



## Incidence of Ventilator-Associated Pneumonia in Iranian Children Undergoing Mechanical Ventilation: A systematic review and meta-analysis

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### Abstract

The aim of this systematic review and meta-analysis was to evaluate the prevalence of Incidence of Ventilator-Associated Pneumonia in Iranian Children Undergoing Mechanical Ventilation.

**Methods:** The present systematic study has applied developed methods that are in line with accurate instruction of PRISMA checklist. Two researchers have separately investigated all studies conducted up to May 2019; the studies had been collected from international databases (PubMed, Google Scholar, and WOS) and national ones (SID and Magiran) without any time limitation in both English and Persian.

**Results:** As many as six studies conducted on 480 children were included in the meta-analysis. In asymptomatic children, according to the results of random effects mode, the Incidence of Ventilator-Associated Pneumonia in Iranian Children Undergoing Mechanical Ventilation was 17.4% in 480 children (95% CI: 14.2, 20.7;  $I^2=91.6\%$ ). The Incidence of Ventilator-Associated Pneumonia in Iranian Children Undergoing Mechanical Ventilation (according to the prevalence in each province) in Tehran and Kermanshah provinces were 28% (95% CI: 23.5%, 32.5%) and 6.4% (95% CI: 1.8%-11%) respectively.

**Conclusion:** the prevalence of Ventilator-Associated Pneumonia in Iranian Children Undergoing Mechanical Ventilation specially in a large province like Tehran is high. Thus, it seems essential to devise and adopt a preventive strategy to avoid ventilator associate infections for reducing the mortality and disability rates.

**Keywords:** pneumonia; ventilator-associated; incidence; mortality; pediatric intensive care units

### Introduction

Nosocomial infections are commonly one of the major causes of mortality among patients, increased hospitalization duration, and increased costs imposed on the health system. Ventilator-associated pneumonia (VAP) is the most prevalent type of nosocomial infection that occurs in patients using a ventilator (1-3). Preventing the incidence of VAP will be followed by numerous positive results both clinically and economically (4). The mortality rate and huge costs arising from VAP in children are not known yet (5).

However, the mortality rate in adults is 10%, and the costs arising from VAP has been estimated to cost \$5000-8000 per each episode (6). Staphylococcus aureus and gram-negative bacteria are the most common causes of VAP in children and adults (7). VAP is regarded as the second most prevalent type of nosocomial infection in patients hospitalized in neonatal intensive care units in the United States (8). Children suffering from a deficiency defect and undergo prolonged endotracheal intubation are

especially at high risk; they are frequently in need of endotracheal intubation (as a part of the resuscitation process) and long-term artificial ventilation; they are at risk of other nosocomial infections as well (9). VAP diagnosis is conducted based on the criteria defined by the national nosocomial infection surveillance (NNIS) (10). Based on the patients' ages, these criteria are varied; they are divided into three groups i.e. patients younger than 1 year of age, 1-to-12-year old patients, and patients over thirteen years of age (11). The diagnostic criteria for VAP in children are as follows: the image of chest with infiltration, new or progressive and stable cavitation occurring 48 hours after the mechanical ventilation, or the presence of at least three clinical criteria including leukopenia of less than 4000 or leukocytosis of more than 15000, the emergence of purulent sputum or increased amount of pus, apnea, tachypnea, whizz, bradycardia, tachycardia, aggravated gas ventilation, and increased need of auxiliary oxygen or ventilation needs (12-15). The patients of neonatal intensive units differ from adults in terms of not only their age but also their underlying disorder, physiological conditions, and medical needs (16).

## Materials and Methods

The present systematic study has applied developed methods that are in line with accurate instruction of PRISMA checklist. However, only observational studies including letters to the editors, journals, poor quality articles (based on HOY tool), and studies conducted on adult participants were removed from the study. It was attempted to include studies only in English and Persian. All observational studies with any sampling and statistical designs have been included in the present systematic study. Two researchers have separately investigated all studies conducted up to November 2018; the studies had been collected from international databases (PubMed, Google Scholar, and WOS) and national ones (SID and Magiran) without any time limitation in both English and Persian. The reference list of the existing studies has been also investigated to find more studies in this regard. Special research strategies have been adopted by a health science librarian (an expert on systematic studies) through applying MESH browsing vocabulary as well as free vocabulary based on PRESS standard (16). Moreover, MEDLINE research strategy has been applied for searching other databases as well. The keywords applied in the research strategy include: pneumonia; ventilator-associated; incidence;

mortality; pediatric intensive care units, and Iran that were combined with Boolean operators such as AND, OR, and NOT. Two researchers have separately investigated the titles and abstracts by considering the qualification criteria. After excluding the repetitive studies, the full texts of the studies were investigated based on the qualification criteria and the required information was extracted. For solving the questions on qualifications, extra information was obtained from the authors whenever needed. Moreover, the required data on conditions, sample size, risk of bias, and the measurement of result were collected as well. The final extracted data were evaluated by using STAT 14.0.

## Results

**Study selection:** In total, as many as 515 studies were selected from the initial research on PubMed, Google Scholar, SID, Magiran, and Web of Science from the beginning to May 1 of 2019. From 442 non-repetitive studies (in terms of title and abstract), as many as 402 studies were excluded in the screening process; their titles were unrelated. From the remaining 40 studies, 6 studies were qualified for having the required criteria. From 34 excluded studies, 6 studies were reviewed, 2 studies were sent to the editor in chief, five studies didn't have the full texts, and 21 studies didn't meet the minimum quality and standards required to be included in this study (Figure 1).

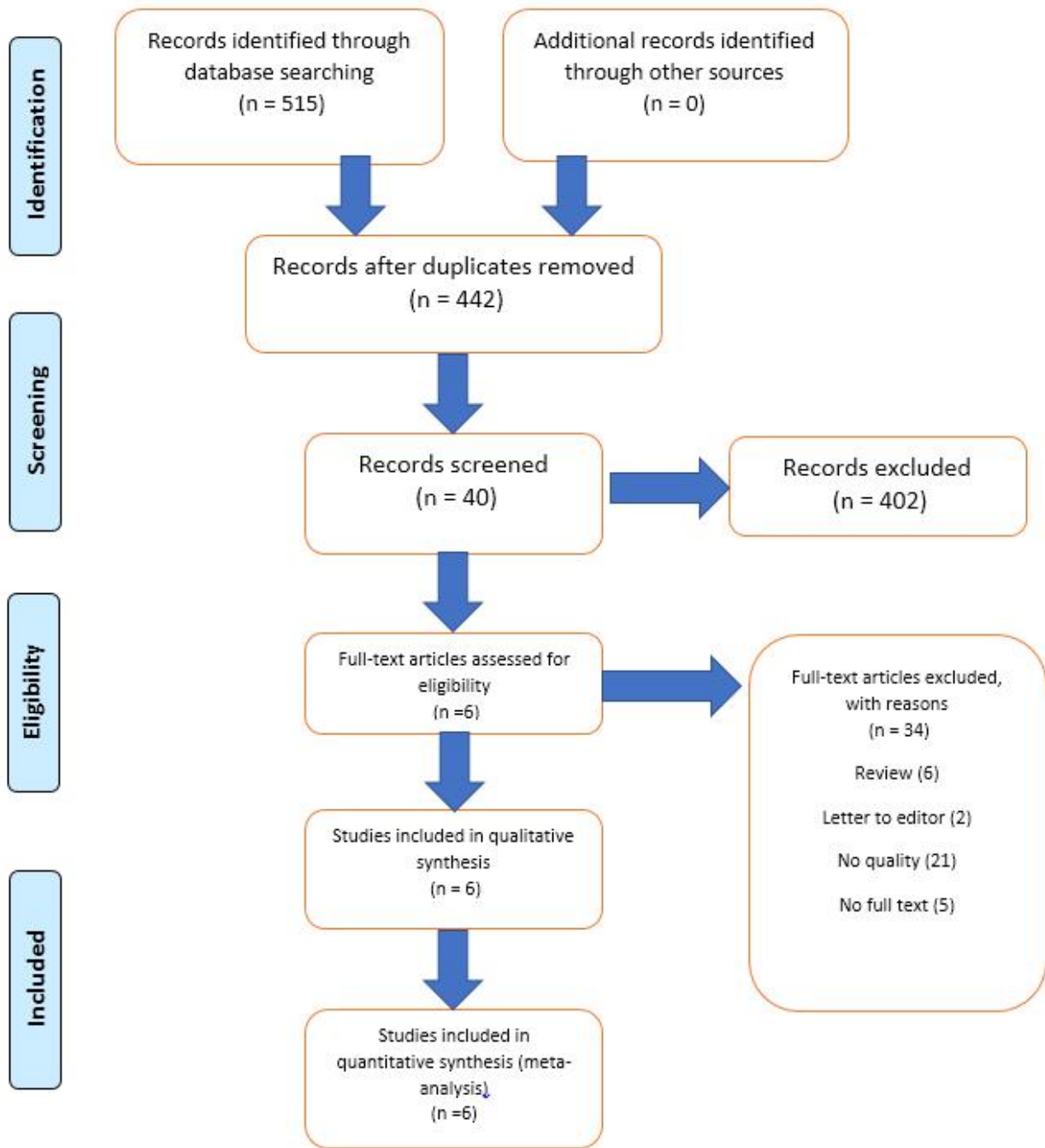


Fig 1. PRISMA flow diagram

**Research characteristics:**

These 6 studies had been conducted on 480 Iranian children aged <14 years. From these 6 studies, 3 studies have provided cross-sectional data, and 3 studies were in a prospective design. From these 6

studies, five studies belonged to Tehran. The most common sampling method applied was convenience sampling method (n=4). More than 80% of the studies had low risk of bias. Hospital was the most prevalent place for conducting the studies (n=6).

**Incidence of Ventilator-Associated Pneumonia in Iranian Children Undergoing Mechanical Ventilation:**

As many as six studies conducted on 480 children were included in the meta-analysis. In asymptomatic children, according to the results of random effects mode, the Incidence of Ventilator-Associated Pneumonia in Iranian Children Undergoing

Mechanical Ventilation was 17.4% in 480 children (95% CI: 14.2, 20.7;  $I^2=91.6\%$ ) [Table1]. The Incidence of Ventilator-Associated Pneumonia in Iranian Children Undergoing Mechanical Ventilation (according to the prevalence in each province) in Tehran and Kerman shah provinces were 28% (95% CI: 23.5%, 32.5%) and 6.4%(95% CI: 1.8%-11%) respectively (Fig 3).

Table 1: Characteristics of final included studies

Author	year	city	N	All province			Tehran				
				ES	95% conf. interval		ES	95% conf. interval		weight	
					low	up		low	up		
Gheini <sup>(20)</sup>	2007	Kermanshah	107	0.064	0.018	0.110	48.89	-	-	-	-
Nateghian <sup>(21)</sup>	2016	Tehran	63	0.410	0.289	0.531	7.11	0.410	0.289	0.531	13.90
Moradi <sup>(22)</sup>	2012	Tehran	38	0.420	0.263	0.577	4.25	0.420	0.263	0.577	8.32
Fallahi <sup>(23)</sup>	2014	Tehran	108	0.333	0.244	0.422	13.33	0.333	0.244	0.422	26.08
Afjeh <sup>(24)</sup>	2012	Tehran	81	0.173	0.091	0.255	15.66	0.173	0.091	0.255	30.64
Amanati <sup>(25)</sup>	2017	Tehran	83	0.229	0.130	0.328	10.76	0.229	0.130	0.328	21.06
Pooled ES	---	-----	480	0.174	0.142	0.207	100	0.280	0.235	0.325	100

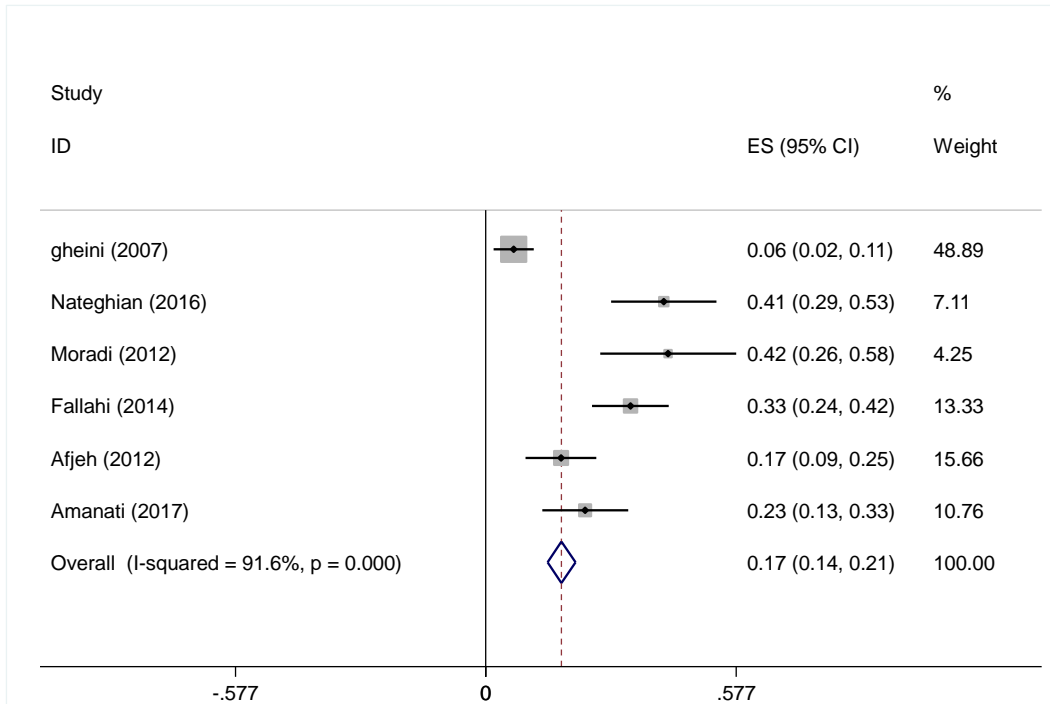


Fig 2. Incidence of Ventilator-Associated Pneumonia in Iranian Children Undergoing Mechanical Ventilation and its 95% interval for the studied cases according to the year and the city where the study was conducted based on the model of the random effects model. The midpoint of each section of the line estimates the% value and the length of the lines showing the 95% confidence interval in each study. The oval sign shows Incidence of Ventilator-Associated Pneumonia in Iranian Children Undergoing Mechanical Ventilation

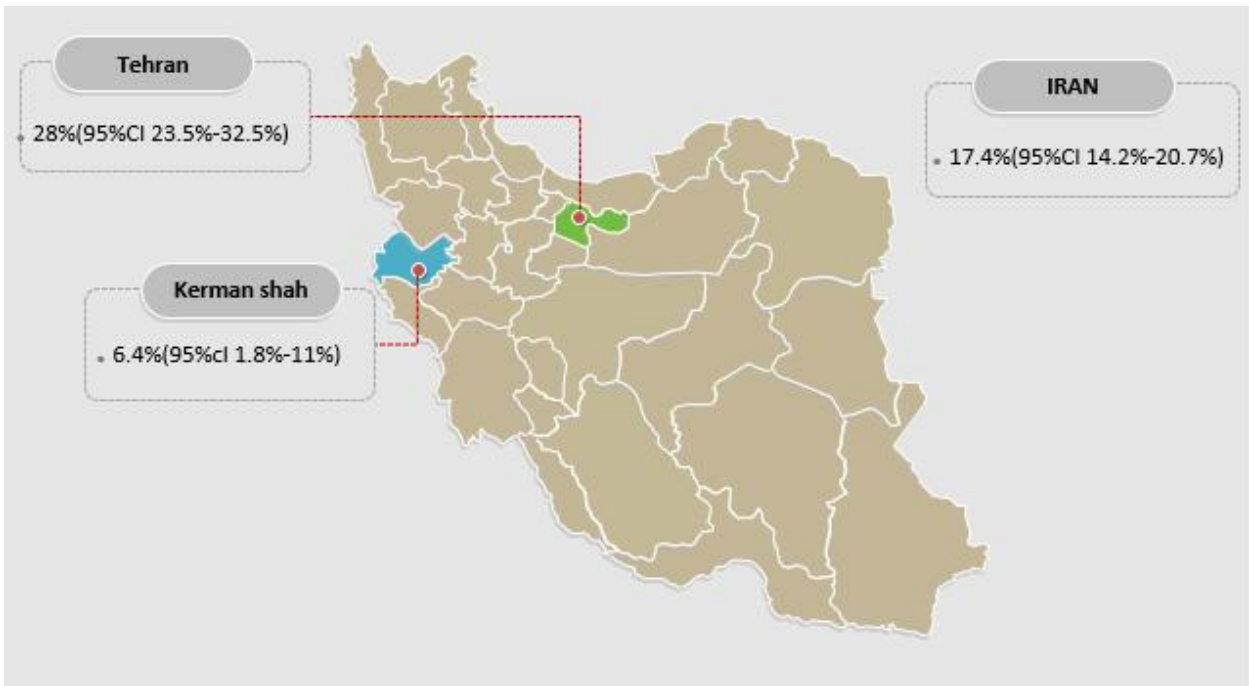


Fig 3. Incidence of Ventilator-Associated Pneumonia in Iranian Children Undergoing Mechanical Ventilation (according to the frequency in children in each province)

## Discussion

As many as six studies conducted on 480 children were included in the meta-analysis. In asymptomatic children, according to the results of random effects mode, the Incidence of Ventilator-Associated Pneumonia in Iranian Children Undergoing Mechanical Ventilation was 17.4% in 480 children (95% CI: 14.2, 20.7;  $I^2=91.6\%$ ). The Incidence of Ventilator-Associated Pneumonia in Iranian Children Undergoing Mechanical Ventilation (according to the prevalence in each province) in Tehran and Kerman shah provinces were 28% (95% CI: 23.5%, 32.5%) and 6.4%(95% CI: 1.8%-11%) respectively. Ventilator-associated pneumonia (VAP) occur in patients undergoing at least 48 hours of artificial ventilation. Moreover, VAP is regarded as the second most prevalent nosocomial infection (17). Despite the major advances in techniques for the management of VAP patents and the application of effective methods for disinfecting the ventilation equipment, VAP is still bringing about complication in the disease course in 8-28% of patients undergoing mechanical ventilation. VAP is thus regarded as a major threat for patients undergoing mechanical ventilation and a serious medical and diagnostic challenge for doctors of neonatal intensive care units (18). The rate of

pneumonia is remarkably higher among patients hospitalized in ICU than other units and wards. Moreover, the risk of pneumonia for intubated patients undergoing mechanical ventilation is 3-10 times higher. The mortality rate of VAP ranges from 24 to 50%. At some special conditions or when lung infections occur due to high-risk pathogens, the mortality rate of VAP is likely to reach 76%. For preventing VAP, various strategies have been provided. Some of these strategies are common i.e. they are effective for preventing all kinds of nosocomial infections. These strategies include hand washing, sufficient and proper nutrition. However, there are other strategies that are specifically effective for preventing VAP. They include the immediate removing tubes inside the trachea and nasogastric tubes, preventing from unplanned extubation and excessive replacement of ventilator connections and continuous aspiration of subglottic secretions. the prevalence of Ventilator-Associated Pneumonia in Iranian Children Undergoing Mechanical Ventilation specially in a large province like Tehran is high Thus, it seems essential to devise and adopt a preventive strategy to avoid ventilator associate infections for reducing the mortality and disability rates (19).

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