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Clinical paper

Cost-effectiveness of the i-gel supraglottic airway device compared to tracheal intubation during out-of-hospital cardiac arrest: Findings from the AIRWAYS-2 randomised controlled trial

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Abstract

Aim: Optimal airway management during out-of-hospital cardiac arrest (OHCA) is uncertain. Complications from tracheal intubation (TI) may be avoided with supraglottic airway (SGA) devices. The AIRWAYS-2 cluster randomised controlled trial (ISRCTN08256118) compared the i-gel SGA with TI as the initial advanced airway management (AAM) strategy by paramedics treating adults with non-traumatic OHCA. This paper reports the trial cost-effectiveness analysis.

Methods: A within-trial cost-effectiveness analysis of the i-gel compared with TI was conducted, with a six-month time horizon, from the perspective of the UK National Health Service (NHS) and personal social services. The primary outcome measure was quality-adjusted life years (QALYs), estimated using the EQ-5D-5L questionnaire. Multilevel linear regression modelling was used to account for clustering by paramedic when combining costs and outcomes.

Results: 9296 eligible patients were attended by 1382 trial paramedics and enrolled in the AIRWAYS-2 trial (4410 TI, 4886 i-gel). Mean QALYs to six months were 0.03 in both groups (i-gel minus TI difference −0.0015, 95% CI −0.0059 to 0.0028). Total costs per participant up to six months post-OHCA were £3570 and £3413 in the i-gel and TI groups respectively (mean difference £157, 95% CI −£270 to £583). Based on mean difference point estimates, TI was more effective and less costly than i-gel; however differences were small and there was great uncertainty around these results.

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Conclusion: The small differences between groups in QALYs and costs shows no difference in the cost-effectiveness of the i-gel and TI when used as the initial AAM strategy in adults with non-traumatic OHCA.
Keywords: Cost-effectiveness analysis, Out of hospital cardiac arrest, Airway management

Introduction

Up to 30,000 people receive resuscitation following out-of-hospital cardiac arrest (OHCA) in England each year, yet only 25% achieve a return of spontaneous circulation (ROSC) and 8% are discharged from hospital.[1] Optimal cardiopulmonary resuscitation (CPR), requiring a clear airway and uninterrupted chest compressions, and early ROSC are key to avoid or minimise neurological impairment in OHCA survivors.[2,3] Early effective airway management, to prevent and relieve airway obstruction is fundamental. However, optimal airway management during OHCA is uncertain, with little high-quality research to base treatment recommendations on.[4] Options range from basic airway intervention (e.g. bag-mask ventilation with or without airway adjuncts) to advanced procedures such as inserting a supraglottic airway (SGA) device or tracheal intubation (TI).[5]

Tracheal intubation has been considered the 'gold standard' way to manage the airway during OHCA. However, this assumption is not well supported by research evidence and not without risks, as intubation attempts can cause interruptions to chest compressions. SGAs are an alternative, and considered as quicker and easier to insert, with fewer complications than TI.[6] However, SGAs have not been extensively tested, particularly in OHCA clinical trials.

Equipoise between the two techniques led to calls for a large randomised controlled trial (RCT) comparing them.[7,8] Relatively small gains in survival of 2–3% would be clinically meaningful,[9] providing the technique is cost-effective.

AIRWAYS-2 was a cluster RCT designed to assess whether the i-gel SGA is superior to TI in non-traumatic OHCA in adults, in terms of clinical and cost-effectiveness. As OHCA is an extreme medical emergency, it was not considered practical to randomise individual patients. Therefore, paramedics were randomised and each treated as a cluster. The trial recruited paramedics from four large emergency medical service (EMS) provider organisations (ambulance services) in England covering around 21 million people. 1523 paramedics volunteered to participate and were randomised 1:1 to use the i-gel SGA (759 paramedics) or TI (764 paramedics) as their initial advanced airway management (AAM) strategy when attending adult patients with non-traumatic OHCA. The trial primary outcome was good functional outcome (modified Rankin Scale score of 0–3) at hospital discharge or 30 days post-OHCA. 9296 eligible patients were attended by 1382 trial paramedics and enrolled in the AIRWAYS-2 trial (4410 TI, 4886 i-gel). Not all paramedics who volunteered attended an OHCA during the study period, hence the number attending is lower than the numbers volunteering. The trial reported no difference in the primary outcome between the groups (primary outcome was observed in 6.8% and 6.4% of participants in the TI and i-gel groups, respectively).[10] This result supported the use of either airway management strategy.

However, given pressure on healthcare systems, it is important to consider the cost-effectiveness of treatment. We are not aware of other trial-based cost-effectiveness analyses of alternative AAM strategies after non-traumatic OHCA. This paper reports the methods and results of the cost-effectiveness analysis for the AIRWAYS-2 trial.

Methods

The AIRWAYS-2 trial (ISRCTN08256118) collected detailed patient-level data on resource use and health-related quality of life (HRQoL) of participants. The trial methods and results are detailed elsewhere.[10,11]

The economic evaluation was a within-trial cost-effectiveness analysis, with the main outcome measure being quality-adjusted life years (QALYs). Our analysis was conducted from a National Health Service (NHS) and personal social services perspective, as recommended by the UK National Institute for Health and Care Excellence (NICE).[12] The time horizon was six months, starting when the first paramedic arrives at the OHCA scene. We anticipated most major resource use would occur within this timeframe as this included the ambulance, accident and emergency and intensive care and inpatient components.

Resource use and costs

Resource use data were collected on all NHS care resource episodes for trial participants to the six-month follow-up. Detailed resource use data on the pre-hospital phase of the patient care pathway were collected on the trial case report forms (CRFs): airway devices used and management at the scene, ambulance staff (and vehicles) that attended, and time spent with the patient. Following hospital arrival, data were largely obtained from Hospital Episode Statistics (HES) datasets, collected routinely in the NHS, supplemented by in-hospital trial CRFs. Resource use included emergency department attendance, length of stay by level of care, operations and procedures. For patients surviving to hospital discharge, hospital resource use (readmissions, outpatient and emergency department attendances) were obtained from HES; primary and community care resource use post hospital discharge were captured on bespoke follow up resource use questionnaires at three and six months post-OHCA, for participants who consented to follow up after hospital discharge.

Although there was excellent case ascertainment for three of the HES datasets received (Accident and Emergency, Admitted Patient Care, Outpatients), there were fewer participants in the Critical Care dataset than expected, based on CRF data (<25% of those expected). Given this wide disparity between data sources, we did not use the HES Critical Care dataset and used time in intensive care captured on the CRFs instead.

Unit costs to attach to healthcare resource use were largely from national sources; National Schedule of Reference Costs for ward costs, scans and surgery; and Unit Costs of Health and Social Care for community costs[13,14] (Supplementary appendix 1). Resources were valued in 2017/18 pounds sterling, and costs not in 2017/18 prices were adjusted to 2017/18 prices using the NHS cost inflation index (NHSCII).[15]

HRQoL and QALYs

The main outcome measure for the economic evaluation was HRQoL, using QALYs estimated from the EQ-5D-5L questionnaire.[16,17] The EQ-5D-5L was completed at three time points by participants who consented to follow up: at hospital discharge (or 30 days-post OHCA if sooner), and at three and six months post-OHCA. Questionnaire responses were assigned valuations from published UK population tariffs, in line with NICE recommendations;[18,19] utility scores were then used to calculate QALYs.

As OHCA is a medical emergency, and participants cannot complete the EQ-5D-5L at (or close to) the time of enrolment, baseline HRQoL (at the time of OHCA) data were not available. We assumed a baseline EQ-5D value for all participants of −0.402, equivalent to the unconscious health state for the EQ-5D-3L, in line with a published review recommending including a constant or imputed baseline value (rather than ignoring it).[20] An alternative assumption of assuming a zero value, the health state value for death, was explored in a sensitivity analysis.

The number of QALYs accrued by participants was calculated assuming that a participant's utility (from their EQ-5D data) changed linearly between each of the time points (time of OHCA, hospital discharge, and three and six months post-OHCA). The utility of participants who died during the trial was assumed to change linearly between the preceding time point and time of death, and take the value of zero from death onwards.

Analysis methods

Analyses were performed on an intention-to-treat basis. Costs and effects were not discounted as our time horizon was <12 months. We summarised the amount of missing data for resource use and

Table 1 – Observed resource use for patients known to be alive at each stage.

Resource use	Randomised to TI (n = 4407)		Randomised to i-gel (n = 4882)		i-gel vs. TI
	n[a] (%)	Mean number[b] (SE)	n[a] (%)	Mean number[b] (SE)	Mean difference (95% CI)
Pre-hospital	**4407 patients (100%)**		**4482 patients (100%)**		
Advanced airway management devices used by A2 paramedic					
TI	4138 (94)	0.94 (0.01)	4662 (96)	0.19 (0.01)	−0.75 (−0.78, −0.72)
i-gel	4138 (94)	0.33 (0.01)	4662 (96)	1.03 (0.01)	0.69 (+0.66, +0.73)
Other (OPA, NPA, LMA)	4138 (94)	0.47 (0.01)	4662 (96)	0.28 (0.01)	−0.19 (−0.23, −0.16)
Ambulance staff at scene (time in hours)[c]					
Band 6 and above	4402 (100)	0.78 (0.03)	4873 (100)	0.82 (0.03)	0.04 (−0.04, +0.13)
Band 5	4402 (100)	1.07 (0.03)	4873 (100)	1.07 (0.03)	0.00 (−0.07, +0.08)
Band 4	4402 (100)	0.28 (0.01)	4873 (100)	0.26 (0.01)	−0.02 (−0.06, +0.02)
Band 2 or 3	4402 (100)	0.61 (0.01)	4873 (100)	0.63 (0.01)	0.02 (−0.02, +0.06)
Total time	4402 (100)	2.73 (0.03)	4873 (100)	2.76 (0.03)	0.03 (−0.06, +0.12)
Vehicles					
Rapid response vehicle	4404 (100)	1.13 (0.02)	4878 (100)	1.14 (0.02)	0.01 (−0.05, +0.06)
Ambulance	4404 (100)	1.23 (0.01)	4878 (100)	1.23 (0.01)	−0.00 (−0.03, +0.02)
Air ambulance	4404 (100)	0.10 (0.01)	4878 (100)	0.11 (0.01)	0.01 (−0.01, +0.03)
Other	4404 (100)	0.13 (0.01)	4878 (100)	0.11 (0.01)	−0.01 (−0.04, +0.01)
Total	4404 (100)	2.59 (0.02)	4878 (100)	2.60 (0.02)	0.00 (−0.04, +0.05)
Taken to hospital	**1919 patients (44%)**		**2259 patients (46%)**		
ED attendance[d]	1919 (100)	0.99 (0.00)	2259 (100)	0.99 (0.01)	0.00 (−0.00, +0.01)
Admitted to hospital	**861 patients (20%)**		**1033 patients (21%)**		
Initial days in ICU[e]	861 (100)	3.87 (0.29)	1033 (100)	4.25 (0.22)	0.38 (−0.34, +1.09)
Further days in ICU[e]	612 (71)	0.52 (0.11)	756 (73)	0.21 (0.06)	−0.31 (−0.56, −0.06)
Total days in hospital (includes ICU)	816 (95)	12.22 (0.84)	987 (96)	12.19 (0.86)	−0.03 (−2.38, +2.32)
Post hospital discharge (or 30 days if sooner)	**377 patients (9%)**		**404 patients (8%)**		
Further inpatient days	352 (99)	2.46 (0.49)	383 (100)	2.01 (0.35)	−0.46 (−1.64, +0.73)
Further ED attendances	303 (98)	0.61 (0.08)	332 (99)	0.63 (0.06)	0.02 (−0.17, +0.22)
OPT appointments	322 (99)	5.63 (0.49)	353 (99)	5.84 (0.35)	0.20 (−0.99, +1.40)
GP contacts	106 (94)	4.21 (0.37)	105 (94)	3.34 (0.39)	−0.87 (−1.92, +0.18)
Nurse contacts	108 (94)	1.92 (0.26)	100 (94)	2.05 (0.49)	0.13 (−0.96, +1.22)

Percentages are rounded to the nearest whole number.

A2 = AIRWAYS-2; CI = confidence interval; ED = emergency department; GP = general practitioner; ICU = intensive care unit; LMA = laryngeal mask airway; NPA = nasopharyngeal airway; OPA = oropharyngeal airway; OPT = outpatient; SE = standard error; TI = tracheal intubation.

[a] 'n' is the number of participants with data for each resource use item.

[b] 'mean number' is the average use of a resource per participant.

[c] 'Bands 2–6' are NHS pay bands.

[d] 28 patients are admitted directly to a ward without going to ED (13 straight to ICU, 15 to a ward).

[e] "Initial days in ICU" captures ICU stay straight from ED or ambulance. If participants are discharged from there to a ward, but deteriorate and return to ICU, this is captured in "Further days in ICU".

outcomes (EQ-5D scores) and explored why and how data might be missing.[21] Multiple imputation was used to take account of missing data in accordance with guidelines,[21,22] (see Supplementary appendix 2).

As AIRWAYS-2 was a cluster RCT, statistical methods for combining costs and outcomes needed to account for the correlation between costs and outcomes at the individual and cluster (paramedic) level.[23] We used multilevel linear regression modelling to take account of the clusters, since this can also accommodate missing data and cost skewness.[24]

The incremental cost-effectiveness ratio (ICER) is calculated as the incremental change (difference) in costs between groups divided by the incremental change in health outcome. Our ICER was derived from the average costs and QALYs (outcome) gained in each trial group, producing an incremental cost per QALY gained of the i-gel compared with TI. Non-parametric bootstrapping of costs and QALYs was used to examine uncertainty around the ICER. Analyses were performed using Stata version 15.1 (StataCorp) and Microsoft Excel 2016.

Presentation of results

The mean costs and QALYs in each trial group, with standard errors (SEs) and 95% confidence intervals (CIs), are provided as well as the ICER. Uncertainty around the ICER is shown on the cost-effectiveness plane by the bootstrap replicates of the mean difference in costs and QALYs between the groups.

Sensitivity analyses

Univariable sensitivity analyses (considering one variable at a time) examined the impact on costs and cost-effectiveness results of variation in key variables and major cost drivers. These were: unit costs for paramedics, emergency department attendance, intensive care stay and inpatient care, and the impact of excluding high-cost participants. Factors varied for health outcomes were: the assumed baseline quality of life (assuming a baseline utility of zero rather than −0.402); and considering life years as an alternative outcome to QALYs. For further details, see Supplementary appendix 3.

Results

9296 eligible patients were attended by 1382 trial paramedics between June 2015 and August 2017 and enrolled in the AIRWAYS-2 trial (4410 TI, 4886 i-gel). Participants had a median age of 73 years, and 36% were women. 21% of participants had some missing

Table 2 – Observed costs for patients known to be alive at each stage.

Cost category	Randomised to TI (n = 4407)		Randomised to i-gel (n = 4882)		i-gel vs. TI
	n[a] (%)	Mean (SE) cost	n[a] (%)	Mean (SE) cost	Mean difference (95% CI)
Pre-hospital	**4407 patients (100%)**		**4882 patients (100%)**		
Initial airway management devices used pre A2 paramedic	4386 (100)	£1 (0)	4859 (100)	£1 (0)	−£0 (−0, +0)
Advanced airway management devices used by A2 paramedic					
TI	3901 (89)	£11 (0)	4607 (94)	£2 (0)	−£9 (−9, −8)
i-gel	4138 (94)	£2 (0)	4662 (95)	£5 (0)	£3 (+3, +4)
Other (OPA, NPA, LMA)	4138 (94)	£1 (0)	4662 (95)	£0 (0)	−£1 (−1, −1)
Total	3901 (89)	£13 (0)	4607 (94)	£7 (0)	−£6 (−7, −6)
Ambulance staff at scene[b]					
Band 6 and above	4402 (100)	£22 (1)	4873 (100)	£23 (1)	£1 (−1, +4)
Band 5	4402 (100)	£25 (1)	4873 (100)	£25 (1)	£0 (−2, +2)
Band 4	4402 (100)	£5 (0)	4873 (100)	£5 (0)	−£0 (−1, +0)
Band 2 or 3	4402 (100)	£10 (0)	4873 (100)	£10 (0)	£0 (−0, +1)
Total	4402 (100)	£61 (1)	4873 (100)	£62 (1)	£1 (−1, +3)
Vehicles	4404 (100)	£146 (1)	4878 (100)	£147 (1)	£1 (−2, +3)
Pre-hospital total	3890 (88)	£221 (2)	4586 (94)	£216 (2)	−£4 (−9, +1)
Taken to hospital	**1919 patients (44%)**		**2259 patients (46%)**		
ED attendance	1682 (88)	£330 (3)	1994 (88)	£327 (3)	−£3 (−11, +6)
Admitted to hospital	**861 patients (20%)**		**1033 patients (21%)**		
Index inpatient care (excludes ICU)	802 (93)	£6802 (296)	974 (94)	£6469 (269)	−£333 (−1118, +452)
ICU days	612 (71)	£7031 (538)	756 (73)	£6931 (317)	−£99 (−1323, +1124)
Post hospital discharge (or 30 days if sooner)	**377 patients (9%)**		**404 patients (8%)**		
Further inpatient days	352 (99)	£2082 (324)	383 (100)	£1705 (207)	−£378 (−1132, +377)
Further ED attendances	303 (98)	£132 (16)	332 (99)	£135 (13)	£3 (−37, +43)
OPT appointments	322 (99)	£748 (54)	353 (99)	£840 (60)	£92 (−67, +251)
GP contacts	106 (94)	£111 (11)	105 (94)	£86 (10)	−£26 (−55, +3)
Nurse contacts	108 (94)	£34 (6)	100 (94)	£41 (14)	£7 (−23, +37)

A2 = AIRWAYS-2; CI = confidence interval; ED = emergency department; GP = general practitioner; ICU = intensive care unit; LMA = laryngeal mask airway; NPA = nasopharyngeal airway; OPA = oropharyngeal airway; OPT = outpatient; SE = standard error; TI = tracheal intubation.
Percentages are rounded to the nearest whole number, and costs are rounded to the nearest pound.
[a] 'n' is the number of participants with data for each cost item.
[b] 'Bands 2–6' are NHS pay bands.

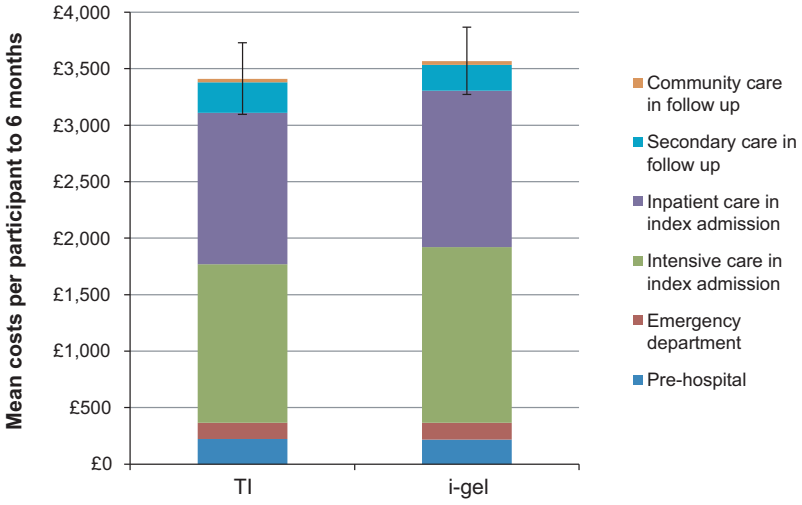

Fig. 1 – Breakdown of total costs to six months for all participants in each treatment group.
TI = tracheal intubation.
The error bars represent the 95% confidence interval around total costs in each treatment group.
Mean cost components in this figure are unadjusted for cluster, as some components were not estimable.

resource use or outcome data (24% TI, 19% i-gel). Multiple imputation was used to handle missing data (see Supplementary appendix 2), and 25 imputations were conducted. Baseline variables (age, sex and ambulance trust) were included in the regression models as they were significant predictors of missing data.

Our base case analysis included all trial participants, except seven who were transported to hospital but could not be identified and were lost to follow up (three TI, four i-gel), so there was insufficient information to reasonably impute their follow up data (consistent with trial effectiveness analyses).

Resource use and costs

Since many participants die at the scene of their OHCA or in A&E, Table 1 reports the observed resource use for participants known to be alive at pre-hospital, taken to hospital, admitted to hospital and post hospital discharge. Apart from the AAM strategy used, resource use at the scene was similar between the two groups. On average 2.7 h of paramedic time was spent per OHCA, with 2–3 vehicles attending. A slightly higher proportion of participants in the i-gel group were taken to hospital (46% compared with 44% in the TI arm, Table 1). For participants surviving to hospital admission, most were admitted to intensive care. Participants in the i-gel group spent slightly longer as inpatients and in intensive care than the TI group, but these differences are non-significant. Resource use for participants surviving to hospital discharge was similar between groups.

Table 2 presents the observed costs for participants known to be alive at each stage. Costs were similar between the groups for participants who were alive. The airway devices are inexpensive, and costs associated with them small.

A breakdown of total costs for all participants (based on imputed data) is provided in Fig. 1. Total mean (average) costs (SE) were £3570 (£152) and £3413 (£162) in the i-gel and TI groups respectively (mean difference £157, 95% CI −£278 to £592). Despite only 20% of participants being admitted to hospital, the key cost drivers are inpatient stay and time in intensive care. Since more participants in the i-gel group were transported to hospital, hence, spending slightly longer in hospital and in intensive care, these costs are slightly (non-significantly) higher in the i-gel group; mean (SE) combined inpatient and intensive care costs for the index admission were £2938 (£142) and £2746 (£148) in the i-gel and TI groups respectively (mean difference £192, 95% CI −£210 to £593). However, costs are similar between the groups.

HRQoL and QALYs

There is little difference in mean observed EQ-5D scores between the groups at the three time points, resulting in a small (non-significant) difference in observed QALYs (Table 3, and similar patterns based on imputed data, in Supplementary appendix 4). The QALYs gained in each group are small, influenced by the large proportion of participants who die early in the trial. The actual difference in QALYs to six months is less than 14 h between the two groups.

Cost-effectiveness

The differences in costs and QALYs between the groups are small and neither difference is statistically significant (Table 4). The difference between the groups for QALYs is especially small, creating a really large ICER, because the difference in QALYs is the denominator for calculating the ICER. Based on the point estimate of the ICER (−£102,362), TI is considered cost-effective, being more effective and less costly than i-gel; in health economic terms TI is therefore considered "dominant" over i-gel. However, there is much uncertainty around this result, as shown on the cost-effectiveness plane (Fig. 2), where the bootstrap replicates of the cost and QALY differences cover three quadrants of the plane. The black dot is the point estimate of the cost and QALY difference, and is close to the origin. The small non-significant differences and the large number of points over three quadrants indicate there is no evidence of a difference in cost-effectiveness between the two groups. This suggests that if a decision-maker is willing to pay £20,000 for an additional QALY, then

Table 3 – Observed EQ-5D scores and QALYs to 6 months.

Outcome	Randomised to TI (n = 4407)		Randomised to i-gel (n = 4882)		i-gel vs. TI
	n (%)	Mean (SE)	n (%)	Mean (SE)	Mean difference (95% CI)
EQ-5D time point[a]					
Hospital discharge (or 30 days)	4200 (95)	0.027 (0.002)	4662 (95)	0.024 (0.002)	−0.002 (−0.008, +0.003)
3 months	4195 (95)	0.026 (0.002)	4636 (95)	0.023 (0.002)	−0.003 (−0.009, +0.003)
6 months	4214 (95)	0.029 (0.002)	4661 (95)	0.026 (0.002)	−0.003 (−0.009, +0.003)
QALYs to 6 months	4153 (94)	0.0100 (0.0010)	4601 (94)	0.0088 (0.0009)	−0.0012 (−0.0037, +0.0013)

CI = confidence interval; SE = standard error; TI = tracheal intubation; QALY = quality-adjusted life-year.
[a] Deaths included as zero.

Table 4 – Base case cost-effectiveness results.

Cost-effectiveness element	Randomised to TI (n = 4407)	Randomised to i-gel (n = 4882)	i-gel vs. TI difference	ICER (Cost/QALY)
Total costs (95% CI)[a]	£3413 (£3112, £3714)	£3570 (£3279, £3860)	£157 (−£270, +£583)	TI dominant (−£102,362)
QALYs (95% CI)[a]	0.0274 (0.0243, 0.0305)	0.0259 (0.0230, 0.0287)	−0.0015 (−0.0059, +0.0028)	

CI = confidence interval; ICER = incremental cost-effectiveness ratio; QALY = quality-adjusted life-year; TI = tracheal intubation.
[a] Confidence intervals are based on 5000 bootstraps (200 bootstraps for each of the 25 imputed datasets).

the probability of the i-gel being cost-effective is 18%. The probability that the i-gel is cost-effective is low across all willingness to pay thresholds from £0 to £100,000, and gradually reduces as the threshold is increased (from 23% to 7%), becoming less likely that the i-gel would be cost-effective.

Sensitivity analyses

Sensitivity analyses (Supplementary appendix 3) show that conclusions were robust to changes in unit costs, to assuming a baseline utility of zero rather than −0.402 and to using life-years instead of QALYs as an alternative outcome measure. Nine high-cost participants (total costs exceeding £100,000) have a significant impact on the cost results, but do not alter the conclusions.

Discussion

There was very little difference between the groups for costs or effects, and great uncertainty around the cost-effectiveness results. Total costs were slightly higher in the i-gel group, due to being in intensive care slightly longer. Despite only 20% of participants surviving to hospital admission, inpatient and intensive care costs were the key drivers of total costs. The QALYs gained were similar in both groups and small (because of the large number of patients who died early in the trial) and not statistically significantly different. There is no evidence of a difference in cost-effectiveness between groups. Based on the point estimate of cost-effectiveness only, TI was more effective and less costly than the i-gel (i.e. "dominant") and, therefore, cost-

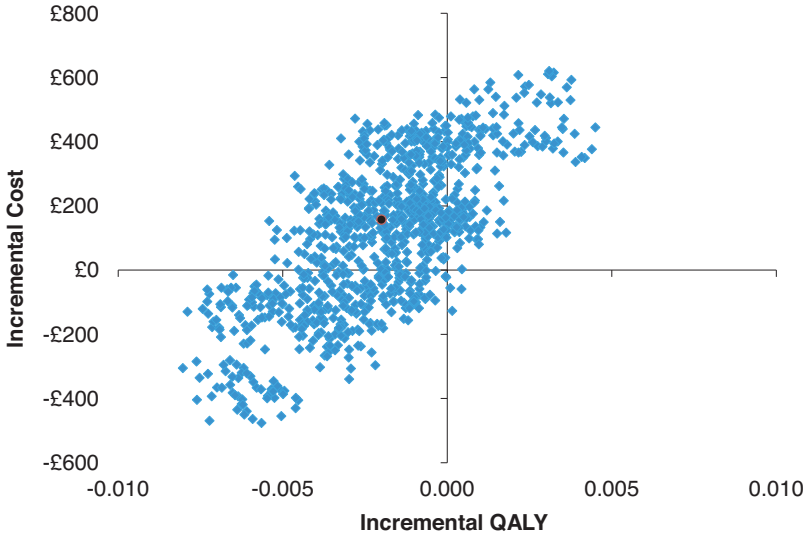

Fig. 2 – Cost-effectiveness plane.
QALY = quality-adjusted life-year.

effective. However, we need to consider the variability around the differences in costs and effects not just the point estimate, and bootstrap replicates of these differences which consider uncertainty, covered three quadrants of the cost-effectiveness plane, showing substantial uncertainty around these results and in reality there is no evidence of any difference between groups. These conclusions on cost-effectiveness held after sensitivity analyses.

This economic evaluation was an integral part of the largest RCT of airway management in OHCA to date, which incorporated automatic enrolment of all eligible patients to minimise bias.[10,25] We collected HRQoL data to six months, longer than most clinical trials in OHCA and exceeded the minimum of 90 days recommended in the core outcome set for cardiac arrest.[26] We believe this is the first trial-based cost-effectiveness analysis of an SGA with TI for first AAM for adults with non-traumatic OHCA. The recent Pragmatic Airway Resuscitation Trial (PART) of North American patients with OHCA compared the laryngeal tube SGA with TI in 3004 patients, but did not include an economic evaluation.[27]

Our economic evaluation has limitations. First, we were reliant on questionnaire completion at the three-and six-month follow up (EQ-5D data and primary and community healthcare resource use). Despite considerable effort by the research teams, only 52.4% of survivors consented to active follow up. This may have been due to a lack of perceived benefit from participation, since the intervention had already occurred, or may reflect patient health. However, the proportion of missing data is similar across the two groups, with no evidence that the availability of follow-up data was influenced by patient allocation.

Second, there was a slightly larger proportion of participants in the i-gel group surviving to ICU admission (TI, 19.5%; i-gel, 21.2%). Although this did not translate into an improvement in the primary outcome of good recovery (TI, 6.8%; i-gel, 6.4%) or a significant improvement in any of the outcomes measured in AIRWAYS-2,[10] this does result in slightly higher average costs per participant in the i-gel group for ICU and hospital stay. This means that i-gel may appear slightly less cost effective than TI, however there is a high degree of uncertainty, and neither approach is clearly superior. Whilst additional survival to hospital and ICU admission alone were not considered clinically beneficial in this trial, hospital admission is the first step on the journey to a successful outcome (long-term high-quality survival), and may improve the experience of families by providing additional time to say goodbye to their relative.

Third, we used some secondary care data collected routinely. Thus, despite AIRWAYS-2 being one of the largest health economic analyses of OHCA patients completed, there was minimal data collection burden on paramedics and local hospital teams. However, when the datasets arrived there was poor case ascertainment in the Critical Care dataset. Given that intensive care costs were a key driver of total costs, this was disappointing.

Fourth, given that participants are severely incapacitated at enrolment, baseline HRQoL could not be collected. This could introduce bias into QALY estimation if randomisation is unbalanced between treatment groups. Whilst a published review concluded that there is no one clear way of dealing with this,[20] it recommended including a constant or imputed baseline value, and collecting HRQoL as early as possible post randomisation, in line with our approach.

Finally, we did not include training costs for either treatment. As tracheal intubation training costs are likely to be higher than i-gel costs (more complex procedure), this may have underestimated the costs of these devices.

Conclusions

There is no health economic evidence to suggest a difference in cost-effectiveness between the two AAM strategies, as there were tiny (non-significant) differences between the groups in costs and effects, and substantial uncertainty around cost-effectiveness results.

Contribution of authors

Dr Elizabeth Stokes (Senior Researcher) was involved in trial concept and design, interpreted the data, jointly designed the cost-effectiveness analysis (with Professor Sarah Wordsworth), undertook the cost-effectiveness analysis and drafted the first version of this manuscript.

Ms Michelle Lazaroo (Medical Statistician) interpreted the trial data, critically revised this manuscript and helped to interpret the cost-effectiveness analysis results.

Ms Madeleine Clout (Clinical Trial Manager) interpreted the data, drafted and critically revised this manuscript and provided technical and project support.

Dr Stephen Brett (Head of Research for the Directorate of Anaesthetics and Critical Care) was involved in trial concept and design, helped design the cost-effectiveness analysis, interpreted the data from the cost-effectiveness analysis and critically revised this manuscript.

Ms Sarah Black (Research & Audit Manager) was involved in trial concept and design, interpreted the data and critically revised this manuscript.

Ms Kim Kirby (NIHR Clinical Doctoral Research Trainee and Lead Research Paramedic) was involved in trial concept and design, interpreted the data and critically revised this manuscript.

Dr Jerry Nolan (Consultant in Anaesthesia and Intensive Care Medicine) was involved in trial concept and design, interpreted the data and critically revised this manuscript.

Professor Barnaby Reeves (Professor in Health Services Research) was involved in trial concept and design, interpreted the data and critically revised this manuscript.

Ms Maria Robinson (Research Manager) was involved in trial concept and design, interpreted the data and critically revised this manuscript.

Professor Chris Rogers (Reader in Medical Statistics and Consultant Statistician) had full access to all the data in the trial, was involved in cost-effectiveness analysis design, interpreted the data, critically revised this manuscript.

Ms Lauren Scott (Research Associate in Medical Statistics) was involved in trial concept and design, interpreted the data, critically revised this manuscript and undertook statistical analysis.

Dr Helena Smartt (Medical Statistician/Data Manager) interpreted the data, critically revised this manuscript and undertook statistical analysis.

Mr Adrian South (Deputy Clinical Director) was involved in trial concept and design, interpreted the data and critically revised this manuscript.

Dr Jodi Taylor (Research Associate in Clinical Trials Management) was involved in trial concept and design, interpreted the data, critically revised this manuscript and provided technical and project support.

Dr Matthew Thomas (Consultant in Anaesthesia and Intensive Care) was involved in trial concept and design, interpreted the data and critically revised this manuscript.

Dr Sarah Voss (Senior Research Fellow in Emergency Care) was involved in trial concept and design, interpreted the data and critically revised this manuscript.

Professor Jonathan Benger (Professor of Emergency Care and Consultant in Emergency Medicine) was the AIRWAYS-2 trial Chief Investigator, was involved in trial concept and design, interpreted the data, and critically revised this manuscript.

Professor Sarah Wordsworth (Professor of Health Economics) was involved in trial concept and design, jointly led the design of the cost-effectiveness analysis, interpreted the results and critically revised this manuscript.

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Conflicts of interest

Rogers salary was funded by a grant from the British Heart Foundationuntil March 2017; part of Reeves salary was funded by grants from the National Institute for Health Research. All other authors declare no conflicts of interest.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.resuscitation.2021.06.002.

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