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Attitudes to Error and Patient Safety

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Abstract *The vast majority of patients clearly benefit from modern health care. However, the rate of injury and death inadvertently caused by medical treatment remains too high, and exacts enormous human and financial costs. Organisational change is not solely a technological issue however, and the attitudes of clinicians are critical to the successful improvement of safety and the effective re-design of procedures and equipment. We purposively surveyed a group of clinicians for whom treatment-caused harm is of particular concern in order to better understand some of the difficulties involved in technological change and the potential attitudinal barriers to safety improvement.*

Keywords: Iatrogenic error; safety; attitudes; technological change; anaesthesia.

Introduction

Health care is one of the last complex, high-technology industries to adopt a systematic approach to safety, and typically relies heavily on the resolve and vigilance of individual clinicians to avoid bad outcomes for the patient. The Institute of Medicine in the United States claims, 'health care is a decade or more behind other high-risk industries in its attention to ensuring basic safety'.[1] Despite this, technology in health care is rapidly increasing in sophistication and complexity, thereby introducing new risks for the patient and rendering clinical resolve and vigilance increasingly inadequate for the maintenance of patient safety.[2] Although the vast majority of patients clearly benefit from modern health care, the rate of injury and death inadvertently caused by medical treatment remains too high and exacts enormous human and financial costs. Each year, in Britain and the United States alone, hundreds of thousands of patients are injured, tens of thousands are killed and billions of dollars are spent on additional health care because of treatment-caused harm.[3]

Errors and system failures in the administration of drugs to patients have been highlighted as a leading cause of patient harm, and professional and public concern about the problem is widespread.[4] The problem is of particular concern in anaesthesia because of the sheer number of potent drugs which anaesthetists are

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required to administer during the relatively short period of an anaesthetic. Notwithstanding the perception of many of the general public that drug administration is a simple act, the technology of drugs and their administration is an aspect of modern medical practice as technologically complex as any other.

Despite high levels of professional concern, the medical literature contains divergent opinions about the best way to reduce rates of drug administration error and the level of expenditure that is appropriate and necessary to achieve such a reduction.[5] In addition, safety improvement is not solely a technological issue, as the attitudes of clinicians determine, to a large degree, the remedies that individuals are prepared to take to improve safety. Therefore, we have conducted a survey designed to purposively sample the attitudes of clinicians with regard to a number of prominent safety issues in anaesthesia, including the perceived importance of the drug error problem, the risks posed to patients and clinicians, and the difficulty in making the procedural and technological changes involved in improving safety.

Methods

A questionnaire was developed which covered two sides of a single A4 page and comprised two questions about the demographics of the respondent and 12 questions concerning perceptions about various aspects of the drug error problem (Table 2). In nine of the latter 12 questions, responses were recorded on continuous 100 mm visual analogue scales (VAS) where respondents were asked to make a mark between two extreme end-points or anchors (Table 2). In order to detect any personal biases in attitudes, respondents were asked to answer twice for each VAS question, once in terms of their own practice and once in general terms. With regional ethics committee approval, delegates attending a major national anaesthesia conference[6] were invited to complete the questionnaire anonymously and return it to a collection box.

Numerical data were analysed with standard statistical tests.[7] Significant effects were designated as $P \leq 0.01$, and for clarity non-significant results are not reported. Responses to questions requiring comments were summarised according to themes and tabulated.

Results

One hundred and seventy seven (84%) conference delegates were from New Zealand, 26 (12%) were from Australia, three (1%) were from the United States of America, two (1%) were from Hong Kong, and one each was from the United Kingdom and Canada. Seventy five of the possible 210 delegates returned a completed questionnaire (a 36% response rate), with an average of 98% of individual questions answered. Forty eight (64%) survey respondents were consultant anaesthetists, 10 (13%) were anaesthetic technicians, seven (9%) were trainee anaesthetists, nine (12%) were other allied clinicians, and one was a non-specialist anaesthetist (Table 1).[8]

Visual Analogue Score (VAS) Responses

VAS responses were highly variable overall, with most questions yielding a range of responses spanning the entire scale. Table 2 shows median VAS responses to questions 3–11 in relation to the respondents' own practices and in general terms.

Table 1. Experience of survey respondents

		Years of experience			
Respondents[a]	***n***	**<5**	**5–10**	**10–20**	**>20**
Anaesthetists	56	4	14	21	17
Other clinicians	19	9	7	3	

Note: [a] Anaesthetists are made up of 48 consultant anaesthetists, seven trainee anaesthetists, and one non-specialist anaesthetist. Clinicians in the 'other' category were made up of 10 anaesthetic technicians, five doctors, three nurses (one pain specialist), and one pharmacist.

Anaesthetists' Perceptions of Their Own Practices

Median VAS scores indicated that anaesthetists were concerned with the problem of drug administration error in their own practice (75 mm, question 3) and were in strong agreement that the public were becoming less tolerant of professional error (94 mm, question 7). Anaesthetists rated the risk in their own practices of an individual patient being harmed by a drug error as relatively low (median 36 [range 2–99] mm, question 4), but rated the chance of harming a patient through drug error in the course of a career in anaesthesia as high (83 [14–100] mm, question 5, $P<0.001$). The 'safety culture' of the aviation industry,[9] in which dangerous aspects of systems are re-designed in the wake of an accident rather than blaming individuals for carelessness, is often held up as an ideal for medical safety programmes to emulate. However, anaesthetists rated the aviation safety culture as corresponding only somewhat to the culture in their own practices (37.5 mm, question 11), and saw considerable scope to improve the safety of traditional methods of drug administration (70.5 mm, question 6). Changing long-established patterns of behaviour and practice was rated as relatively difficult (62 mm, question 10), but changing the system or environment in which anaesthetists work was rated as less difficult (49 mm, question 9). Respondents indicated that in their own practices, 27% additional funding (question 8) over and above the current cost of anaesthesia would be warranted to achieve the goal set by the Institute of Medicine of a reduction in medical error by 50% in five years.[10]

Anaesthetists' Perceptions in General

All scores reported in general terms have similar direction and magnitude to those related to the respondents' own practices (Table 2), but a number of interesting differences between the two sets of scores were found. Anaesthetists reported significantly less scope for safety improvement in methods of drug administration used in their own practices than in general—median 70.5 [range 6–100] mm vs 81 [6–100] mm respectively, $P=0.008$ (question 6). The difficulty of changing the system or environment in which anaesthetists work was rated as significantly greater in general terms than in the respondents' own practices—65.5 [15–100] mm vs 49 [8–100] mm respectively, $P=0.001$ (question 9). Similarly, the difficulty of changing long-established patterns of behaviour was rated as significantly more difficult in general terms than in the anaesthetists' own practices—69.5 [23–100] mm vs 62 [1–100] mm respectively, $P=0.001$ (question 10). Finally, respondents rated the correspondence between the safety culture of the

Table 2. Questions and anchors used on the questionnaire and median visual analogue scale responses for questions 3–11[a]

		Anaesthetists		Other clinicians	
	O=own practice, G=in general	**O**	**G**	**O**	**G**
1.	What is your occupational grade?				
2.	How many years of experience do you have?				
3.	How concerned are you about the problem of drug administration error (not at all–very)?	75	75.5	73	78.5
4.	How would you rate the risk of an individual patient undergoing anaesthesia being harmed by a drug error (very low–very high)?	36	44	[b]	42
5.	How would you rate the risk to an anaesthetist of causing harm to a patient by drug error during an entire career (very low–very high)?	83	82	[b]	80
6.	What scope do you believe exists to improve the safety of traditional methods of drug administration (very little–a great deal)?	70.5	81	47	57.5
7.	Do you believe the public is becoming less tolerant of professional error (disagree–agree)?	94	95	92	95
8.	The United States Institute of Medicine recently initiated the Quality of Healthcare in America Project—its goals include the reduction of error in health care by 50% in five years. How much extra money (as a percentage of the overall cost of anaesthesia, including salaries) do you believe is warranted to achieve this goal (0%–100%)?	27	27[c]	60.5	50[c]
9.	How difficult do you believe it is to change the system or environment in which anaesthetists work (very easy–very difficult)?	49	65.5	[b]	78
10.	How difficult do you believe it is for anaesthetists to change long-established patterns of behaviour and practice (very easy–very difficult)?	62	69.5	[b]	85
11.	How closely do you believe the culture in anaesthesia corresponds to the 'safety culture' of the aviation industry (very close–not at all close)?	37.5	44.5	[b]	28.5
12.	Which mode of drug administration do you consider at the greatest risk of error?				
13.	Have you ever received specific training on how to administer drugs safety?				
14.	We know that most anaesthetists make errors and that most of these are without consequence to the patient. What strategies do you employ in your practice to reduce the risk of harming patients by drug administration error?				

Notes: [a] Participants' responses to all visual analogue scale questions are shown above in terms of their own practices and in general. Ranges have been omitted as most span the entire scale and so are unhelpful in interpreting the data—these are given in the text where statistical comparisons are made.

[b] These questions refer specifically to anaesthetists' own practices.

[c] Three anaesthetists and eight other clinicians indicated that more than 100% extra funding is warranted.

aviation industry and that of anaesthesia as significantly more related in their own practices than in general—37.5 [2–100] mm vs 44.5 [5–100] mm respectively, P=0.002 (question 11).

Other Clinicians' Perceptions

The VAS responses of other clinicians are also contained in Table 2. In broad terms the responses of other clinicians agreed with those of anaesthetists, but with one

interesting exception. Other clinicians rated the amount of extra money that would be required to achieve a 50% reduction in error in five years in their own practices as more than double that reported as necessary by anaesthetists—median 60.5% [range 7–100%] mm vs 27% [9–100%] mm respectively, P=0.014 (question 8). A significantly larger proportion of other clinicians compared to anaesthetists also indicated that more than 100% extra funding would be required to achieve a 50% reduction in error (eight of 19 vs three of 56 respectively, P<0.001).

Modes of Administration

Modes of drug administration ranked by their reported risk of error are shown in Table 3. Intravenous drug administration was rated the most prone to error by both anaesthetists and other clinicians, with 77% and 50% of responses respectively. Infusion of drugs by automated pumps followed in a distant second place with 12% and 17% of responses respectively.

Drug Administration Training

Of the 53 anaesthetists and 18 other clinicians who answered question 13, only 10 (19%) anaesthetists and five (28%) other clinicians indicated that they had received specific training on how to administer drugs safely.[11] Half of anaesthetists who had received specific training indicated that this took place during their time as a trainee or by a colleague.

Error Prevention Strategies

Methods used by anaesthetists in their own practices to minimise the risk of harm to patients through drug administration error are listed in Table 4, grouped under similar categories and in order of frequency.

A total of 187 strategies were reported (Table 4), or a median of three per respondent (range 1–8). The most common strategy was manual checking of drugs (28% of reported strategies overall), followed by labelling techniques, which made up 18%. Syringe-size coding, in which syringes of specific size are used for specific drugs or classes of drug, was reported as the third most common safety strategy used by 13% of respondents. However, inconsistencies in the meaning of syringe sizes were apparent in reports: a 5 ml syringe was used by one anaesthetist for

Table 3. Modes of drug administration judged as at the greatest risk of error[a]

	Anaesthetists		Other clinicians	
	n	%	*n*	%
Intravenous	44	77	12	50
Infusion	7	12	4	17
Fluids	2	3.5	4	17
Inhalational	2	3.5	1	4
Intraspinal	2	3.5	2	8
Subcutaneous	0	0	1	4

Note: [a] It should be noted that some respondents designated more than one mode of administration.

Table 4. Error prevention strategies employed by anaesthetists in their own practices[a]

a.	*Checking techniques (n=53)* Double check ampoules (17); check when injecting drug (8); check with colleague (4); consciously check—try to avoid 'autopilot' (5); triple check (3); read labels out loud (3); read expiry date to focus on checking task (3); check when drawing up (2); check dose (2); personally draw up and check (2); check drug administration equipment (1); check label when picking up syringe (1); check for allergies (1); review drug tray occasionally (1).
b.	*Labelling techniques (n=33)* Label all drugs (29); label one syringe at a time and check (2); handwrite names on syringes (2).
c.	*Syringe-size coding (n=25)* Particular syringe sizes for certain drugs (22); 5 ml for muscle relaxants (1); 3 ml for infiltration—5 ml for spinal administration (1); specific syringe size per dilution (1).
d.	*Simplicity-based strategies (n=16)* Keep workspace tidy (5); perform as a sole practitioner to avoid divided tasks (3); discard old syringes (3); apply KISS [keep it simple stupid]—use simple anaesthetic technique (2); if in doubt throw it out (1); use same drugs for similar cases (1); use one drug tray per patient (1).
e.	*Colour coding (n=15)* Coloured labelling by drug class (8); red syringe plunger for relaxants (3); colour coded drug drawer (1); extra colour-coded label for suxamethonium (1); red label for relaxants (1); needle colour coding (1).
f.	*Position coding (n=13)* Specific lay out pattern for syringes/ampoules (6); keep 'emergency' drugs in separate location (4); separate by class of drug (2); layout drugs in order of use (1).
g.	*Ampoule techniques (n=11)* Retain ampoules for double check (10); don't re-use ampoules once open (1).
h.	*Additional miscellaneous safety strategies (n=21)* Draw up only when needed (7); avoid interruptions/distractions when preparing/administering drugs (3); care and competence (2); documentation (1); avoid fatigue (1); maintain a paranoid and vigilant state of mind (1); treat each administration as potential crisis—not always achievable (1); don't give drugs drawn up by others (1); do not allow anyone to tamper with your syringes (1); consult data sheet for uncommon drugs (1); use suxamethonium label to seal needle to syringe (1); put neostigmine in relaxant syringe for use at end of anaesthetic (1).

Note: [a] Numbers in parentheses indicate frequency of individual strategies within each category.

muscle relaxant, for spinal administration by another, while a third anaesthetist reported using syringe size to denote different dilutions of drug. Notably, only 8% of reported safety strategies involved the use of colour coding of drug labels or syringes—this is despite colour coding being considered ergonomically effective in many other technological fields.[12] Here too, inconsistencies were apparent—some respondents reported the use of colour-coded labelling by class of drug, while another reported the use of coding by needle-hub colour (available in a different colour range to that of user applied drug labels in anaesthesia).

Discussion

This survey demonstrates that opinion concerning many of the issues surrounding the problem of drug administration error in anaesthesia is varied. However, it does make clear that clinicians consider this a serious problem, of which they believe the public is intolerant. It is also clear that most surveyed anaesthetists believe they are likely to harm a patient through drug error in the course of their careers—a result consistent with reliable empirical estimates of the incidence of drug error.[13] Despite the often-used comparison between the safety culture of the aviation

industry and that of anaesthesia, the two were rated as corresponding only somewhat in this survey and the scope for safety improvement in anaesthesia was seen as considerable.

The response rate of those attending the conference (36%) is typical of the survey method generally.[14] Moreover, it is in the middle of the range of response considered acceptable for surveys of representatives of organisations (36%±13%)[15]—a category arguably appropriate for clinicians attending a major national conference. As the sample selected for the survey was purposive, the results may not be nationally representative of anaesthetists in New Zealand. However, our data do demonstrate significant personal biases in clinicians' attitudes toward important safety issues. In addition, the attitudinal and volitional aspects of safety improvement in health care remain considerably underresearched and our survey yields data useful to the further investigation of this area, and to the technological and policy aspects of safety improvement throughout medicine.

A number of significant differences were seen between anaesthetists' 'personal' and 'general' responses to questions. Clearly attitudes are complex and influenced by many factors, however, a number of these effects are consistent with the common psychological phenomenon known as optimist bias, in which individuals, on average, view and report their abilities as better than average—a clearly impossible state of affairs.[16] For example, anaesthetists reported a higher correspondence between the safety culture of the aviation industry and that of anaesthesia in their own practices than in general terms, and reported less scope for safety improvement in their own practices than in general. Both results are consistent with individuals believing that their practices, on average, are already safer than average. Similar optimistic biases have been reported in other aspects of anaesthesia. For example, in an Australian survey, anaesthetists estimated the risk of patients experiencing some level of awareness during their operations (a highly undesirable and potentially traumatising event) as half as likely in their own practices than in that of others.[17] Optimist bias therefore indicates an attitudinal barrier that may hinder the adoption of new safety systems. However, optimist bias may not be entirely disadvantageous. Anaesthetists rated the difficulty of improving the work environment and in changing long-established patterns of behaviour as greater in general terms than in their own practices—consistent with the idea that individuals, on average, believe themselves to be more flexible or accommodating than average. This may indicate attitudes that could facilitate the introduction of new safety systems. Both results also underscore the importance of involving clinicians closely in any system re-design process, not only because technical and medical expertise is essential to appropriate system change, but also to increase rates of compliance once clinical safety systems are implemented.

The Quality of Health Care in America Project, initiated by the Institute of Medicine,[18] has set a goal of a reduction in medical error by 50% in five years. While highly commendable, anaesthetists and other clinicians indicated that achieving such a goal would require considerable investment, far in excess of any such efforts currently being made. Clearly, results of this survey are based on perceptions only, and may bear little resemblance to the actual cost of achieving a 50% reduction in error. For example, it is unclear why anaesthetists rated the amount of additional funds required at less than half that estimated by other clinicians (Table 2). However, overall, the problem of drug error was rated as sufficiently serious to warrant substantial expenditure to achieve solutions. A greater

awareness of the very large potential savings from the prevention of iatrogenic harm is also warranted and should play a larger part in the financial planning of medical organisations. For both these reasons, the avoidance of medical safety initiatives simply because they cost a little more is likely to become increasingly untenable in the future.[19]

A perhaps surprising result of this survey is that intravenous drug administration was designated as by far the most risky mode of administration, and considerably more risky than intraspinal administration (Table 3). Intraspinal administration is generally considered to be technically more difficult, and to carry a higher risk of complication than intravenous administration, and thus specific training is devoted to this technique. However, in general, drug administration is associated with little specific *safety* training; only 19% of anaesthetists and 28% of other clinicians reported that they had received specific training on how to administer a drug safely. This lack of training, and the fact that intravenous administration is used considerably more often than intraspinal, may explain the fact that anaesthetists perceived intravenous administration as 22 times more error-prone than intraspinal. For the surveyed clinicians at least, these data indicate a gap in training and a clear starting point for the re-design of medical systems to achieve greater patient safety.

Optimist bias may also underlie a number of the safety strategies reported by anaesthetists (Table 4). Reported strategies such as 'care and competence', 'treat each administration as a potential crisis', 'try to avoid "autopilot"' and 'maintain a paranoid and vigilant state of mind' appear, at least at face value, to be substantially optimistic approaches to error avoidance. Although many of these strategies would be used in conjunction with others (respondents used a median of three strategies each), these strategies seem too vague or general-purpose to be effective in avoiding error, and are little different from the unhelpful safety directive of 'do not make mistakes'. Well-known human fallibility ensures that such simplistic, general-purpose safety directives will fail.[20] More interesting from a cognitive ergonomic point of view are the reported strategies that attempt to facilitate effective checking by deliberately focusing attention on a specific task at a particular time. For example, reading labels out loud, reading the expiry date to focus on the checking task, and checking at critical times during the anaesthetic, such as when drawing up drugs, when injecting, and when picking up syringes (Table 4). Some of these reported strategies actually add redundant or unusual steps to the checking task, in a deliberate attempt to break out of the 'automatic' or highly practised behaviour which typifies the action of experts—behaviour which can allow complex tasks to be performed with little conscious input, and so lead to slip or lapse errors.[21] Most clinicians appear to have their own set of such attention-focussing strategies, and their specificity is likely to make them more effective than general-purpose directives to avoid error. In the absence of technological support for checking (for example, bar-coded, pre-filled syringes[22]), such specific attention-focussing strategies remain one of the best approaches to safe performance.

Clearly, some of the safety strategies reported in Table 4 do employ aspects of technological or equipment-based support. Labelling, syringe-size coding, colour coding, position coding, and ampoule retention all facilitate manual checking, but most of these techniques are not employed in a consistent manner from one clinician to the next. Conflicting coding and labelling schemes create difficulties and potential safety problems when two clinicians are working together, or during handover from one to another, and this has been confirmed by observation studies

during clinical practice.[23] Indeed, three respondents reported a preference for performing as the sole practitioner to avoid a divided task with such inherent difficulties.

Concluding Remarks

Respondents showed considerable variation in their clinical practice, considered the problem of drug administration error to be serious, particularly with respect to the intravenous administration route, and agreed that substantial investment is required to improve safety. Many beliefs concerning the problem, and the error prevention strategies in response to it, appeared to reflect optimist bias and were inconsistent both with the error prevention strategies adopted by other anaesthetists and with what is known about psychology and human factors.[24] Little technological support in checking drugs was reported, and few clinicians received specific training on how to administer drugs safely. Anaesthetists rated the scope for improvement in the safety of drug administration as large and rated the correspondence between the safety culture of the aviation industry and that of anaesthesia as relatively low. These results suggest that considerable scope remains for safety improvements in anaesthesia through the use of better technological support for the administration of drugs and the systematic re-design of anaesthetic equipment and procedures. In addition, it is often claimed that the specialty of anaesthesia is a leader in health care in terms of the improvement of patient safety.[25] Therefore, it seems likely that even larger scope exists for the improvement of patient safety throughout other health-care specialties.

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7. Statistical analysis was performed using Systat 10 for Windows (SPSS Inc., Chicago, IL, USA). To allow for multiple comparisons and post hoc testing we took a conservative approach to

our analysis by using non-parametric tests and by designating $P \leq 0.01$ as significant. Group comparisons were performed with the Wilcoxon signed-rank test or the Mann-Whitney test as appropriate. The Fisher's exact test was used to compare proportions. For background information on these methods see: D. G. Altman, *Practical Statistics for Medical Research*, CRC Press, Boca Raton, 1999; B. S. Everitt, *The Cambridge Dictionary of Statistics*, Cambridge University Press, Cambridge, 1998.

8. Note, anaesthetists are those personnel able to give an anaesthetic—this includes trainee anaesthetists. The other-clinician group is made up of allied health professionals who work closely with anaesthetists but who cannot give an anaesthetic—this group includes anaesthetic technicians.
9. Safety cultures, such as that in the aviation industry, interpret accidents or failures as indicators of faulty systems with which individuals work. Fixing these systems is the most effective way to improve long-term organisational safety. The opposite approach is the blame-centred organisational culture, which interprets accidents and failures as character weaknesses in personnel and therefore blames individuals for their carelessness or laziness when things go wrong. Thus, blame-centred cultures direct attention away from the faulty work systems that precipitate accidents, thereby leaving them untouched to continue to precipitate further accidents in the future. For further examples and discussion of these issues see: P. Hunt, 'Safety in aviation', *Perfusion*, 3, 1988, pp. 83–96; W. B. Runciman, R. K. Webb, I. D. Klepper, R. Lee, J. A. Williamson and L. Barker, 'Crisis management—validation of an algorithm by analysis of 2000 incident reports', *Anaesthesia and Intensive Care*, 21, 1993, pp. 579–92; R. L. Helmreich and A. C. Merritt, *Culture at Work in Aviation and Medicine*, Ashgate, Aldershot, 2001.
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