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## Independent Study Projects

### Title

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### Publication Date

2018

## **Physiological Effects of a Spit Sock**

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**Running Title:** Study on the Potential of Asphyxiation in The Utilization of Protective Spit Socks (SPAT UPS)

**Keywords:** Spit hood, Spit sock, Spit mask, Spit restraint, physical restraint, mesh hood, spit guard, police

**Word Count:** 2899

**Prior Presentations:** none

**Funding Sources/Disclosures:** Funding was provided by the general research fund of the Department of Emergency Medicine, UC San Diego Medical Center. The investigators have no conflicts of interest to disclose.

**Acknowledgments:**

Department of Emergency Medicine, UC San Diego Medical Center;

University of California San Diego School of Medicine

## **Abstract**

### **Objectives:**

Healthcare providers and law enforcement utilize spit socks to provide a direct method of universal precautions to prevent exposure to communicable diseases transmitted by bodily fluid projection from an agitated or altered individual. There are cases in which death of an individual is reported in part to have occurred from adequate breathing being limited or reduced by use of a spit sock. There are no formally published studies on the use and safety of spit socks in the medical literature. The aim of this study was to evaluate whether there is a clinically significant impact on breathing and ventilation in subjects with a protective spit sock placed on their head.

### **Methods:**

This prospective study evaluated the effect of spit sock application on vital signs and ventilatory parameters of healthy adult volunteers, compared to baseline parameters without the spit sock. The subjects were placed on a chair and baseline vital signs and ventilatory parameters were taken, including heart rate, oxygen saturation, blood pressure, respiratory rate, and end-tidal CO<sub>2</sub>. The subjects then sat with the spit mask over their heads for 15 minutes and their vital signs and ventilatory parameters were recorded after 5min, 10min and 15min of wearing the mask. Vital signs and ventilatory parameters at 5, 10 and 15 minutes after wearing the spit sock were compared to baseline using student's t-test with 95% confidence intervals using SPSS.

### **Results:**

A total of 15 subjects completed the study. The median age was 28 years and 53% were male. There was no significant difference between baseline and wearing the spit sock for 5, 10 or 15

minutes for heart rate ( $p=0.250$ ,  $p=0.181$ ,  $p=0.546$  respectively), oxygen saturation ( $p=0.334$ ,  $p=1.00$ ,  $p=0.173$  respectively), end-tidal  $pCO_2$  ( $p=0.135$ ,  $p=0.384$ ,  $p=0.187$  respectively), and diastolic blood pressure ( $p=0.485$ ,  $p=0.508$ ,  $p=0.915$  respectively). For respiratory rate, the difference between baseline rate and rate after spit sock application was not significant after 5 and 10 minutes ( $p=0.898$  and  $p=0.583$ , respectively), but had a statistically significant decrease at 15 minutes ( $p=0.048$ ). The systolic blood pressure was significantly lower after 5 and 10 minutes of spit sock application ( $p=0.028$  and  $p=0.045$ , respectively), but not significantly different at 15 minutes ( $p=0.146$ ). No subject indicated any distress nor did the study need to be terminated early due to pre-determined concerning vital signs or ventilatory parameters.

### **Conclusions:**

In healthy subjects there were no clinically significant changes in the physiologic parameters of breathing while wearing a spit sock. This study offers a foundation for further research into the use and safety of spit socks.

### **Introduction**

Spit socks are mesh hoods that can be placed over the head of an individual. Healthcare providers, EMS personnel and law enforcement utilize spit socks to provide a direct method of universal precautions to healthcare providers and law enforcement officials. Their purpose is to prevent exposure to communicable diseases transmitted by bodily fluid projection via an agitated or non-compliant patient or subject. The use of spit socks has increased over the last couple years. According to the San Diego Sheriff's Department's Use of Force Statistical Report 2014-2015 and 2015-2016, spit socks were utilized by their department 219 times in 2014, 305 times

in 2015, and 394 times in 2016<sup>1,2</sup>. There has also been a controversial increase in implementation of spit hoods in the UK and Germany<sup>3-6</sup>. The nature of the controversy surrounding spit socks, especially in the light of recent media coverage of alleged police brutality, revolves not only around the public image and psychological effect of placing a spit sock on an individual, but also their safety and potential effect on breathing<sup>3,4</sup>. There have been a few anecdotal judicial cases of litigation in which death is reported with a suggested etiology of potential asphyxiation due to blocking off of some of the apertures in a spit sock by the subject continually spitting into the sock or vomiting when it covers their head<sup>7,8</sup>. It is suggested that the spit sock becomes saturated to the point of covering the holes of the spit sock so that the subject is not able to adequately ventilate or draw air through the spit sock. There have also been allegations that spit socks have caused ventilatory issues and asphyxiation without any foreign materials on them<sup>7</sup>. There are no formally published studies evaluating whether or not exposure of a spit sock alone or with spit or fluid of a similar viscosity or even denser viscosity can prevent a subject from breathing or successfully drawing a breath. A PubMed search of the key terms "spit sock" or "spit hood" or "spit restraint" only reveals one article from AIDS Policy Law, May 2004, which details an order to uphold the use of a spit hood for an HIV positive man to wear in court<sup>9</sup>. There are no other research cases, reviews or protocols detailing the use of spit hoods or spit socks in the literature. The aim of this pilot study is to evaluate whether a spit sock has an impact on breathing and ventilatory parameters in a healthy adult subject.

## **Methods**

### **Study Design**

This was a prospective study evaluating the effect of spit sock application on vital signs and ventilatory parameters of healthy adult volunteers, compared to baseline parameters without wearing the spit sock. The study was reviewed and approved by our Institutional Review Board. All participants provided written informed consent.

### **Study Setting and Population**

This study was performed at an academic medical center using volunteer subjects. Inclusion criteria included individuals between the ages of 18-65 years and exclusion criteria were: being claustrophobic or pregnant, and those who did not wish to undergo the study by personal choice.

### **Study Protocol**

After consent, descriptive data were gathered from the subject, including age, gender, weight, height, and medical conditions. All females underwent urine pregnancy testing and would have been excluded if the test had come back positive. The subject was then placed in a seated position on a chair. A buzzer was placed near his or her dominant hand that the subject was instructed to press should he or she experience distress that could not be verbalized. The spit mask was then applied over the subject's head. The spit sock used for the study was the black MTR Spit Hood (SKU: MTR-SS285W) (see figure 1). The subject sat with the spit mask for 15 minutes. The study would have been stopped and the mask removed if the subject pushed the buzzer, if the O<sub>2</sub> sat dropped below 91%, if the ETCO<sub>2</sub> went 10 points above baseline, if the heart rate went beyond 110 bpm or dropped below 50 bpm (unless baseline heart rate was below

60 bpm – in those subjects the study was stopped if the heart rate dropped 10 bpm below baseline).



**Figure 1.** Image of the Spit Sock used in the study.

## **Measures**

Each subject's vital signs and ventilatory parameters, including oxygen saturation, heart rate, blood pressure, respiratory rate, and end-tidal pCO<sub>2</sub>, were recorded after the subject sat down on a chair prior to the intervention and then 5, 10, and 15 minutes after application of the spit sock. Ventilatory measures, including oxygen saturation, heart rate, respiratory rate, and end-tidal pCO<sub>2</sub> were obtained using a Smith's Medical Capnograph II Hand-Held Capnograph/Oximeter.

## **Data Analysis**

Data were entered in an Excel (Microsoft Corp., Redmond, WA) database for analysis. Analyses were performed using SPSS Version 24.0 (SPSS Inc., Chicago, IL). Student's t-test was utilized to measure differences in means between vital signs and ventilatory parameters at baseline and



after wearing the spit sock for 5 minutes, 10 minutes and 15 minutes. In our analysis,  $p < 0.05$  was considered to represent plausible, significant differences.

## **Results**

### **Characteristics of Study Subjects**

A total of fifteen volunteers completed the study, 53% were male. No subject was screened out prior to or after consent. Two subjects reported a medical history of mild intermittent asthma. No other medical conditions were reported. Other subject characteristics are reported in Table 1.

Table 1. Characteristics of Study Subjects ( $n = 15$ )

	Mean (SD)	Range
Age (years)	30.9 (9.2)	19 - 51
Weight (kg)	71.7 (15.2)	49.9 - 102
Height (m)	1.73 (0.1)	1.57 – 1.93
Body Mass Index ( $\text{kg}/\text{m}^2$ )	23.7 (3.2)	19.3 – 29.4

Table 2. Effect of spit sock Exposure on Vital Signs and Ventilatory Parameters (n = 15)

	Baseline	5 minutes	10 minutes	15 minutes
<b>Heart Rate (bpm)</b>				
Mean (SD)	79 (11.8)	76.9 (11.5)	76.1 (7.8)	77.9 (9.5)
Change from Baseline (SD)	/	-2.1 (6.9)	-2.9 (8.1)	-1.1 (6.7)
95% CI	/	-1.680 - 5.946	-1.539 - 7.405	-2.627 - 4.761
p-value	/	0.250	0.181	0.546
<b>O2 Sat (%)</b>				
Mean (SD)	97.5 (1)	97.3 (1)	97.5 (0.6)	97.1 (1.1)
Change from Baseline (SD)	/	-0.2 (0.8)	0.0 (0.9)	-0.3 (0.9)
95% CI	/	-0.229 - 0.629	-.513 - .513	-0.165 - 0.832
p-value	/	0.334	01.000	0.173
<b>Et pCO2 9mmHg)</b>				
Mean (SD)	38.5 (4.7)	37.3 (5)	37.9 (5.1)	37.6 (6)
Change from Baseline (SD)	/	-1.2 (2.9)	-0.7 (2.9)	-0.9 (2.6)
95% CI	/	-0.424 - 2.824	-.923 - 2.256	-.509 - 2.375
p-value	/	0.135	0.384	0.187
<b>RR (breaths/min)</b>				
Mean (SD)	16.6 (5.5)	16.8 (5.7)	17.3 (5.5)	14.1 (4.7)
Change from Baseline (SD)	/	0.2 (6.0)	0.7 (4.6)	-2.5 (4.5)
95% CI	/	-3.498 - 3.098	-3.210 - 1.877	0.023 - 5.044
p-value	/	0.898	0.583	0.048*
<b>SBP (mmHg)</b>				
Mean (SD)	125.6 (15.4)	120.4 (15.1)	119.8 (15.4)	121.1 (13.7)
Change from Baseline (SD)	/	-5.2 (8.2)	-5.8 (10.2)	-4.5 (11.4)
95% CI	/	0.637 - 9.763	0.148 - 11.452	-1.787 - 10.854
p-value	/	0.028*	0.045*	0.146
<b>DBP (mmHg)</b>				
Mean (SD)	84 (12.1)	82.3 (12.1)	82.1 (12.3)	83.7 (10.9)
Change from Baseline (SD)	/	-1.7 (9.0)	-1.9 (11.0)	-0.3 (9.5)
95% CI	/	-3.320 - 6.654	-4.164 - 8.030	-4.972 - 5.506
p-value	/	0.485	0.508	0.915
Bpm = beats per minute, SD = Standard Deviation), CI = Confidence Interval, Et pCO <sub>2</sub> = End-tidal pCO <sub>2</sub> , RR = Respiratory Rate, SBP = Systolic Blood Pressure, DBP = Diastolic Blood Pressure. p-values and CI are given for comparison between baseline and indicated time after spit sock application. * Significant difference between baseline and after spit sock application (p < 0.05).				

## **Main Results**

Table 2 shows the mean vital signs and ventilatory parameters at baseline without the spit sock and at 5, 10, and 15 minutes after spit sock application. There was no significant difference between baseline and while wearing the spit sock for 5, 10 or 15 minutes for heart rate ( $p=0.250$ ,  $p=0.181$ ,  $p=0.546$  respectively), oxygen saturation ( $p=0.334$ ,  $p=1.00$ ,  $p=0.173$  respectively), end-tidal  $pCO_2$  ( $p=0.135$ ,  $p=0.384$ ,  $p=0.187$  respectively), and diastolic blood pressure ( $p=0.485$ ,  $p=0.508$ ,  $p=0.915$  respectively). For respiratory rate, the difference between baseline rate and rate after spit sock application was not significant after 5 and 10 minutes ( $p=0.898$  and  $p=0.583$ , respectively), and significantly decreased at 15 minutes ( $p=0.048$ ). The systolic blood pressure was significantly lower after 5 and 10 minutes of spit sock application ( $p=0.028$  and  $p=0.045$ , respectively), but not significantly different at 15 minutes ( $p=0.146$ ). No subject pressed the buzzer to indicate distress and in no subject did the study have to be terminated due to pre-determined concerning vital signs or ventilatory parameters.

## **Discussion**

Spit socks are generally considered to be a safe method to provide protection to law enforcement and medical providers from spit and other bodily fluids from an agitated or altered individual. There are a wide variety of spit socks and there is no standardized material, design or vendor. Spit sock designs vary from full mesh to plastic or textile covering over the mouth area. The spit sock used in this study was full mesh, a more commonly used design carried on police patrol cars. There are no national guidelines or protocols for the application of spit socks to an individual, but usually local police guidelines permit application of the spit sock to an individual if the individual has spit (or otherwise purposefully projected bodily fluids) onto a person, or the

police officer believes the person will spit on a person<sup>10-13</sup>. Many, but not all local guidelines also state that the individuals should be closely monitored and not be left alone, and that the spit hood is to be removed if the individual has difficulty breathing or is vomiting<sup>10-12</sup>. Many of the anecdotal litigation cases involved situations in which the spit sock was applied, or not removed, when the person in custody was vomiting, and/or bleeding from the face or had expressed breathing difficulties, although there are some cases in which simple application of the spit sock alone is said to have caused breathing difficulties<sup>7,8</sup>. The suggested mechanism is a blocking off of some of the apertures in a spit sock by spit or other body fluids. It is suggested that the spit sock becomes saturated to the point of covering the holes of the spit sock so that the subject is not able to adequately ventilate or draw air through the spit sock. There are no formal published studies evaluating whether or not exposure of a spit sock alone or with spit or fluid of a similar viscosity can prevent a subject from breathing or successfully drawing a breath. This study served as a pilot study to evaluate whether a spit sock has an impact on ventilation in a comfortably resting, healthy, adult subject. The study demonstrated no changes in heart rate, oxygen saturation, end-tidal CO<sub>2</sub>, and diastolic blood pressure. After wearing the spit sock for 15 minutes, the respiratory rate was slightly decreased compared to baseline from about 16 breaths/minute to about 14 breaths/minute, which would not be considered a clinically significant change. The systolic blood pressure was decreased 5 and 10 minutes after spit sock application, and not significantly different from baseline at 15 minutes. This change would also not represent a clinically significant change. No subject in this study pressed the buzzer to indicate distress and the vital signs and ventilatory parameters did not reach a pre-determined concerning change that would have resulted in removal of the spit sock.

## **Limitations**

This study is a pilot study with a small sample size of 15 subjects, and as such, a large effect size is needed to recognize statistical significance. In addition, the subjects were young, healthy non-pregnant volunteers, whereas subjects in the field may have chronic conditions, claustrophobia, be pregnant or have illicit substance ingestion. Donning of the spit sock could potentially cause excessive disorientation and anxiety in certain individuals, especially if there is an underlying medical or mental health condition, or if the subject is a child<sup>14</sup>. Furthermore, the circumstances of the study do not replicate circumstances in which spit socks are usually used, which are situations of conflict with law enforcement or health care personnel, with the subject often already restrained, possibly injured, lying down, and with spit or other body fluids on the spit sock. There is also a wide variety of spit socks in use and there are no designated standards or requirements. Since there is no standard spit sock material or design, it possible for different spit socks to present varying degrees of aperture size and ventilation ability.

## **Conclusions**

In healthy subjects, there were no clinically significant changes in the physiologic parameters of breathing while wearing a spit sock. This study offers a foundation for further research into the use and safety of spit socks.

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