

Have NAP4 and the DAS 2015 guidelines achieved their aims?

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My view is that the prime aim of both projects was *to improve the way in which airway problems are managed*.

The 4th National Audit Project of the Royal College of Anaesthetists and Difficult Airway Society (NAP4) [Cook 2011a, Cook 2011b] also aimed to

- Identify the extent of the problem of major complications of airway management
- Identify the nature of these problems
- Highlight the issues involved in such events
- Recommend solutions at national, organisational and individual levels

The DAS 2015 guidelines on the management of unanticipated difficult intubation [Frerk 2015], built on the findings of NAP4. More specifically they aimed to

- Update existing 2004 DAS guidance after review of current evidence
- Streamline the guidance
- Incorporate and emphasise non-technical aspects of airway management
- Provide a common pathway to guide management of difficulty with tracheal intubation.

Overall both projects aim to improve *institutional preparedness* and *personal preparedness*.

Summary of NAP4

NAP4 was a one-year national registry (numerator phase) of major airway complications arising during anaesthesia, in ICU or ED leading to death, brain damage, emergency front of neck airway (eFONA), ICU admission or prolongation of ICU stay. It also included a national activity (denominator survey) and a detailed multidisciplinary analysis of each submitted report.

NAP4 reported an incidence of airway-related death and brain damage of 7 per million general anaesthetics in the United Kingdom (UK). There were 133 anaesthesia events, 36 in ICU and 15 in ED. NAP4 reported an event rate of 46 events per million general anaesthetics (95% confidence interval (CI) 38-54) or 1:22,000 (95% CI 1:26,000-18,000). Amongst ≈3 million general anaesthetics, there were 16 airway related deaths and 3 cases of persistent brain damage, equating to a mortality rate of 5.6 per million general anaesthetics (95% CI 2.8-8.3) or 1: 180,000 (95% CI 1: 352,000-120,000).

Point estimates for anaesthesia airway complications in NAP4.

Airway management	Events	Death and brain damage
Any	1:22,000	1:150,000
Tracheal tube	1:12,000	1:110,000
Supraglottic airway	1:46,000	1:200,000
Facemask	1:22,000	1:150,000

Several themes were identified in NAP4:

- Omission of airway assessment (assessing both risk of difficulty and of aspiration) and failure to act on findings at assessment contributed to poor outcomes.
- There was poor planning and 'failure to plan for failure'. There were unstructured responses to unexpected difficulty and failure. Anaesthetists started with a single plan only. Airway *strategies* were advocated, namely a logical sequence of plans, designed to manage failure at each step and thereby achieve oxygenation, ventilation and prevent aspiration.
- Difficulty and failure was often managed with repeated attempts, especially at tracheal intubation, including without a change of technique. This was associated with deterioration from a 'cannot intubate can oxygenate' to a 'cannot intubate cannot oxygenate' (CICO) situation. NAP4 strongly advocate adopting a limited number of attempts as part of any strategy.
- Illogical decisions were made and techniques chosen, including using routine care in the face of known difficulty and avoiding awake fiberoptic intubation when this was strongly indicated. Lack of experience, judgement, skills, confidence and equipment all contributed.
- In three-quarters of cases quality of care was judged to be 'poor' or 'good and poor'. In a follow-up study, human factors were identified in all cases with an average of four factors per case [Flin 2013]. Poor judgement, education and training were the commonest contributory factors. Anaesthetists using 'their usual technique' when this was not in the patient's interest was common. Best care may require involvement of colleagues with other skillsets.
- Difficult, failed or delayed intubation was the primary events in approximately 40% of reports to NAP4. Intubation problems occurred at some point during the evolution of the event in the majority of cases.
- SGAs (predominantly first generation) were used in patients with high aspiration risk or marked obesity and aspiration followed. Use of SGAs by junior doctors and accepting an inadequately positioned and poorly functioning airway led to non-aspiration events. SGAs were also used to avoid anticipated difficult tracheal intubation, but without a rescue plan or strategy. When problems occurred management was unplanned and some cases led to

death. Use of awake techniques or planned tracheal intubation through the SGA would likely have avoided such events.

- Obese and morbidly obese patients were over-represented in all areas of the project. This finding has subsequently been replicated and reinforced in other important studies [de Yong 2015, Huitink 2017].
- The need for multidisciplinary communication and involvement of senior anaesthetic and surgical staff in head and neck cases was emphasised as these cases were prominent, accounting for approximately 40% of all anaesthesia cases.
- The obstructed airway accounted for many cases and these often progressed to CICO. Issues included poor planning, communication, equipment, teamwork and situation awareness were noted. Awake tracheostomy appeared to be rarely considered and was encouraged in the report. When difficulty occurred in anaesthetised patients, and an eFONA performed by a surgeon was the back-up plan, transition was often delayed. This plan necessitates a surgeon who is instantly available and ready to act. This may be termed a 'double set up' with one operator ready to intubate and another scrubbed and ready to perform eFONA as soon as intubation fails.
- During CICO, transition to eFONA was often delayed and often failed. The authors recommended anaesthetists should be skilled and practiced in surgical (now 'scalpel') cricothyroidotomy and that both cannula and scalpel techniques should be taught. This latter recommendation has now been superseded by the DAS2015 guidance – see below.
- Aspiration was the single commonest cause of death in anaesthesia events (51% of reports of death or brain damage) and approximately half of the cases involved tracheal intubation. Poor judgement was causative in many cases, including poor assessment of patient and operation risk, and choosing techniques that provided little or no protection against aspiration. The authors supported rapid sequence induction (RSI) as a technique.
- Surprisingly and disappointingly, unrecognised oesophageal intubation was a cause of events and major harm, accounting for 6% of cases. This occurred in all treatment locations. Capnography should be available and used for all tracheal intubations. Some events occurred during cardiac arrest: even in cardiac arrest during CPR an attenuated capnography trace is present if the tube is in the trachea. A flat capnograph trace indicates failure of lung ventilation and oesophageal intubation or airway occlusion must be assumed and actively excluded.
- Events during emergence and recovery accounted for 25% of anaesthesia events. Common themes were blood in the airway (either caused by surgery or minor airway trauma during anaesthetic instrumentation), airway obstruction and post-obstructive pulmonary oedema. Planning tracheal extubation of the high-risk airway is as important as planning tracheal intubation.

- Of all events reported to NAP4 a quarter occurred in the ICU or ED, though interventions in these settings only numbered approximately 100,000 (compared to 3 million general anaesthetics). Compared to anaesthesia, reports of events leading to death or brain damage were 35-fold higher in ED and 55-fold higher in ICU. Permanent harm or death occurred in 61% of ICU reports, 33% of ED reports and 14% of anaesthesia reports.
- In the ICU, displaced airways (especially tracheostomy) were the greatest cause of major morbidity and mortality. Problems while establishing an airway were less common including during percutaneous tracheostomy. Obese patients were again over-represented. Delayed recognition and lack of a structured plan for such an event was prominent.
- In the ED, most complications followed RSI.
- In both ED and ICU there were concerns about the lack of equipment, skills, assistance and planning for failure during RSI.
- The gaps in care that were identified in ICU and ED reports were more marked than in anaesthesia reports. These included: lack of identification of at-risk patients; poor planning; inadequate or delayed access to appropriately skilled equipment or staff; delayed recognition of problems; lack of structured responses, and lack of prepared and rehearsed strategies for managing predictable airway complications. The project identified avoidable deaths due to airway complications in the ICU and ED. These findings are significant as approximately 6% of ICU patients and 40% of ICUs have a patient with a predicted difficult airway at any given time [Astin 2012].
- Failure to use capnography in ventilated patients contributed to more than 70% of ICU-related deaths. This included contributions to failure to identify airway displacements or to diagnose rescue or failure of attempted rescue, including oesophageal intubation. Errors of interpretation of capnography also contributed. Increasing use of capnography on ICUs was judged the single change with the greatest potential to prevent deaths such as those reported to NAP4. Ensuring training in capnography training for all clinical staff (doctors and allied health professionals) in ICU was also emphasised and is easily achieved [Cook 2013]. The project made 143 recommendations designed to improve individual, institutional and national resilience in airway management. The project was widely disseminated by lecture, literature and on line.

Summary of DAS 2015 guidelines

The DAS 2015 guidelines on management of the unanticipated difficult intubation are significantly influenced by the findings and recommendations of NAP4. In part they can be considered directly related to each other. The main components of the DAS 2015 guidelines in comparison to the 2004 guidelines are

- Retention of a didactic approach (in contrast to the ASA guidelines)
- A streamlined, simplified, linear algorithm.
- Emphasis on oxygenation throughout.
- Emphasis on minimising attempts at any technique (but not adopting the Vortex approach [Chrimes 2016]).
- Increased reference to human factors including explicit audible declaration of failure at each step, introduction of a 'stop-and-think' phase in plan B and graded assertiveness challenging with PACE.
- Harmonising non-RSI and RSI pathways.
- Adoption of evidence based technical advances
 - Videolaryngoscopy promoted during early attempts at intubation
 - 2nd generation SGAs specified for airway rescue
 - Apnoeic (or per-oxygenation) techniques embraced
- A decision to recommend scalpel-bougie-cricothyroidotomy as the eFONA technique and movement away from needle cricothyroidotomy – in keeping with recent evidence [Duggan 2016]

Of note, also in response to NAP4, DAS commissioned guidelines on airway management of the critically ill and these will be published on line in November 2017.

Impact of NAP4

NAP4 is widely referred to and widely cited. In 2016 its two main papers ranked 1st and 5th in all time citations in the British Journal of Anaesthesia, which itself is the most highly cited anaesthesia journal globally. This makes it likely these are two of the most widely cited pieces of airway research ever published. The NAP4 report was also openly available on the College website – it was accessed more than 50,000 times in the first four months after publication from 30 countries. Three years after publication page visits were still >1000 per month.

Two years after the publication of NAP4 a survey identified that practice changes had been made directly in response to NAP4 in 98% of UK hospitals. The survey used a safety gap analysis (assuming compliance with the recommendations to be a metric of safety) to measure change. The highest safety gaps at the time of NAP4 were in the ICU and ED. The

extent to which these safety gaps were closed was 39% closure in anaesthesia, 48% in ED and 59% in ICU. This will be discussed more in the presentation.

An editorial in the BJA [Moppett 2017] stated (EpiCCS). Excitingly, the NAPs (e.g. through the implementation of capnography outside the operating department)¹⁹ and NELA (e.g. through improvements in risk assessment and consultant presence during surgery) have clearly impacted on hospital structures and processes, and perhaps most importantly, on clinician behaviour. These changes are leading to improvements in patient safety and (arting to

Impact of DAS 2015

The DAS 2015 guidelines were well received. They have been translated into 6 languages. Citations are high and no doubt will soon eclipse NAP4.

There has been a generally strongly positive response to all the changes made as described above.

The main, perhaps only significant, area of contention has been the decision to promote scalpel-bougie-cricothyroidotomy. Importantly, the first decision the DAS 2015 guidelines committee made was to promote one technique only, with the second decision being to decide which! There was considerable discussion and external advice taken before deciding as they have. Overall there is general agreement that despite many strong opinions, the optimal technique for eFONA is not known. In the UK, the DAS guidelines are generally supportive of the scalpel-bougie-tube technique, while in Australasia the narrow-bore needle is generally favoured. The topic continues to generate an unnecessary amount of noise! However, as the most important aspect of managing CICO is *the decision to manage it* (death after CICO is much more commonly due to failure to act rather than because of procedural complications) choosing a national strategy and teaching it is logical. Both the UK and Australasian anaesthesia communities have adopted this approach.

On this point it is worth noting that although NAP4 is often quoted as supporting the arguments put forward by those favouring the scalpel-cricothyroidotomy technique, this is a fallacy. NAP4 neither found this nor made recommendations consistent with this. In NAP4 there were 80 eFONAs: 58 in the operating room; 15 in the ED; and seven in ICU. Anaesthetists almost universally chose a cannula-based technique and in the operating theatre 15/25 performed by anaesthetists failed. Overall the (narrow and wide bore) cannulae eFONA failure rate was 65% (22 of 34). Failures occurred for technical, equipment and operator reasons. A total of 45 'surgical or scalpel eFONAs' were captured, and 44 (98%) successfully re-established the airway, though not all patients survived. However, notably almost all surgical eFONAs were performed by surgeons, often while the anaesthetist maintained the airway and oxygenation from above. The surgical procedure in some cases

took up to an hour. Conversely, needle techniques used by anaesthetists were generally 'last gasp' attempts often peri-mortem and other efforts at oxygenation had to be abandoned. Overall NAP4 does not inform us whether the scalpel technique is more effective in the hands of anaesthetists.

Another criticism of the DAS 2015 guidelines (and its predecessor) is that it only addresses unanticipated difficulty in tracheal intubation. It does not address a) anticipated difficult intubation (though DAS guidelines are in preparation) nor b) difficulty with other aspects of airway management.

Conclusions

It is impossible to know whether NAP4 or the DAS 2015 guidelines have made airway management safer in the UK, or elsewhere. It is however clear that NAP4 has changed attitudes and practices (for the good) in the UK. There is anecdotal evidence that it has changed practice considerably more widely. In the future, it may be possible to track major airway complications on a continuous basis to examine trends. The DAS 2015 guidelines have changed the way many hospitals and their employees in the UK (and likely further afield) plan to manage difficult intubation.

In my opinion both projects have likely achieved their goal of increasing the likelihood, that when airway problems arise, this will be in an environment where prior institutional preparedness and personal preparedness exists. This will increase the chances of logical, structured management and in turn, good quality care.

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