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1 **Endotracheal intubation versus supraglottic procedure in paediatric out-of-**
2 **hospital cardiac arrest: a registry-based study**

3
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24 **ABSTRACT**

25 **Background:** Out-of-hospital cardiac arrest (OHCA) in children is associated with a low survival
26 rate. Conclusions in the literature are conflicting regarding the best way to handle ventilation. The
27 purpose of this study was to assess the impact of two airway management strategies, endotracheal
28 intubation (ETI) vs. supraglottic procedure, during cardiopulmonary resuscitation (CPR) on 30-day
29 survival in paediatric OHCA.

30 **Methods:** This was a retrospective, observational, multicentre, registry-based study conducted from
31 July 2011 to March 2018. All paediatric OHCA patients under 18 years of age and managed by a
32 mobile intensive care unit were included. The primary endpoint was 30-day survival in a weighted
33 population (based on propensity scores).

34 **Results:** Of 1579 children, 1355 (85.8%) received ETI and 224 (14.2%) received supraglottic
35 ventilation during CPR. We observe a lower 30-day survival in the ETI group compared to the
36 supraglottic group (7.7% vs. 14.3%, absolute difference, 6.6 percentage points; 95% confidence
37 interval [CI], 2.3–12.0; propensity-adjusted odds ratio [paOR], 0.39; 95% CI, 0.25-0.62; $p < 0.001$),
38 and also a poorer neurological outcome (paOR, 0.32; 95% CI, 0.19–0.54; $p < 0.001$). However, we
39 did not identify any significant association between airway management strategy and return of
40 spontaneous circulation (paOR, 1.15; 95% CI, 0.80–1.65; $p = 0.46$).

41 **Conclusions:** The findings of this large cohort study suggest that ETI in paediatric OHCA, although
42 performed by trained physicians, is associated with a worse outcome, regardless of traumatic or non-
43 traumatic aetiology.

44 **Keywords**

45 Paediatric out-of-hospital cardiac arrest; Airway management; Endotracheal intubation; Supraglottic
46 ventilation

47

48 **Background**

49 Out-of-hospital cardiac arrest (OHCA) in children remains a rare event representing around 8
50 events versus 62.3 events per 100,000 people in the adult population.¹⁻⁴ Despite medical progress in
51 post-cardiac arrest care, paediatric OHCA still carries a low likelihood of survival.⁵ Evidence on
52 practices in the management of paediatric cardiac arrest remains weak and guidelines are partly based
53 on extrapolations from adult data.^{6,7} Aetiologies of OHCA differ strongly between adults and
54 children; hypoxic OHCA represents up to 42% of OHCA in the paediatric population.⁸ Thus, airway
55 management is a key issue in paediatric OHCA. Most up-to-date guidelines on paediatric
56 cardiopulmonary resuscitation (CPR) recommend positive pressure ventilation combined with
57 thoracic compressions and still consider tracheal intubation as the most secure and effective procedure
58 to maintain the airway and provide efficient oxygenation.⁶

59 Although endotracheal intubation (ETI) remains the standard procedure in France during
60 CPR, it is now subject to debate, and data from the most recent literature are conflicting.^{9,10} Several
61 studies have found an association between ETI and increased mortality in OHCA in children, whether
62 it occurs inside or outside of the hospital.¹¹⁻¹⁴ The most recent results are provided by a prospective
63 and randomised study comparing bag-valve mask (BVM) ventilation and ETI in adult OHCA, and
64 were not able to conclude that ETI was not inferior, but highlighted a lower rate of adverse effects in
65 the ETI group.¹⁵ Performing an ETI on a child during CPR is challenging and can result in significant
66 interruptions in chest compressions, especially since it takes place out of the hospital.¹⁶⁻¹⁸ These
67 conflicting data call into question the best way to handle ventilation in paediatric OHCA.

68 The purpose of this study was to assess the impact of airway management strategies during
69 CPR (ETI vs supraglottic procedure) on 30-day survival in paediatric OHCA, in a large cohort
70 involving physician-staffed mobile intensive care units.

71

72

73

74 **Methods**

75 *Study design*

76 We performed a retrospective, observational, multicentre cohort study analysis using the data
77 from the French National OHCA Registry (RéAC) collected from July 2011 to July 2018. This cohort
78 includes all OHCA patients managed by a physician-staffed mobile intensive care unit (MICU) in
79 France. MICUs consist of an ambulance driver, a nurse and a trained emergency physician
80 experienced in airway management and tracheal intubation as a minimum team. A detailed description
81 of the French emergency medical system (EMS) has been previously published.¹⁹ Briefly, it is a two-
82 tiered system with a fire department ambulance or private ambulance available for prompt
83 intervention and basic life support (BLS), and MICU for advanced life support (ALS) on scene.²⁰
84 Importantly, BLS providers are not able to provide advanced airway management (supraglottic airway
85 [SGA] or ETI). The choice of airway management strategy is made by the physician. The database
86 includes patients managed by 94 MICUs representing 90% of French MICUs. The RéAC form meets
87 the requirements of the French Emergency Medical Service organisations and is structured according
88 to the Utstein universal style.²¹ Data are collected in the secured RéAC database
89 (www.registrereac.org).

90 The present study was approved by the French Advisory Committee on Information
91 Processing in Health Research (CCTIRS) and the French National Data Protection Commission
92 (CNIL, authorisation no. 910946). As it was approved as a medical assessment registry study,
93 informed consent was waived.²²

94

95 *Study sample*

96 We included all RéAC patients under 18 years of age for whom resuscitation was attempted
97 by a first response team and a MICU was called to the scene. Patients were included regardless of the
98 suspected aetiology of OHCA. Subjects with obvious signs of death such as rigor mortis or an
99 instruction not to resuscitate were not included in the study.

100

101 ***Variables of interest and study outcomes***

102 Patient characteristics obtained from the database included sex, age, CPR initiated by
103 bystander witness, arrest location, on-scene time of first response team and MICU, aetiology of
104 OHCA, initial rhythm, automated external defibrillator (AED) use, no-flow duration (time between
105 collapse and initiation of basic life support), low-flow duration (time between initiation of basic life
106 support and return of spontaneous circulation), airway management strategies, drug administration
107 route (intraosseous, peripheral vein, central vein or endotracheal access) and adrenaline
108 administration. Patients were classified in two groups depending on airway management strategy
109 during CPR: those for whom an ETI was performed and those for whom ventilation was performed
110 by a supraglottic procedure (SGA or BVM). The supraglottic group is a combination of subjects who
111 received either BVM or SGA ventilation during CPR, whereas the ETI group only included subjects
112 who benefited from orotracheal intubation. The primary outcome of interest was 30-day survival,
113 irrespective of Glasgow-Pittsburgh Cerebral Performance Category (CPC). The secondary endpoints
114 were the return of spontaneous circulation (ROSC) and a good neurological outcome, defined as a
115 CPC score of 1 (no neurologic disability) or 2 (moderate disability).

116

117 ***Statistical analysis***

118 The study population was characterised using descriptive analysis. Categorical variables are
119 reported as counts and percentages and continuous variables as means and standard deviations (SD),
120 or median and first and third quartiles for non-normally distributed variables. Categorical variables
121 were compared using the χ^2 test, with Yates' continuity correction when relevant, or Fisher's exact
122 test. Continuous variables were compared using Student's t-test or the Wilcoxon rank sum test when
123 relevant. Analyses were performed using an intention to treat strategy, which means that in cases of
124 ETI failure and subsequent BVM ventilation, the patients were analysed in the ETI group.

125 In order to minimise the impact of missing data, we performed multiple imputation using
126 chained equations (MICE) with predictive mean matching for continuous data and logistic regression
127 for binary data.²³ The list of variables used for imputation are available in the *Data Supplement (Table*
128 **S2)**, including characteristics of CPR and outcomes.

129 Because of the retrospective design of this study, we used the inverse probability of treatment
130 weighting (IPTW) to obtain unbiased estimations of the average treatment effect.^{24,25} The goal of this
131 strategy is to simulate random assignment of the treatment. We firstly estimated the propensity score
132 (PS) of treatment (ETI during CPR), which is defined as the probability of being assigned to the
133 treatment group (ETI) given all relevant covariates. The PS was estimated using a generalised boosted
134 logistic regression model that incorporated all relevant variables listed above. The average treatment
135 effect (ATE) was used to generate balanced groups. After PS was generated, weights were applied to
136 the patients, corresponding to $1/PS$ for patients in the ETI group and $[1/(1 - PS)]$ for patients in the
137 supraglottic group. Then, we checked weighted data for covariate balance using standardised mean
138 differences (SMD). SMD exceeding ± 0.1 were considered to be significantly unbalanced. There is
139 no consensus on the cut-off point for SMD in the literature, but several authors have proposed that a
140 value above 0.1 could denote meaningful imbalance in the baseline covariate.²⁶ This conservative
141 strategy was preferred to PS matching because it limits the loss of data.²⁴ The limited number of
142 events in this cohort forced us to carefully select the variables to be included in the PS estimation.
143 Including variables not or weakly correlated to the outcome could indeed have increased the variance
144 of the effect and resulted in a low reduction of bias.²⁷ Covariates included in the model were selected
145 using a univariate analysis of their impact on treatment assignment and on 30-day survival.

146 The primary endpoint was adjusted according to the IPTW method. Then, the impact of airway
147 management on good neurological outcome and ROSC were assessed using the same strategy. Results
148 are expressed as odds ratios and standardised marginal probabilities with 95% CIs. The threshold of
149 significance was set at $P < 0.05$ and all associations were determined using two-sided testing.
150 Statistical analyses were performed using the R environment (version 3.4.4) in Rstudio software

151 (version 1.2.1335) using the packages mice (version 3.6.0), survey (version 3.35-1) and twang
152 (version 1.5).

153

154 **Results**

155 ***Characteristics of the patient population***

156 Overall, we included 1641 children under 18 years of age with OHCA (**Figure 1**). Sixty-two
157 patients were excluded from the analysis because of missing data about airway management
158 procedure by MICU (n = 58) or vital status on day 30 (n = 4, all receiving ETI).

159 The final population consisted of 1579 children with a median age of 3 years (0–13) (**Table**
160 **1**). Cardiac arrests mostly occurred in boys (62.0%, 979 of 1579), at their home/residence (58.7%,
161 927 of 1579) and were witnessed by a bystander (62.6%, 988 of 1579). Often, CPR was not initiated
162 immediately by a witness (37.8%, 597 of 1579). Bystander CPR included chest compressions in most
163 cases (54.4%, 859 of 1579) but often did not include ventilation (25.8%, 407 of 1579). Cardiac arrest
164 mostly occurred in a non-traumatic context (73.3%, 1157 of 1579).

165 The first response team was on the scene within a mean time of 10.9 (SD 9.5) minutes and the
166 MICU within a mean time of 20.2 (SD 13.5) minutes. The initial rhythm was mostly unshockable
167 (88.4%, 1396 of 1579). After MICU arrival, most patients underwent ETI (85.8%, 1355 of 1579) and
168 received adrenaline during CPR (79.7%, 1259 of 1579) via a peripheral vein (53.5%, 844 of 1579).
169 Most of the patients in the supraglottic procedure group (n = 224) received BVM ventilation (92.9%,
170 208 of 224) and some received ventilation through SGA (7.1%, 16 of 224). MICU teams reported a
171 failure in ETI procedure for 31 patients (2.0%).

172 The most important characteristics associated with 30-day survival are detailed in **Table S1**
173 in the *Data Supplement*. Only the covariates that were the most significantly associated with outcome
174 were included in our PS calculation and are detailed in **Table 2**.

175

176 ***Overall outcomes and unadjusted analysis***

177 The overall 30-day survival was 8.6% (136 of 1579). In unadjusted univariate analysis, ETI
178 during CPR was associated with a lower 30-day survival (7.7% [104 of 1355] vs. 14.3% [32 of 224];
179 absolute difference, 6.6 percentage points; 95% CI, 2.3–12.0; OR, 0.50; 95% CI, 0.33–0.76, $P =$
180 0.001) (**Table 1**). ROSC occurred in 29.4% of children (465 of 1579). A good neurological outcome
181 was observed for 5.6% of all children (88 of 1579). In unadjusted univariate analysis, ETI during
182 CPR was associated with increased ROSC (30.5% [413 of 1355] vs. 23.2% [52 of 224], absolute
183 difference, 7.3 percentage points; 95% CI, 0.8–12.9; OR, 1.45; 95% CI, 1.04–2.02) and decreased
184 favourable neurological outcome (4.6% [63 of 1355] vs. 11.1% [25 of 224], absolute difference, 6.5
185 percentage points; 95% CI, 2.8–11.4; OR, 0.39; 95% CI, 0.24–0.63).

186

187 *Inverse probability of treatment-adjusted analysis*

188 The baseline characteristics of the weighted population and comparisons between groups are
189 presented in **Table 2**. We observed 346 missing items of data for immediate CPR by bystander, 599
190 for first response team time on site, 13 for bystander-witnessed OHCA, six for CPR by MICU and
191 four for ROSC. All were managed using the previously described multiple imputation strategy. After
192 IPTW, the population was well matched for all included variables as shown in **Figure 2** and **Table 2**
193 and univariate comparisons were non-significant after IPTW (all $P > 0.15$ and standardised mean
194 differences between -0.1 and +0.1, except for shockable rhythm with SMD = 0.102). In the weighted
195 population, survival at day 30 was lower in patients intubated during CPR (propensity-adjusted odds
196 ratio [paOR], 0.39; 95% CI, 0.25–0.62; $P < 0.001$).

197 Secondary adjusted analysis showed that children in the ETI group did not show a significant
198 difference in the frequency of ROSC (paOR, 1.15; 95% CI, 0.80–1.65; $P = 0.46$) compared to those
199 in the supraglottic group. However, we identified a worse neurological outcome at 30 days in the ETI
200 group (paOR, 0.32; 95% CI, 0.19–0.54; $P < 0.001$).

201

202 **Discussion**

203 In our work, we assessed the impact of airway management strategies during CPR on 30-day
204 survival in paediatric OHCA by comparing ETI to supraglottic procedures in a large prospective
205 cohort. The main findings were that 30-day survival and neurological outcomes were worse in the
206 ETI group.

207 Airway management during CPR in children remains a thorny issue and the optimal strategy
208 is still unclear. Current guidelines recommend BVM ventilation as the first-line method for managing
209 the airways during cardiac arrest, but also consider ETI as the most secure and effective procedure
210 for maintaining the airway.⁶

211 OHCA in children is a rare event with a low survival rate of 8.6% in our cohort. These results
212 are consistent with previous studies that found a survival rate of between 10.9% and 11.3%.^{12,13,28}
213 Our data confirm that ETI remains the standard of care in France for airway management in OHCA,
214 as 85% of children were intubated during CPR. In this work, the rate of children undergoing
215 intubation was higher than in previously published studies.^{12,13,29} As the aetiology of cardiac arrest
216 may strongly influence outcomes, our model was weighted according to the reported aetiology
217 (medical or traumatic). Indeed, traumatic cardiac arrest is associated with a lower survival rate.³⁰
218 Importantly, we found that, in paediatric patients who suffered OHCA, ETI was significantly
219 associated with a lower 30-day survival after accounting for the probability of receiving this
220 treatment, regardless of aetiology. These results did not differ from previous, lower-powered
221 retrospective studies, which found an association between ETI during CPR and lower survival rates,
222 with risk ratios of 0.89 and 0.39, respectively.^{11,12} We also observed a non-significantly different
223 proportion of ROSC in children who were intubated during CPR, where previous in-hospital and out-
224 of-hospital studies reported a decreased or non-significantly modified rate of ROSC.^{11,12,14} As found
225 in previous cohort studies, we identified an association between airway management strategy and
226 neurological outcome.¹²

227 Cardiac arrest in children is mainly caused by hypoxia, and providing efficient and secured
228 oxygenation—could be a key element in CPR.⁸ Previous studies have reported higher survival rates

229 with chest compressions in association with ventilation in children.¹⁷ However, a major concern about
230 ETI is that rapid and successful intubation depends on the experience and skill of the operator and
231 that delayed intubation could increase interruptions in chest compressions during CPR.³¹⁻³³ Indeed,
232 interruption of chest compressions has been shown to negatively impact favourable functional
233 survival.³⁴ This is especially true for children because intubation is reported to be more difficult than
234 in adults.¹⁸ However, in a randomised trial in adult OHCA, BVM ventilation was associated with a
235 greater number of pauses longer than 2 seconds in chest compressions.¹⁵ In our cohort, we report that
236 intubation was not possible in only 2.0% of cases, which is similar to the results of a previously cited
237 study in adults, with a corresponding rate of 2.1%.¹⁵ However, we were not able to record the time of
238 interruption of chest compressions caused by the ETI procedure. The literature reports that BVM may
239 have several advantages over ETI because it is easier to use and ventilation may be achieved more
240 quickly and efficiently, limiting adverse events.^{31,32} However, a higher rate of ventilation failure and
241 adverse events such as pulmonary aspiration and gastric distension have been observed in patients
242 undergoing BVM ventilation, supporting that ETI may provide more secure access to the airways.¹⁵

243

244 ***Limitations***

245 This was an observational study using a registry, although we performed IPTW survival
246 analysis and adjusted for selection bias to balance the groups and control for confounding factors.
247 However, under these conditions, some authors consider the measured effect to be comparable to
248 randomised trials.³⁵ As airway management strategy was not randomly assigned to children, we can
249 assume that some confounding factors that may have affected assignment to SGA or ETI or the
250 outcomes were not controlled in our study. We were also unable to consider the time-to-intubation,
251 weight-related adrenaline dose administered, or the time of interruption of chest compressions in our
252 analysis because we could not obtain these data. An inherent limitation of this type of registry analysis
253 is the incompleteness of the data, which may have resulted in a limited quality of the adjustment of

254 the groups. To account for this and limit their impact on the calculation of PS, we used a multiple
255 imputation strategy (MICE) for the covariates included in the model.

256 Ultimately, the generalisability of our findings is limited by the organisation of the EMS which
257 includes here a trained emergency physician in the MICU, in contrast with paramedic teams from
258 other European and non-European countries. Indeed, we report a lower rate of ETI failure than in
259 previously published studies for emergency departments.¹⁸

260

261 **Conclusions**

262 The findings of this nationwide population-based study of paediatric OHCA suggest that ETI
263 was associated with a worse outcome regardless of its traumatic or non-traumatic aetiology compared
264 to supraglottic procedure. These results are in agreement with previous registry-based studies, which
265 found an association between ETI and lower survival rates in the paediatric population. Even with a
266 high rate of successful intubation by a trained emergency physician in our study, the ETI procedure
267 during CPR was deleterious. This work questions the optimal airway management strategies for
268 OHCA in children. A large, randomised, multicentre trial is warranted. Also, further data are needed
269 to establish if and when intubation should be performed: during CPR or in comatose post-cardiac
270 arrest patients.

271

272 **List of abbreviations:** OHCA: out-of-hospital cardiac arrest; CPR: cardiopulmonary resuscitation;
273 ETI: endotracheal intubation; IPTW: inverse probability of treatment weighting; PS: propensity
274 score; ROSC: return of spontaneous circulation; BVM: bag-valve mask; MICU: mobile intensive care
275 unit; EMS: emergency medical system; AED: automated external defibrillator; SGA: supraglottic;
276 CPC: Cerebral Performance Category; MICE: multiple imputation using chained equations; ATE:
277 average treatment effect; SMD: standardised mean differences

278

279 **Declarations**

280 *Ethics and patient consent*

281 The present study was approved by the French Advisory Committee on Information Processing in
282 Health Research and the French National Data Protection Commission (authorisation no. 910946). It
283 was approved as a medical assessment registry study without a requirement for patient consent.

284

285 *Availability of data and materials*

286 The datasets used and/or analysed in the current study are available from the corresponding author
287 on reasonable request.

288

289 *Conflicts of interests*

290 The authors declare that they have no competing interests.

291

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298

299 *Authors' contributions*

300 QLB and FJ conceptualised the study, conducted the analysis, drafted the initial manuscript, and
301 reviewed and revised the manuscript; JR conceptualised the study, conducted the initial analysis and
302 drafted the initial manuscript; EM conceptualised the study and reviewed and revised the manuscript;
303 VB collected data and reviewed and revised the manuscript; MR reviewed and revised the
304 manuscript; HH collected data and reviewed and revised the manuscript; SL reviewed and revised the
305 manuscript. All authors approved the final manuscript as submitted and agree to be accountable for
306 all aspects of the work.

307

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416

417 **Figure legends**

418

419 **Figure 1. Flow chart of patient inclusion**

420

421 **Figure 2. Standardised mean differences (SMD) before and after population weighting**

422 Vertical broken lines represent absolute standardised mean differences of -0.1 and $+0.1$, above which
423 covariates are considered significantly unbalanced. Grey triangles represent the standard mean
424 difference before IPTW and black circles represent the standard mean deviation after IPTW.

425 Abbreviations: OHCA: out-of-hospital cardiac arrest; CPR: cardiopulmonary resuscitation.

426

427 ***Data supplement***

428 **Table S1. Characteristics of survivors and non-survivors.**

429 Abbreviations: MICU: Mobile intensive care unit; CPR: Cardiopulmonary resuscitation; ROSC:
430 Return of spontaneous cardiac activity; AED: Automated external defibrillator; EtCO₂: End-tidal
431 capnography; SD: Standard deviation; Q1:Q3: first and third quartiles. *P* values were calculated using
432 Student's T-test, Wilcoxon rank sum test, χ^2 test or Fisher's exact test.

433 ^aNo-flow duration: time between collapse and initiation of basic life support.

434 ^bLow-flow duration: time between initiation of basic life support and return of spontaneous
435 circulation.

436

437 **Table S2. List of variables included for multiple imputation using chained equations (MICE)**

438

439 **Names of GR-RéAC members (name – surname):**

440 Jacob Line, Ricard-Hibon Agnes, Dall acqua David, Watrelot Olivier, Narcisse Sophie, Sadoune Sonia,
441 Guillaumee Frederic, Courcoux Hubert, Dhers marion, Gonzalez Geraldine, Capel Olivier, Ta Trung hung,
442 Megy-Michoux Isabelle, Masson Caroline, Pernot Thomas, Poher Fabien, Joly Marc, Bages-Limoges
443 Florence, Tentillier Eric, Blottiaux Emmanuel, Bohler Clio, Thibaut Klein, Coletta Mauro, Agostinucci Jean marc,
444 Goument Melanie, Le pimpec Philippe, Letarnec Jean yves, Robart Jean-Christophe, Branche Fabienne,
445 Kindle Carine, Dagoret Elodie, Lefevre Nathalie, Jardel Benoit, Prineau Stevens, Segard Julien, Beharelle
446 Julien, Bernadet Patricia, Vial Michael, Bertrand Philippe, Simonnet Bruno, Jonquet Sebastien, Ursat Cecile,
447 Vergne Muriel, Kernaleguen Cecile, Longo Celine, Boucard Severine, Thiriez Sylvain, Clementine Bonnet, Gay
448 Julien, Pes Philippe, Puchois Aurelien, Besnier Sylvie, Arnaud Gaele, Robert Helene, Bousserie Catherine,
449 Heydel Virginie, Kamga Cyrille, Hullin Thomas, Meyran Daniel, Roudiak Nathalie, Kaliszczak Isabelle, Fuster
450 Patrick, Peguet Olivier, Bouilleau Guillem, Begaudeau Aurelie, Forel Alban, Jenvrin Joel, Laot Melanie, Lacroix
451 Arnaud, Wassong Corinne, Abarrategui Diego, Grua David, David Serrano, du Besset Marc, Hollecker Eric,
452 David Olivier, Tellier Robin, Herkelmann Laurent, Champenois Anne, Leroy Antoine, Vignaud Frederic,
453 Martinage Arnaud, Moine Linda, Andre Antoine, Cabanne Laurent, Lancon Virgine, Pavageau Laure, Spriet
454 Audrey, Lespiaucq Christine, Benenati Sylvain, Bernigaud Emmanuel, Fournier Marc, Tabary Romain, Myriam
455 Van tricht, Raconnat Julien, Campagne Guillaume, San miguel Marie, Salaun Beatrice, Frances Herve, Morel
456 Jean-Charles, Jammes Guillaume, Lagadec Steven, Garay Emilie, Robert Frederique, Sanchez Oriana,
457 Benguigui Yony, Dumouchel Julie, Paula palma Serge, Peyrat Sylvie, Dissait Francois , Cornuault Mathieu,
458 Robert Damien, Vassor Isabelle, Deleu Stephanie, Chesneau Anne sophie, Fiani Nasri, Khiter Mounir,
459 Rakotonirina Jean-Louis, Laborne Francois xavier, Girault Fabrice, Legeard Estelle, Resplandy Emilie,
460 Gauclere Vincent, Fritsch Emmanuelle, Marchi Jacques, Hourdin Nicolas, Cohen Rudy, Legay Lea, Viallard
461 Marie-Sophie, Chauveau Celine, Polini Stephanie, Cornaglia Carole, Sanjuan Chantal, Paringaux Xavier,
462 Guinard Sollweig, Arnaudet Idriss, Heleniak Karina, Gaillard Florence, Maugein Laure, Guerin Thomas, Cys
463 Alain, Hamdan David, Fillatre Olivier, Carle Olivier, Kadji Roger, Kuczer Vincent, Thivellier Agnes, Sapir David,
464 Le jan Arnaud, Escutnaire Josephine, Benard Amandine, Bazzoli Cyril, Delattre Catherine, Saada Laure,
465 Roucaud Nicolas, Sussat Myriam, Babet Thierry, Vasseur Laurene, Guillot Philippe, Line Sebastien, Roze
466 Guillaume, Devillard Arnaud, Orhon Frederic, Lougnon Jean-Paul, Menot Pascal, Bredel Stephanie, Ruellan
467 Gautier, Soulat Marie, Chassery Carine, Guiot Olivier, Gonet-Dubois Corinne, Benaziz Imane, Ayllon-Milla
468 Sonia, Mariage Julien, Barthelemy Francois-Xavier, Versmee Gregoire, El abdi Mounir, Menay Marion,
469 Rungswad Phloy, Rousselon Charlotte, Delbos Marc, Quibel Thomas, Gaillard Nancy, Lalande Jessica, Yali

470 Matthieu, Desclefs Jean-Philippe, Moulinet Fanny, Baert Valentine, Sejourne Gerald, Vally Rishad, Anette
471 Bastien, Abdelkhalek Sami, Federici Laura, Villoing Barbara, Gomes de mattos Charles, Villard Maxime,
472 Corradi Laure, Vidil Elodie, Fournier Emmanuelle, Kottmann Vincent, Goulois Nathalie, Berthier Frederic, Ferre
473 Juliette, Maurel Marion, Dussoulier Sebastien, Evain Yoann, Menu Elsie, Duconge Antoine, Rahmani
474 Raphaelle, Clauzel Maxens, Grard Charlene, Coppin Vincent, Bosc Juliane, Decoster Alice, Moreno maestre
475 Maria elena, Ginoux Lucie, Gautier Lise, Cendrie Pascal, Tasei frederic, Vercher Laurent, Dojat Sandrine,
476 Hecker Christine, Evrard Gregoire, Cavalli Pascale, Reydy Franck, Leveau Marion, Dhote Christophe, Lefort
477 Alexandra, Goubet potiron Christine, Plenier Cecile, Leclerc Maxence, Acer Okan, Chardin Adeline, Garcia
478 Carolina, De dinechin Laurene, Marina Dubois, Picart Jeanne, Fleurival Kleeve, Treels Justine, Bouvier Simon,
479 Velly Laetitia, Harle Laure, Chassin Coralie, Penverne Yann, Chouraqui Mikhael, Segard Lionel, Villain-Coquet
480 Laurent, Roche Florent, Magimel-Pelonier Edouard, Hennache Jonathan, Staes Sophie, Prouve Christina,
481 Gondret Coralie, Steenbeke Laurence, Ospital Jennifer, Messieux Alexis, Marrakchi Faycal, Pointaire
482 Delphine, Katz Elodie, Sigaux Antoine, De schlichting Marie alix, Benaniba Josiane, Martin Thibault, Lecoz
483 Julien, Pantaloni Francois, Guegan Annaig, Simon Benoit, Pauchet Nicolas, Bois-De-Fer Jennifer, Oganov
484 Kirill, Dessoy Anne-Laure, Girard Cecile, Durand Marion, Mansouri Nadia, Olive Stephanie, Serres Marine,
485 Sawadogo Jasmine, Dabri Amira, Fresse Louis, Singier Allison, Bokobza Romain, Nussbaum Camille,
486 Kassasseya Christian, Pettinotti Oceane, Gaubert Julien, Lafay Marina, Lenne Claire, Morel marechal
487 Emanuel, Boudard Olivia, Vermersch Celine, Jauneau Charline, Dubernat Manon, Orcival Francois, Zitouni
488 Laila, Hiller Pascale, Collin Amandine, Saint paul Amelie, Dansou Dizae, Gendraud Sarah, Mercier Catherine,
489 Sauder Irina, Dubourg Marie, Revaux Francois, Schmit Anne catherine, Chadelaud Fabien, Florentin
490 Jonathan, Mathieu Benedicte, Foulgoc Helene, Boutin Celia, Ngonga Marie yves, Galtier Veronique, Nenert
491 Eloi, Jacquemin Renaud, Chopinaud Pierre-Amaury, Lefevre Stephanie, Dupin Aurelie, Poincet Sebastien,
492 Toumert Karim, Lauvray Adrien, Boursier Marion, Faivre-Pierret Caroline, Lefranc Delphine, Mathie Clement,
493 Mahi Zakaria, Dumont Jean-Baptiste, Theurey Odile, Ruiz Solene, Lorge Sarah, Chapelle Anais, Boyer
494 Romain, Berard Cecile, Beaka Placido, Fleury Amandine, Desroziers Marie, Corre Melanie, Rotival Julie,
495 Lesaca Julien, Ducasse Pierre, Antonic-Ravaut Celia, Ibrahim Amr, Jaeger Deborah, Jeziorny Alexandre,
496 Armand Aurelie, Allers Mona, Fanchon Armelle, Barret Morgane, Guez Charlene, Lacaze Melanie, Hammouti
497 Najat, Javaudin Francois, Sciacca Christelle, Belli Marie-Camille, Hugenschmitt Delphine, Dumont Nathalie,
498 Grar Sarah, Carruesco Chloe, Debelle Aurelien, Piccardi Mailis, Zemouri Maria, Davost Camille, Kamboua
499 Mounir, Lebrun Cecile, Altervain Yohan, Le Thomas, Grignon Oceane, Drosseau-Philippe Cisse, Allemandet
500 Elodie, Gentilhomme Angelie, Pretalli Jean-Baptiste, Cattin Vincent, Gerard Aurelien, Oliveira Larissa,
501 Raynaud Camille, Lepeve Alexandra, Grave Eric.

1641 Paediatric OHCA

62 excluded because of missing value
58 Airway management by MICU
4 Vital status on day 30 (all received ETI)

1579 Analysed

1355 ETI procedure
224 Supraglottic procedure

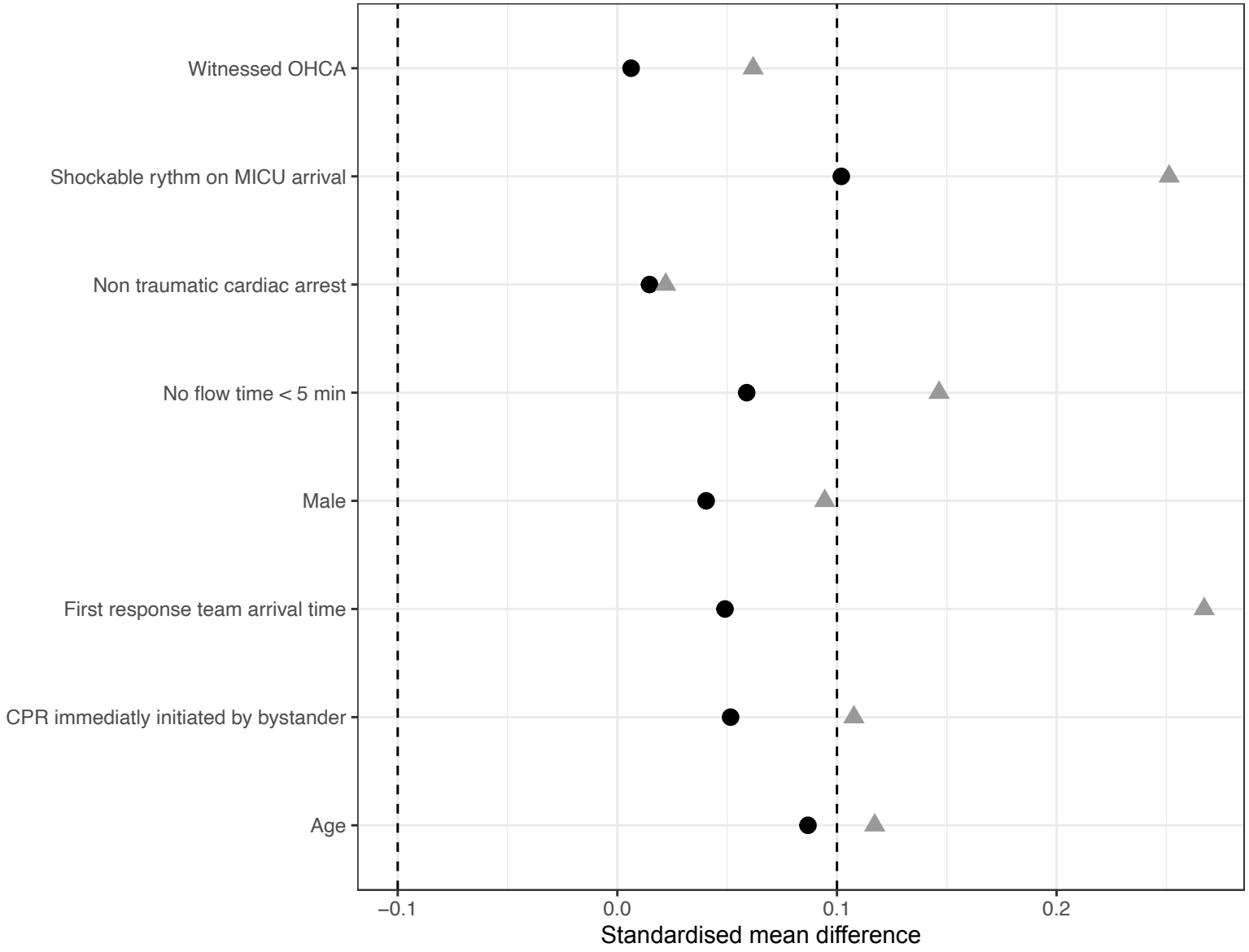


Table 1. Characteristics of Patients and Cardiac Arrest Management

Characteristics	No. of Patients (%)			P Value
	Overall Population (n = 1579)	ETI (n = 1355)	Supraglottic Procedure (n = 224)	
Age, med, (Q1;Q3), years	3 (0;13)	3 (0;13)	2 (2;11.3)	0.1
Gender (male)	979 (62.0)	849 (62.7)	130 (58.0)	0.05
Witness and bystander				
Bystander-witnessed	996 (63.1)	849 (62.7)	147 (62.5)	0.4
First response team- or MICU-witnessed	102 (6.5)	85 (6.3)	17 (7.6)	0.6
Location of arrest				
Home	927 (58.7)	806 (59.5)	121 (54.0)	0.1
Street/highway	273 (17.3)	237 (17.5)	36 (16.1)	
Public building	98 (6.2)	84 (6.2)	14 (6.3)	
Other or non-specified	281 (17.8)	228 (16.8)	53 (23.7)	
Bystander CPR				
Immediate CPR by bystander	606 (38.4)	530 (39.1)	76 (33.9)	0.08
Bystander compression only	859 (54.4)	767 (56.6)	92 (41.1)	< 0.001
Bystander compression and ventilation	407 (25.8)	358 (26.4)	49 (21.9)	0.2
Bystander defibrillation	115 (7.3)	108 (8.0)	7 (3.1)	0.007
Time from first call to contact to patient in minutes, mean (SD)				
First response team time on scene	11.4 (10.3)	11.0 (10.4)	13.6 (9.1)	0.02
MICU time on scene	20.2 (13.5)	19.9 (12.6)	22.3 (17.9)	0.06
Cardiac arrest baseline characteristics				
Non-traumatic cardiac arrest	1157 (73.3)	991 (73.1)	166 (74.1)	0.8
First documented rhythm by MICU				
Shockable	58 (3.7)	57 (4.2)	1 (0.4)	< 0.001
Non-shockable	1396 (88.4)	1210 (89.3)	186 (83.0)	
ROSC	125 (7.9)	88 (6.5)	37 (16.5)	
No-flow duration, mean (SD), min ^a	10.2 (11.0)	9.8 (11.0)	12.6 (15.6)	0.01
Low-flow duration, mean (SD), min ^b	37.7 (27.3)	40.3 (26.0)	22.3 (29.8)	< 0.0001
Basic life support				
Basic life support by first response team	1298 (82.2)	1176 (86.8)	122 (54.5)	< 0.001
Use of AED	829 (52.5)	760 (56.1)	69 (30.8)	0.2
Defibrillation	94 (6.0)	89 (6.6)	5 (2.2)	0.09
Advanced life support				
Intubation failure ^c	31 (2.0)	31 (2.3)	0 (0)	< 0.001
Pulmonary aspiration	449 (28.4)	441 (32.5)	8 (3.6)	< 0.001
EtCO ₂ max during CPR, mean (SD), mmHg	30.7 (23.2)	30.8 (23.2)	25.5 (21.4)	0.29
Defibrillation	141 (8.9)	139 (10.3)	2 (0.9)	< 0.001
Number of shocks delivered, med, (Q1;Q3), (n = 141)	2 (1;4)	2 (1;4)	3 (2.5;3.5)	0.54
Intraosseous vascular access	607 (38.4)	577 (42.6)	30 (13.4)	< 0.001

Peripheral venous vascular access	844 (53.5)	811 (59.8)	33 (14.7)	< 0.001
Central venous vascular access	21 (1.3)	19 (1.4)	2 (0.9)	0.75
Endotracheal access	56 (3.5)	56 (4.1)	0 (0)	< 0.001
No vascular access	20 (1.3)	9 (0.7)	11 (4.9)	< 0.001
Adrenaline administration	1259 (79.7)	1209 (89.2)	50 (22.3)	< 0.001
Outcomes				
ROSC after advanced life support	465 (29.4)	413 (30.5)	52 (23.2)	0.03
Vital status on hospital admission (n = 566)				
ROSC	407 (25.8)	355 (26.2)	52 (23.2)	0.04
Dead on admission	73 (4.6)	70 (5.2)	3 (1.3)	
Manual chest compressions	65 (4.1)	64 (4.7)	1 (0.4)	
Automatic chest compressions	20 (1.3)	19 (1.4)	1 (0.4)	
Alive on day 30	136 (8.6)	104 (7.7)	32 (14.3)	0.002
Neurologically favourable survival (CPC 1 & 2)	88 (5.6)	63 (4.6)	25 (11.1)	< 0.001

Abbreviations: ETI: endotracheal intubation; MICU: mobile intensive care unit; CPR: cardiopulmonary resuscitation; ROSC: return of spontaneous circulation; AED: automated external defibrillator; EtCO₂: end-tidal capnography; SD: standard deviation; Q1:Q3: first and third quartiles. *P* values were calculated using Student's T-test, χ^2 test with Yates' continuity correction, Wilcoxon rank sum test or Fisher's exact test.

^aNo-flow duration: time between collapse and initiation of basic life support.

^bLow-flow duration: time between initiation of basic life support and return of spontaneous circulation.

^cThe intubation failure rate for the "supraglottic procedure" group represents patients for whom intubation failed and management was pursued using a supraglottic device.

Table 2. Patients, Arrest and Intervention Characteristics Included in Primary Analysis Before and After Inverse Probability of Treatment Weighting (IPTW)

Baseline Characteristic, mean (SD)	Before IPTW			After IPTW		
	Supraglottic Procedure	ETI	<i>P</i> value	Supraglottic Procedure	ETI	<i>P</i> value
Age (years)	5.49 (6.41)	6.24 (6.48)	0.10	5.60 (6.23)	6.15 (6.47)	0.22
Gender (male)	0.58 (0.49)	0.63 (0.48)	0.19	0.64 (0.48)	0.62 (0.49)	0.57
Witnessed OHCA	0.65 (0.48)	0.63 (0.48)	0.38	0.63 (0.48)	0.63 (0.48)	0.93
No-flow time < 5 min	0.29 (0.45)	0.36 (0.48)	0.039	0.38 (0.49)	0.35 (0.48)	0.42
CPR immediately initiated by bystander	0.33 (0.47)	0.39 (0.49)	0.037	0.36 (0.48)	0.39 (0.49)	0.47
First response team arrival time	13.59 (9.07)	10.98 (10.4)	< 0.001	10.86 (7.70)	11.31 (10.41)	0.45
Non-traumatic cardiac arrest	0.74 (0.44)	0.73 (0.44)	0.75	0.74 (0.44)	0.73 (0.44)	0.84
Shockable rhythm on MICU arrival	0.004 (0.07)	0.04 (0.2)	< 0.001	0.02 (0.14)	0.04 (0.19)	0.11

Abbreviations: CPR: cardiopulmonary resuscitation; SD: standard deviation. *P* values were calculated using Student's T-test, χ^2 test or Fisher's exact test.