>9</sup> recommends that ideally, all i.v. drug administration should be checked by two qualified practitioners. Several publications<sup>10–14</sup> suggest that errors can be reduced through double-checking. A review of strategies for preventing drug errors during anaesthesia concluded that double-checking could have prevented 58% of the errors, which made it the

most effective single measure.<sup>10</sup> The need to double-check to prevent drug errors during anaesthesia has been strongly emphasized.<sup>15</sup> However, the use of double-checking as a process to reduce drug errors continues to be disputed because of the variability in, and paucity of, rigorous conclusive research evidence of its effectiveness.<sup>16</sup> A recent study concluded that double-checking medicines should be a selective and systematic procedure informed by key principles and encompassing certain behaviours learned from psychological research and aviation industry.<sup>16</sup>

In an independent review of serious adverse incidents in oncology practice,<sup>17</sup> the author has strongly recommended the use of an explicit appropriately configured verbal double-checking safety protocol, which, if done correctly, would reduce drug preparation and administration errors. An integrated drug administration and automated anaesthesia record system which utilizes bar-code technology to provide a computerized confirmation of the label that is 'rapid, accurate and not subject to human suggestibility' has been developed.<sup>11</sup>

In September 2007, in the UK, the Royal College of Anaesthetists (RCoA), Association of Anaesthetists of Great Britain and Ireland (AAGBI), and the National Patient Safety Agency (NPSA) set up a multidisciplinary Expert Reference Group to provide strategic direction to a project called 'improvement through partnership'. On the basis of incidents reported to the NPSA which showed the majority of drug errors occurred during administration, and the suggestion that these could have been prevented had a double-checking measure been in place,<sup>18</sup> the group decided that feasibility of introducing a double-check of drugs given during anaesthesia should be explored. It was noted that confirmation of the drugs administered during anaesthesia, either using a second-person check or a technology-based system, is not routinely practiced in the UK or elsewhere in the world.

The present qualitative study aimed to explore the feasibility of introducing a practice of confirmation of drugs given during anaesthesia in seven NHS pilot sites within England and Wales over a 3 month period during 2008.

## Methods

We used qualitative research methods. In patient safety meetings, held at the Royal College of Anaesthetists, delegates were invited to participate. A pragmatic approach of purposive sampling was used to select anaesthetists from those who volunteered. They represented a range of NHS secondary and tertiary referral centre Hospitals, geographically spread across England and Wales. Anaesthetists from seven NHS Trusts were selected. Two of these Trusts were identified as having a technology-based system (integrated drug administration and automated anaesthesia record system which utilizes bar-code technology) installed and five Trusts were identified to use the two-person confirmation protocol.

Approval was granted by a multi-domain Ethics Committee and local NHS research governance was gained at all sites. It was left up to the lead participant at each site to

identify other anaesthetists who were willing to participate. A total of 36 consultant anaesthetists and three trainee anaesthetists, 15 Operating Department Practitioners (ODPs), and seven anaesthetic nurses participated. Each participant was sent a letter of invitation and information sheet and signed a consent form before taking part.

The two methods of confirmation of drugs were integrated into clinical practice for a period of 3 months. At all the participating sites, the process of confirming the drug to be drawn up into the syringe was standardized through the use of a flowchart (Supplementary Appendix, Fig. 1). At the five sites, which participated in two-person confirmation, a second flowchart was used (Supplementary Appendix, Fig. 2) for drug administration. The flow charts were designed by the human factors team within the NPSA, and piloted at an independent NHS Trust before the study.

At the two sites assigned to use the technology-based system, a specific label that contained a bar code identifying the drug was used. The label was placed onto the syringe after drawing up the drug, and the computer-assisted bar-code reader was used to 'confirm' drugs before administration. Hence, the first flow chart was used to draw up the drug, and the electronic system was used during administration. The electronic system has been designed specifically for use within anaesthesia with the aim of reducing the error in drug administration and record keeping.<sup>11</sup> Scanning the bar-coded syringe produces audible and visual drug confirmation, while at the same time the name of the drug and the dose administered are entered into an electronic anaesthetic record. The system also utilizes barcodes to enter anaesthetic events on the record, such as the start of surgery or the size and placement of the i.v. cannula. The electronic system gathers physiological data directly from the patient monitor via the serial connector. A real-time anaesthetic record is produced from these data, and any further information that is entered via the bar code reader.

All the participants at the pilot sites were asked to keep reflective diaries. The reflective diaries were provided by the study team and were standard across all sites. Each diary entry was divided into five areas for the participant to reflect on: Setting, Drug Preparation, Time, Feasibility, and Other [Supplementary Appendix, Box 1]. The prompts provided within these five areas were only a guide and were by no means prescriptive. Participants were asked to complete these diaries after every surgical session for the first 2–3 weeks of the study.

Independent observation was provided by a number of anaesthetists ( $n=4$ ), theatre nurses ( $n=4$ ), and ODPs ( $n=3$ ), working in NHS Hospital Trusts not participating in the pilot. The independent observers were recruited through RCoA, the College of ODPs, and the Association for Perioperative Practice. They were randomly allocated to observe the two-person confirmation and the electronic bar code confirmation during the 3 month study period. Each person visited two pilot sites and observed both methodologies. In addition, two members of the study team made independent observations of the conduct of the study at all

the sites, and this allowed for comparisons and internal validity checks on the data collected. All observers were provided with instructions and a schedule to record observations in order to promote consistency. The observers were asked to transcribe the detailed notes taken during the observation period immediately afterwards.

At the end of the 3 month study period, a total of four focus groups were held (Table 1). Two focus groups, consisting of anaesthetists ( $n=5$ ), ODPs ( $n=3$ ), and anaesthetic nurses ( $n=3$ ) from the participating pilot sites were conducted within 2 weeks of the end of the study. The other two focus groups, each with four to five independent observers, were conducted within 2 weeks of the completion of all observations. One of the authors moderated the groups and another took notes. Before the start of the focus groups, a brief outline was given of the format of questions. We used the SWOT format to focus on Strengths, Weaknesses, Opportunities, and Threats of both methods of confirming drug administration in relation to patient safety. All participants were assured of confidentiality and anonymity. A digital recorder was used to tape all discussions. Pre-defined questions and prompts were used to ensure continuity across

all focus groups. The discussions were continuously taped and transcribed by one of the researchers within 7–10 days of completing each focus group. The finished transcripts were read through and checked against the original recordings by an independent researcher for accuracy and integrity; any further comments were added at this stage.

The data from the reflective diaries were used to check outliers emerging from the observation data to enhance validity and provide triangulation.<sup>19 20</sup> Outlying themes were also explored further within the Focus Groups, allowing for a more comprehensive picture of the issues surrounding the introduction of the drug confirmation into clinical practice. A research diary was also maintained by one of the investigators (R.E.) during the study period, which acted as a ‘memo’ during analysis.<sup>21 22</sup>

The emphasis of analysis was on determining meaning and understanding rather than counting events or proving hypotheses.<sup>23</sup> Qualitative methodology was adopted to generate detailed descriptions and categories, as guided by data<sup>24</sup> to explain the phenomenon under investigation.<sup>19</sup> The analyses were iterative rather than sequential.<sup>23</sup>

Initially, one of the researchers (R.E.) read, re-read, and line-by-line coded the transcripts (Focus Groups and Observations) as described by Charmaz.<sup>25</sup> This allowed the development of concepts which may have escaped attention through the initial read through and to identify themes and categories within and across the transcripts.<sup>25</sup> A second researcher (R.M.) independently read through the transcripts and coded them as described above. R.E. and R.M. then met to discuss the coding and to concur or revise the thematic categories.

The line-by-line coding generated more than 150 codes; these were then synthesized using focused coding into theoretical categories of which two categories were further broken down into three subcategories. Throughout the analysis, the transcripts were repeatedly revisited to compare categories, to look for ‘negative’ or contradictory themes, and triangulation of data from reflective diaries and observations. These themes could then be explored further during the study period through collecting additional purposive data in order to reach the point where no new themes were emerging known as data saturation. After finalizing the categories, the memos about each thematic category were written to define them and ensure consistency between researchers. Memo-writing allowed the researcher to elaborate on a category, specify its properties, define any relationships found between categories, or identify gaps in the data collected.<sup>26</sup>

## Results

The two main thematic categories that emerged from the data were two-person confirmation and electronic bar-coding system, with their subcategories being benefits, disadvantages, and practicalities. Other categories that emerged were perception of drug errors and wider cultural issues related to patient safety.

**Table 1** Details of the participants

Participant number	Occupation	Which method of confirmation observed or used?
Focus Group 1: observers		
1	Consultant anaesthetist	Both
2	ODP	Both
3	Nurse	Both
Focus Group 2: observers		
1	Nurse	Both
2	Consultant anaesthetist	Both
3	Consultant anaesthetist	Both
Focus Group 3: participants		
1	ODP	Electronic
2	Consultant anaesthetist	Two person
3	Consultant anaesthetist	Two person
4	Nurse	Two person
5	Consultant anaesthetist	Electronic
6	ODP	Two person
7	ODP	Two person
Focus Group 4: participants		
1	Consultant anaesthetist	Two person
2	Nurse	Two person
3	Consultant anaesthetist	Electronic
4	Nurse	Electronic

Second-person confirmation

Benefits

Participants felt that the second-person confirmation had the potential to enhance patient safety, but it had to be carried out properly, with allocated time and without distraction (Table 2). An additional benefit that emerged was that its introduction into clinical practice appeared to have increased awareness of drug errors and other safety issues.

Disadvantages

One of the major barriers to the use of second-person confirmation was that in an emergency, when the drugs were needed in a hurry, and when the potential for drawing up the wrong drug or misadministration could be increased, the confirmation was often abandoned. Having to stop and wait for somebody to be available to confirm the drug was not an intuitive action, and it had an impact on the way the anaesthetist worked. The impact was seen in the form of anaesthetists checking more than one drug at a time, or sometimes giving inhalation agents when no one was available to confirm the i.v. drug. Several participants described how they had started to modify the confirmation flowcharts in order to prevent any perceived delays to the theatre list.

This had led to the drug confirmation becoming no more than lip service.

Practicalities

The main practical issues related to two-person confirmation were continued availability of a second person, and some people refusing to take on the role. In addition, the observers noted that while the anaesthetists drew up the drugs in most instances, in some sites, ODPs often drew up the drugs for induction of anaesthesia to speed up the lists. In these instances, availability of a second person for confirmation was a major issue. Overall, the introduction of the confirmation protocol, generally, was not seen as too much of an infringement on their clinical practice by nurses and ODPs. However, there were occasions when the confirmation was perceived as a nuisance, and was not carried out. Some participants were reluctant to perform confirmation in front of the patient. The perception of some clinicians was that double-checking a drug would cause delays to the administration of that drug or to the running of the theatre list. However, others felt that it could be performed without causing too much of a delay.

Electronic bar-coding system

Benefits

One of the main benefits was the ability to check the drug without a second person being present (Table 3). The

**Table 2** Subcategories, key emerging themes, and quotes for two-person confirmation (see Supplementary material for expanded version of the table)

Subcategory	Themes	Quote(s)
Benefits	No additional equipment	... all we need are two people
	Patient safety	... no doubt that it is a robust ... fail-safe method... I think it has heightened awareness among users...
Disadvantages	Not always feasible	In an emergency situation it goes straight out of the window... ... in the middle of an operation... and the ODP was not around...
	Impact on practice	I was giving my drugs when my ODA was there rather than when I wanted to give drugs
Practicalities	Attitude	Some members of staff were refusing to be involved
	Lack of resources	Its resources and time ... if that allotment arrives ... then it could be made to work
	Process-driven	My experience ... not just that it was time consuming, but it also became menial and frustrating ... I was speeding up the process, so instead of checking one drug at a time ... I could be checking more...

**Table 3** Subcategories, key emerging themes, and quotes for electronic confirmation (see Supplementary material for the expanded version of the table)

Subcategory	Themes	Quote(s)
Benefits	Feasibility/ patient safety	unblinking, untiring 'eye' on the drug, you never need to find someone else to do it (double check)
	Accurate record	It's an accurate record of what's going on and it's my record
Disadvantages	Distraction during learning curve	There is potential for the system to be a distraction from other matters of patient/anaesthetic care
	Can be by-passed	There are ways round the system, because you can scan all the drugs for induction and have them sitting on the side, so there is still a potential for picking up the wrong syringe
Practicalities	Logistics and space orientation	One of the issues ... was the remoteness of the scanner from the cannula, if it was right by the cannula then you are likely to scan it,...
	IT-issues	Occasionally we'll lose data from the monitoring that's going into the servers and it will just stop collecting data



system itself was found to be easy to use and effective. Another perceived benefit noted by many of the participants was the automated electronic record that the technology-based system produced. The ability to view the anaesthetic record in advance in areas such as the recovery unit was perceived to be immensely important.

Some elements of patient safety were perceived to be essentially a by-product of the electronic anaesthetic record. The quality of the anaesthetic record produced by the system was seen, by both participants and observers, as a great incentive to use the system. The electronic system was also seen to allow the participants more time to concentrate on the patient.

Disadvantages

It was noted by observers and participants that there is the potential for the electronic bar-coding system to become a distraction while working through the learning curve. Another disadvantage that emerged consistently from the data was the permissive design of the system. The drugs could be given without having to swipe them through the bar code reader, or multiple drugs could be scanned before administration, defeating the object of confirmation at the time of administration. Locating the scanner close to the i.v. drug administration port could have overcome this problem.

Practicalities

The induction of anaesthesia in an anaesthetic room has been a traditional feature of anaesthetic practice in the UK since 1860.<sup>21</sup> Before transferring the patient from the anaesthetic room to the operating theatre, the ‘system’ was ‘parked’, once in the operating theatre the second system was initiated and the patient data were retrieved. The unexpected consequence of utilizing the system in this way, however, was the ability to retrieve multiple patient records.

The other practical issues related to initial teething problems that were encountered at both sites related to the physical placement of the system, some drugs not being in the database of the system, and getting hospital monitoring devices and IT facilities to integrate with the system. This was all part of the learning curve, these issues became fewer as the participants became more familiar with the system.

Perception of drug errors and cultural issues

There was the overall impression of both participants and observers that although drug errors ‘happened’, they were not a big problem (Table 4). This was due to rarity of the events, lack of significance attached to the error, ability to ‘get out of trouble’, and perception that anaesthesia is safe. This was the view of all groups, not just confined to the anaesthetists.

However, the attitudes to double-checking varied among professionals. In general, nurses thought that it was a good idea to confirm drug administration, but there were mixed feelings among ODPs over confirmation. The majority of ODPs thought that it was a good idea. One ODP

**Table 4** Key emerging themes and quotes for perception of drug errors and cultural issues (see Supplementary material for the expanded version of the table)

Category	Themes	Quote(s)
Perception of drug errors	Favourable attitude to double-checking	We're all used to double checking anyway. As a nurse its routine... I feel that double checking of drugs should always take place Does everybody have to make a mistake before being convinced?
	Unfavourable attitude to double-checking	...just a waste of time... ... are you questioning my capability... ...just another hassle...
Cultural issues	Shared responsibility	All of a sudden the responsibility for the preparation and administration of drugs becomes shared between two people
	Sanitizing the errors	Sanitising error... that's what we do... and it really doesn't matter, it happens but it really doesn't matter, and we're all guilty of that...
	Managing change	How do you change a culture though, I'm really not sure, you'd have to prove I think that there really is a reduction in error in some way

commented that they found the different reactions, to the drug confirmation protocol, from anaesthetists and ODPs quite interesting; some anaesthetists were reluctant, whereas the ODPs were of the opinion they already checked drugs, this was no different to their current practice.

Some anaesthetists thought there was no enough evidence that drug errors are a problem to warrant this intervention, while others felt measures to prevent errors should be supported. It was apparent from the data that there was a need for clear guidelines on the responsibility and accountability of the second person confirming the drug. Overall, anaesthetists showed a preference for the electronic system, which did not rely on the presence of a second person, as it did not break the ‘rhythm of the work’.

Discussion

This study was designed to explore the feasibility of introducing a method of confirming the anaesthetic drug administration, within the existing environment of NHS hospitals, along with the attitudes, experiences, and behaviours of the participants. Hence, a qualitative methodology was chosen for the study. We found that both methods, that is, two-person and the electronic confirmation, were perceived

to have the potential to minimize drug errors and enhance patient safety. However, second-person confirmation was not always feasible as it depended on the availability of a second person at the time of drug administration. In addition, it was perceived to be time-consuming, prone to human manipulations, and met with some resistance from the staff. On the other hand, the electronic confirmation was independent of the presence of the second person, and was reliable and easy to use. However, it required a period of training for the staff, and overcoming the problems of introducing and installing new technology to the anaesthetic room and operating theatre environment.

The use of an explicit, appropriately configured, verbal double-checking safety protocol has been strongly recommended, with the expectation that if one person misses an error, the other will detect it.<sup>17</sup> In our study, we developed two distinct protocols and flow charts for two-person confirmation. The protocol design, developed by experts in human factors, ensured active engagement of the second person in the process. However, our participants found it difficult to adhere to these protocols, in particular, in emergency situations, and when there was a perceived shortage of time. We also found some reluctance among anaesthetists, which could have been the result of cultural change, as two-person confirmation was more acceptable to nurses and ODPs, who already double-check any injectable drug they prepare or give.

Verbal double-checking does not always prevent drug errors. This may be due to diffused responsibility, where two people are supposed to be responsible for the same task, but in reality neither person is truly responsible, both relying on the other to be rigorous resulting in neither giving the task their full attention.<sup>17 27–29</sup> However, some believe the benefits of double-checking as opposed to single-checking remain undetermined.<sup>30</sup> It is important that some of our participants felt that drug confirmation would prevent errors, but they stressed the need for it to be performed correctly.

In our study, the observers noted that due to resource pressures, at some sites, an ODP often drew up the drugs for induction of anaesthesia independently, which were subsequently administered by an anaesthetist. This is clearly in contradiction to the existing norm of good practice that, in normal circumstances, the anaesthetist should draw up the drugs that he/she administers, or intends to administer, during anaesthesia. In addition, the circumstances described by one participant of trying to speed up the process, by simultaneously confirming more than one drug at once, defeats the whole purpose of drug confirmation. This in turn creates a situation where the confirmation becomes futile and involuntary automaticity can take hold. The process of involuntary automaticity has been described as the repeated use of identical checking procedures unintentionally leading to a ritualistic chant of the checklist items.<sup>31</sup> This can lead to 'the literal meaning of the message being ignored'.<sup>32</sup> It is important to note that this behaviour is not calculated but unconscious. Although the task actually demands careful attention, once under the influence of involuntary

automaticity, the check becomes only cursory and the risk of overlooking any errors present is increased.<sup>31</sup> Our data suggest that, in practice, two-person confirmation will not be achievable unless the resource issues such as time and availability of a second person, and the culture in which anaesthetists work, are adequately addressed.

Merry and colleagues<sup>11</sup> designed the electronic system for double-check before administration of the drug. They suggested that the anaesthetists' attention would be regained through listening to the information articulated when the syringe is passed over the bar code reader immediately before administering the drug, providing a 'computerized two person check' which is prompt, definitive, and not prone to human susceptibility. In this study, the electronic system was accepted into clinical practice readily at one site, and after few organizational teething problems in the other. The benefit of the anaesthetic record was seen as one of the driving factors in this swift adoption. When compared with the two-person confirmation, this system appeared to be more feasible and less challenging culturally. Increased familiarity with the system resulted in greater efficiency of use, particularly during emergencies.<sup>11</sup> From our data, training and education of all members of staff in the use and purpose of the system was of paramount importance in its adoption. Reducing cognitive load is helpful to decision-making, and so is the clear display of accurate physiological data; the automated record achieves both of these.<sup>11</sup>

One of the perceived disadvantages of the electronic system, in our study, was that the anaesthetist could bypass many of its safety features by scanning a number of drugs at the same time. The risk of this could be reduced by locating the scanner close to the i.v. port. Other technical issues were also raised in our study which included integration with the existing technologies and IT within the operating theatre, the possibility of technical failure, space utilization, and the location of the scanner. These are more issues regarding the logistics of integrating new technology into an existing environment rather than a limitation of the system. Of the two methods, all observers preferred electronic over two-person confirmation and the participants using the electronic system were positive about its potential to reduce error. However, we suggest that any system used to confirm drug administration, during anaesthesia, should be capable of overcoming the logistical and technical issues as raised in our study for its appropriate utilization in enhancing patient safety.

The introduction of any new technology may have its own hazards which may not have become immediately obvious in this study. We suggest that a further detailed expert technical hazard assessment exercise should be conducted with a view to develop recommendations for introducing such a system in the NHS environment.

Our data suggested that clinical staff differed in their perception of significance of drug errors and their attitude towards measures to prevent them. It is therefore important that the introduction of any method of preventing drug errors should be accompanied by a drive towards awareness

of drug errors, which may be achieved by active engagement of professionals in reporting, analysis, and dissemination of learning from critical incident reporting at the local and national level. We believe that, for any measure of patient safety to be successful, acceptance by the professionals involved is essential. This study has uncovered a number of factors, barriers, and facilitators, which can determine successful uptake of safety interventions in clinical practice within or even outside anaesthesia. We believe that further studies exploring the cultural issues, some of which are uncovered by the present study, are required for successful implementation and long-lasting uptake of safety initiatives in health-care systems.

One of the potential limitations of this study is that all the participants had attended safety meetings, and had shown willingness to participate in the study. Hence, the results may be limited to the anaesthetists who are motivated in the area of patient safety. However, the findings of the participants were triangulated by using independent multi-professional observers and the reflective diaries. In addition, we included the nursing staff and ODPs from the participating sites in the study to build a more complete picture. The participating sites were selected to provide a wide geographical distribution and hospitals of different sizes ranging from a general district hospital to tertiary referral centre.

The relationship between the researcher and the participants has been recognized as a source of potential bias. In this study, this relationship was recognized. To a large extent, these influences are unavoidable; however, the researchers tried to minimize these by having a heightened level of awareness, adhering to basic rules of interviewer's behaviour, and having more than one method of collecting data.

Our study has produced a considerable amount of data from multiple sources. The issue of the observers causing a Hawthorne effect has been discussed previously.<sup>22</sup> We believe that the introduction of observers did not change the behaviour of any of the anaesthetists or assistants during the process, as the phenomenon of observation is not new in the NHS environment. The risk of different observers placing importance onto different aspects of the process was limited through the use of the observation schedule [Supplementary Appendix, Box 2], the observers were also encouraged to reflect on what they had observed at the end of the session in order to capture any prejudices or preconceptions they may have that could impact on the data collected. We also aimed to limit the bias through using two independent study team members, one unfamiliar with the anaesthetic environment, to cross-check the observations of those more familiar with the setting under observation and these produced correlative accounts. We believe that the data collected were an accurate account of the experiences of the participants, and this was confirmed at the focus groups for those who had participated, and through the reflective diaries. The findings were also similar across all seven sites which support their generalization.

These findings may be transferable on international scale, but this study does have idiosyncrasies that are only typical in the NHS.

In summary, the introduction of two-person drug confirmation was found to be difficult to achieve, at times, due to staff availability and its reliance on time being allocated for the process to take place unhindered. If this check was to be introduced in the NHS, it would have a significant impact on the existing working practices of the anaesthetist, and issues related to resource and cultural change will need to be addressed for it to be successful. Electronic confirmation, on the other hand, is more feasible as it is not reliant on a second person to be available and is more intuitive to the anaesthetist's current working practice. It allows the anaesthetist to remain as an independent practitioner being able to give the drug when they want to give it and not when a colleague is available to check. For it to be effective, technological aspects of making its integration into the operating theatre environment will require further attention.

## Supplementary material

Supplementary material is available at *British Journal of Anaesthesia* online.

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## Conflict of interest

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