Ventilator use by emergency medical services during 911 calls in the United States

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ABSTRACT

Background: Emergency and transport ventilators use in the prehospital field is not well described. This study examines trends of ventilator use by EMS agencies during 911 calls in the United States and identifies factors associated with this use.

Methods: This retrospective study used four consecutive releases of the US National Emergency Medical Services Information System (NEMSIS) public research dataset (2011–2014) to describe scene EMS activations (911 calls) with and without reported ventilator use.

Results: Ventilator use was reported in 260,663 out of 28,221,321 EMS 911 scene activations (0.9%). Patients with ventilator use were older (mean age 67 ± 18 years), nearly half were males (49.2%), mostly in urban areas (80.2%) and cared for by advanced life support (ALS) EMS services (89.5%). CPAP mode of ventilation was most common (71.6%).

"Breathing problem" was the most common dispatch complaint for EMS activations with ventilator use (63.9%). Common provider impression categories included "respiratory distress" (72.5%), "cardiac rhythm disturbance" (4.6%), "altered level of consciousness" (4.3%) and "cardiac arrest"(4.0%).

Ventilator use was consistently higher at the Specialty Care Transport (SCT) and Air Medical Transport (AMT) service levels and increased over the study period for both suburban and rural EMS activations. Significant factors for ventilator use included demographic characteristics, EMS agency type, specific complaints, provider's primary impressions and condition codes.

Conclusions: Providers at different EMS levels use ventilators during 911 scene calls in the US. Training of prehospital providers on ventilation technology is needed. The benefit and effectiveness of this intervention remain to be assessed.

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1. Background

The number and type of clinical interventions continue to increase in the prehospital field in an attempt to reduce time to valuable treatment and improve patient outcomes. Emergency and transport ventilators (ETV) are now commonly used by ground and air transport medical services mainly during transportation of critical care patients [1].

Clinical applications of ventilation technology will also continue to expand with the increased portability of ventilators [2] and increased patients' clinical complexity. This will mandate updating the skills of EMS providers and expanding their scope of practice to meet the needs of patients who are ventilator dependent or for whom mechanical ventilation might be useful during an emergency response.

Current use of ventilators by emergency medical services (EMS) during emergency scene calls (911 calls in the United States) is not well described and is limited to studies examining continuous positive airway pressure (CPAP) ventilation for patients with acute respiratory distress secondary to suspected acute cardiogenic pulmonary edema or acute exacerbations of chronic obstructive pulmonary disease [3-6]. In the US, 911 scene calls might also include for some agencies conducting interfacility transfers (from one emergency department (ED) to another or from nursing homes to EDs).

Examining existing clinical practices is useful for EMS medical directors, EMS administrators and educators to plan for future resource allocations including ventilator equipment use and for training of prehospital providers.

NEMSIS (The National Emergency Medical Services Information System) is a database that collects EMS activations from EMS agencies in 48 states and territories in the US [7]. A publicly available database is released every year.

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The aim of this study was to describe trends in ventilator use by EMS providers during 911 scene calls and to examine factors associated with this use by examining four consecutive releases of the NEMSIS database (2011 through 2014).

2. Methods

2.1. Study design

We carried out a retrospective study using combined NEMSIS datasets, specifically the 2011 through 2014 datasets. Being a de-identified dataset, an Institutional Review Board (IRB) exemption from the XX was obtained.

2.2. Study setting

NEMSIS is a convenience sample of EMS activations in the US covering 48 States and territories. The database maintains information through standardized definitions and formats for patient care reports, and includes approximately 83 variables [7]. Local EMS agencies collect data that are then aggregated at the State level and submitted to the NEMSIS national database [7]. Inclusion criteria and proportion of EMS activations submitted vary by State [8,9]. Each case in the NEMSIS database represents a single EMS activation submitted by a single responding vehicle. Thus, the NEMSIS database is a collection of EMS activations for emergency care rather than a collection of unique patients.

2.3. Study population

The combined NEMSIS public datasets include information on 83,936,070 EMS activations. In this study, we analyzed only EMS activations where the type of service requested was "911 response (scene)". We excluded activations with "call cancelled", or where no patient was found or if the patient refused treatment. Activations with missing information on procedures performed were also excluded. Fig. 1 shows the exclusions done at every step of the analysis and which yielded a total of 28,221,321 activations that were included in the final analyses.

2.4. Available data

Standardized definitions in the NEMSIS manual were used. Ventilator use is reported under procedures performed to the patient as "Airway Ventilator Operation", "Airway Ventilator with PEEP", "Airway BIPAP" or "Airway CPAP" [10]. Additional variables that were analyzed included EMS agency information such as: EMS service area urbanicity (population setting using United States Department of Agriculture (USDA) and Office of Management and Budget (OMB) definitions) [8,9] and reported Center for Medicare and Medicaid Services (CMS) service level. The CMS service levels utilized were: Basic Life Support (BLS [BLS and BLS emergency]); Advanced Life Support (ALS [ALS Level 1, Level 1 emergency and Level 2]); Air Medical Transport (AMT) including both fixed wing (airplane) and rotary wing (helicopter) and; Specialty Care Transport (SCT).

In addition, information used from the dataset included event-related information such as patient age and sex, complaint reported by dispatch, condition code, provider's primary impression, and type of destination. Additionally, time intervals related to events were collected including public safety answering point (PSAP) to Unit in Route, PSAP to on scene time, total on scene time, transport time and total prehospital time (PSAP to arrive at destination).

2.5. Data analysis

Data were extracted from the NEMSIS files and imported into the Statistical Analysis Software (SAS) version 9.1, which was used for data management and analyses. Descriptive analyses were carried out by presenting the number and percent for categorical variables, whereas mean and standard deviation were presented for continuous variables. Additional stratification by invasive and non-invasive (CPAP or BIPAP) modes of ventilation was done to describe further details about ventilator use. Bivariate analyses were then carried out to assess the association between ventilator use and categorical variables using the Chi-square test and the independent Student's t-test for continuous variables. This was followed by multivariate logistic regression analyses to adjust for confounders with a reference group selected for categorical variables with more than two groups. Results were presented as
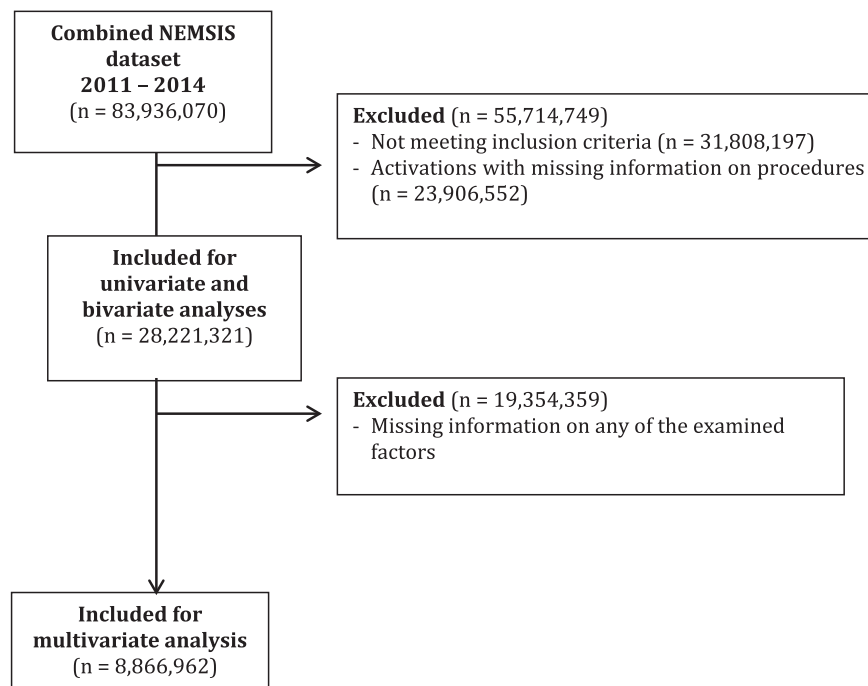

Fig. 1. Constitution of the study group.