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The infection prevention and control practices of the ambulance service[1]

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Abstract

Objective: The aim of this research was to comprehensively evaluate the infection prevention and control practices of the ambulance service. Methods: This cross section survey was carried out in Izmir between June and September 2010. The study sample consisted of 213 ambulance service workers and all the emergency and rescue station buildings and ambulances. A questionnaire and two check-list forms were used as a means of data collection. Results: According to the employees' responses, an average of 25 (24.86±4.09) of 40 items of infection prevention and control criteria that are required to be met for the ambulance service were met, while 15 were not. In the observations, it was found that the infection prevention and control criteria for ambulances were met at an average of 32.96±5.22 out of 40. It was found that 33 out of 50 items of the criteria for infection prevention and control in ambulances were met while 17 were not. According to observations, an average of 6 (5.88±1.52) of 17 items of infection prevention and control criteria for emergency and rescue station buildings, were met while 11 were not. Conclusion: The questionnaire responses given by the ambulance personnel and observations made by the researchers in the ambulances and emergency and rescue station buildings suggest that the criteria set for infection prevention and control practices were not met at a satisfactory level, which meant the infection prevention and control practices were not sufficient. It is advised that an IPC guideline should be prepared to include standards and procedures to be followed by ambulance service personnel.

Keywords: Emergency medical service; ambulance; ambulance; infection prevention and control practices; decontamination.

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1. Introduction

Today, infection prevention and control (IPC) practices recognized as a quality standard in healthcare institutions are more hospital-based. On the other hand, IPC practices in pre-hospital emergency medical service (EMS) also known as the ambulance service (AS), which is one of the healthcare institutions, have been ignored (Alves and Bissell 2008; Noh et al. 2011a; Ro et al. 2012).

As in all health institutions, three components of the AS – the healthcare worker, the patient and the unit where the patient is transported – carry a risk of transmission of infectious agents. AS staff are a high risk group because of working condition such as the obligation to perform medical procedures while the ambulance is moving, lack of knowledge of the patient's disease history (Porter/patient HBV, HCV, HIV etc.), intervention in traumatic injuries, having to carry out a medical intervention in a confined space or a dark environment, and limited time for decontamination of the contaminated medical equipment and patient's cabin (Becker et al. 2003; Boal, Hales, and Ross 2005; Gershon et al. 1985; Hochreiter and Barton 1988; Merchant et al. 2009; Pepe et al. 1986; Reed et al. 1993; Valenzuela et al. 1985). Some researchers have pointed out that microorganisms in the patient's cabin and on the surfaces of the medical equipment could become a serious source of infection transmission (Andersen et al. 2006; Kanz 1981; Nigam and Cutter 2003a). In additionally, the presence of multiple drug resistant (MDR) pathogens including methicillin-resistant *Staphylococcus* spp., *Stenotrophomonas maltophilia*, *Pseudomonas* spp., *Klebsiella* spp. and *Acinetobacter* spp. have been detected by microbiological investigations in samples taken from the patient's cabin and medical equipment surfaces (Alves and Bissell 2008; Brown et al. 2010; Fischer et al. 2004; Galtelli, Deschamp, and Rogers 2006; Nigam and Cutter 2003b; Roline, Crumpecker, and Dunn 2006).

Effective IPC practices in the AS are extremely important for the prevention of microbial transmission to AS staff, patients who are undergoing intervention and the unit to which the patient is transferred (Alves and Bissell 2008; Becker et al. 2003; Boal, Hales, and Ross 2005; Brown et al. 2010; Fischer et al. 2004; Galtelli, Deschamp, and Rogers 2006; Kanz 1981; Merchant et al. 2009; Nigam and Cutter 2003b; Noh et al. 2011a; Roline, Crumpecker and Dunn 2006). In this context, the importance of IPC practices for pre-hospital EMS has been understood and IPC guidelines have been prepared in some countries. The factors to be investigated in this research are the absence of studies regarding IPC for the AS in this country, and suggestions by AS workers that studies should be conducted on the IPC in the AS. The current study aimed to investigate IPC practices in the AS in a comprehensive manner, and try to find answers for the following problem statements.

Are IPC practices in the AS adequate?

What factors in the IPC practices are effective?

2. Method and material

2.1. The place and time of the study: This descriptive, cross-sectional study was carried out in Izmir between June and September 2010 using data collected from the AS known as "112 EMS". Pre-hospital EMS provides a service depending on the Turkish Ministry of Health. There were a total of 56 emergency aid and rescue stations (EARS) including 24 A1, 28 A2, 2 B1, and 2 of type C in the study region. The number of EARS buildings where the ambulances are located was 52.

A Type EARS: The station of this type gives twenty-four hours of uninterrupted service a day

A1 Type EARS has a physician in the team,

A2 Type EARS does not have a physician in the team.

B Type EARS: Stations of this type provide uninterrupted service.

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If it is integrated with the hospital emergency service, it is called type B1 EARS

If it is integrated with the primary health organization, it is called type B2 EARS

C Type EARS: Stations of this type provide service according to needs at specified hours of the day.

2.2. Population and sample selection: The research population consisted of A1 type and A2 type EARS buildings (N = 52), ambulances (N = 52), and ambulance staff who had worked actively in A1 type, A2 type, B1 type and C type EARS, between June and September 2010 (n = 660). The study sample was made up of of all of the EARS buildings and ambulances, and 243 employees (physicians, paramedics, emergency medical technicians, midwives, nurses and health officers) who had worked in type A1 and A2 EARS. The number of employees in the sample in this study was calculated with the formula used in case of a known number of individual samples in the universe, but unknown standard deviation. B1 type and C type EARS buildings and employees were excluded from the sample.

2.3. Data collection: Research data was collected using a questionnaire form and two checklist forms, which were prepared on the basis of the literature (3, 19). A pilot implementation was conducted between 23.06.2010 and 30.06.2010 with C type EARS buildings, ambulances, and 24 employees to determine the intelligibility and compliance of the questionnaire and checklist forms. The questionnaire and checklist forms were revised in accordance with the pilot implementation.

The questionnaire form, named Infection Prevention and Control Practices in the Ambulance Service, is divided into two sections, Individual Identification and ICP Practices. The individual identification section included some questions which might affect IPC practices such as age, occupation, and duty time in the AS. The IPC practices section was formed from a total of 40 criteria under four subtitles including standards and procedures, decontamination practices, medical waste management and personal protective equipment (PPE). The specific criteria which must be met to IPC in the AS were determined for each subtitle, 1, 24, 3 and 12 criteria.

The checklist named Infection Prevention and Control Practices for the Ambulances was formed from a total of 50 criteria under five subtitles including ventilation system (two criteria), decontamination practices (32 criteria), medical waste management (nine criteria) and PPE and hand antisepsis (seven criteria).

The checklist named Infection Prevention and Control Practices for the Emergency Aid and Rescue Station Buildings was formed from a total of 17 criteria under three subtitles including features of the EARS buildings (five criteria), existence of guidelines to guide employees for IPC (seven criteria), and adequacy of the decontaminating supplies in the EARS buildings (five criteria).

The questionnaire form data was collected from AS workers by-face to-face interview. Ambulances and EARS buildings were observed and investigated by the researchers in accordance with the checklists.

2.4. Limitations of the study: The few studies of IPC for the AS in this country and around the world restricted discussion of research findings.

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2.5. Research ethics: Ethical Approval was obtained from the Scientific Ethics Committee of Ege University Faculty of Nursing and written permission was obtained from the Izmir Provincial Directorate of Health. Also, oral and written approvals were obtained from all of the study participants.

2.6. Evaluation of data: The data was analyzed using IBM SPSS Statistics version 16 (IBM, Somers, NY) with statistical significance established at $p \leq 0.05$. The frequency of the data in the questionnaire and checklists forms was calculated, and Chi-square tests were used for statistical comparison.

3. Results

3.1. Results Obtained from the Survey

The average age of the respondents was 31.36 ± 7.72 years. It was found that 25.1% of the AS workers were physicians, 18.5% were paramedics, 37.4% were emergency medical technicians (EMT), and 19% were nurses and midwives. The employees' average working time at the EMS was 5.27 ± 4.05 years.

3.1.1. Standards and Procedures

41.6% of AS workers stated that there were no IPC standards and procedures, and 95.9% of the AS workers stated that standards and procedures should be created for the IPC (Table 1).

Table 1. Standards and procedures for IPC[a] (n=243)

Standards and procedures		N	%
▪ Are there any standards and procedures in the AS[b] for IPC?	Yes	142	58.4
	No	101	41.6
▪ Do you believe that you are sufficiently informed about IPC standards and procedures?	Yes	85	35.0
	No	158	65.0
▪ Should IPC standards and procedures be created in the AS?	Yes	233	95.9
	No	10	4.1

[a] Infection Prevention and Control; [b] Ambulance Service

3.1.2. Decontamination Practices

47.7% of AS workers stated that the patient's cabin was unsuitable for decontamination, and 48.1% stated that the cleaning materials used in the process of decontamination were inadequate. In addition, 69.1% of AS workers did not make area separation among cleaning materials. 83.2% of the employees (N=92) who did not clean the patient's cabin at regular intervals cleaned it in case of contamination with blood and body fluids, while 10.5% did not clean the patient's cabin because of intensive workload. 39.1% of the employees indicated that medical equipment used in the patients was not decontaminated for the next patient and 7% reported that disposable medical equipment including nasal cannulas and oxygen connection tubes were not replaced from one patient to another on grounds of insufficient stock. 13.6% of the employees stated that disinfectant in the AS was insufficient to meet needs (Table 2). 63.1% of the employees reported that there was only medium to low level disinfectant. The proportions of employees reporting that there was only high or middle and, low level disinfectant in the EARS building were 18.9% and 3.1% respectively. In additionally, 6.3% of the employees stated that there was no disinfectant other than sodium hypochlorite in their EARS building (data not shown).

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Furthermore, according to employees' responses, there was no standardization in the use of disinfectant for critical, semi-critical and non-critical medical equipment decontamination. 41.6% of employees used high level disinfection for laryngoscope blade decontamination, while 56.4% used medium to low level disinfection. 47.3% of the employees did not use any procedure for ventilator connector tube decontamination. 58.4% of the employees used medium to low level disinfection for balloon valve mask decontamination and 60.5% used medium to low level disinfection for suction device decontamination. 63% of the employees did not perform cervical collar cleaning (Table 3).

Table 3. Decontamination methods used for cleaning medical equipment and the patient's cabin (n=243)

What is the cleaning procedure for medical equipment and the patient's cabin when they are contaminated with patients' blood and body fluids?										
	Procedure									
	No Decontamination		Cleaning (Water & Detergent)		Disinfection Medium to Low Level		Disinfection High Level		Sterilization	
Cabin & equipment	**N**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Laryngoscope [1]	-	-	5	2.1	137	56.4	101	41.6	-	-
VCT (n=228) [2]	115	47.3	-	-	-	-	-	-	113	46.5
Resuscitator [3]	-	-	5	2.1	142	58.4	96	39.5	-	-
Aspirator	-	-	12	4.9	147	60.5	84	34.6	-	-
Patient Stretcher	-	-	23	9.5	172	70.8	48	19.8	-	-
Back Board	-	-	33	13.6	167	68.7	43	17.7	-	-
Cervical Collar Set	153	63.0	31	12.8	-	-	59	24.3	-	-
POP [4]	1	0.4	34	14.0	167	68.7	41	16.9	-	-
Wires and Tips [5]	1	0.4	36	14.8	166	68.3	40	16.5	-	-
Stethoscope	1	0.4	27	11.1	174	71.6	41	16.9	-	-
Vehicle floor	-	-	20	8.2	155	63.8	68	28.0	-	-
Cuff [6]	6	2.5	43	17.7	152	62.6	42	17.3	-	-

[1] Laryngoscope Blades [2] Ventilator Connection Tube [3] Balloon Valve Mask [4] Pulse-oximeter probe [5] Defibrillator, Electrode Wires and Tips [6]Blood Pressure

3.1.3. Medical Waste Management

The rates of employees who indicated that infectious waste bags and puncture resistant containers were sufficient to meet the needs were 97.1% and 98.4%, respectively. 4.5% of the employees reported that they did not use puncture resistant containers for contaminated needles and sharp objects (Table 4).

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Table 2. Decontamination practices in the ambulance service (n=243)

			n	%
DECONTAMINATION PRACTICES	Is the patient's cabin surface appropriate for cleaning ?	Yes	127	52.3
		No	116	47.7
	Who is patient's cabin cleaning done by?	Health personnel [a]	145	59.7
		Shift team	98	40.3
	Are the cleaning materials (disposable cleaning swabs, mats, brushes, etc.) sufficient to meet needs?	Yes	126	51.9
		No	117	48.1
	Are the cleaning materials which are used for the ambulance used for cleaning other areas?	Yes	49	20.2
		No	194	79.8
	Is there any procedure for "area distinction" in the ambulance and EARS [b] building cleaning?	Yes	75	30.9
		No	168	69.1
	Is the driver's cabin cleaned at regular intervals?	Yes	104	42.8
		No	139	57.2
	Is general cleaning of the patient's cabin performed at regular intervals?	Yes	151	62.1
		No	92	37.9
	Is the medical equipment that is used for the patient cleaned for the next utilization?	Yes	148	60.9
		No	95	39.1
	How is medical equipment that is contaminated with a patient's blood and body fluids cleaned?	With detergent and water	4	1.6
		with disinfectant	76	31.3
		With detergent and disinfectant	163	67.1
	Is disinfectant sufficient to meet needs?	Yes	210	86.4
		No	33	13.6
	If diluted disinfectant is used, are the usage times and dilution rates taken into account? (n=153).	Yes	116	75.8
		No	37	24.2
	Is the antiseptic solution for hand hygiene sufficient to meet needs?	Yes	213	87.7
		No	30	12.3
	Is disposable medical equipment changed from patient to patient?	Yes	226	93.0
		No	17	7.0

[a] Non-physician
[b] Emergency Aid and Rescue Station

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Table 4. Medical waste management in the ambulance service (n=243)

Medical waste management practices		n	%
▪ Are the infectious waste bags sufficient to meet needs?	Yes	236	97.1
	No	7	2.9
▪ Are the puncture resistant containers sufficient to meet needs?	Yes	239	98.4
	No	4	1.6
▪ Are puncture resistant containers used for contaminated needles and sharp objects?	Yes	232	95.5
	No	11	4.5

3.1.4. Personal Protective Equipment

The rate of using gloves and masks in case of need was over 98%, but on the other hand, the utilization rates of respirator type masks, face shields and waterproof aprons were 27.2%, 7.4% and, 5.8% (Table 5).

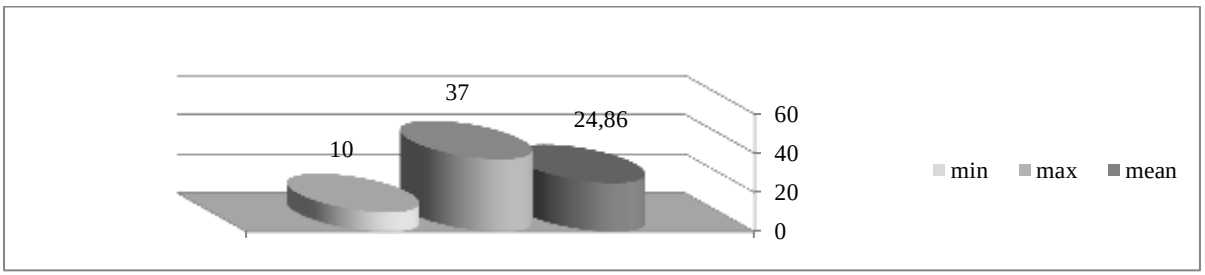
Table 5. Use of PPE[a] in the ambulance service (n=243)

			Is PPE sufficient to meet needs?		Is PPE used in case of need?	
			n	%	n	%
Type of PPE	Gloves	Yes	241	99.2	242	99.6
		No	2	0.8	1	0.4
	Mask	Yes	239	98.4	219	90.1
		No	4	1.6	24	9.9
	Respirator Mask (i.e. N95)	Yes	66	27.2	41	16.9
		No	177	72.8	202	83.1
	Goggles	Yes	192	79.0	98	40.3
		No	51	21.0	145	59.7
	Face Shield	Yes	32	13.2	18	7.4
		No	211	86.8	225	92.6
	Waterproof Apron	Yes	25	10.3	14	5.8
		No	218	89.7	229	94.2

[a] Personal Protective Equipment

3.1.5. IPC Practices in the AS According to Employees' Responses

The rate of meeting all IPC criteria (40 criteria) for IPC in the AS was 0%. Considering general distribution, at most 37 IPC criteria were met, and the ratio was very low (0.8%). In other words, the average of all the IPC criteria met in the AS was 24.86±4.09 (Graph 1).



Graph 1. The average of infection prevention and control criteria that is required to be met for the ambulance service (n=243)

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3.2. Results Obtained from Checklist I (Ambulances)

3.2.1. Ventilation System

It was observed that the patient's cabin ventilation system in 67.3% of the ambulances was unsuitable, and the filter for ensuring cabin air filtration in 76.9% was not integrated into the ventilation system (data not shown).

3.2.2. Decontamination Practices

The patient's cabin furniture in 59.6% of the ambulances any or all including floor, shelves, cabinet, patient stretcher and back board were unsuitable for cleaning. According to observations that were carried out at appropriate times, the patient's cabin in 32.7% of ambulances was dirty with patients' blood/body fluids (Table 6).

Table 6. Decontamination of the patient's cabin furniture. (n=52)

	Furniture		**n**	**%**
Is the patient's cabin furniture suitable for decontamination?	Floor	Yes	41	78.8
		No	11	21.2
	Seats	Yes	44	84.6
		No	8	15.4
	Shelves and cabinet	Yes	45	86.5
		No	7	13.5
	Patient stretcher	Yes	36	69.2
		No	16	30.8
	Back board	Yes	46	88.5
		No	6	11.5
	Total	Yes	21	40.4
		No	31	59.6
Is there visible contamination on the patient's cabin furniture surfaces?	Contamination without patient's blood/body fluid	Yes	15	28.8
		No	37	71.2
	Contamination with patient's blood/body fluid	Yes	17	32.7
		No	35	67.3
	Total	Yes	22	42.3
		No	30	57.7

It was observed that some non-disposable supplies including cervical collar (40.4%), portable aspirator (43.1%), laryngoscope (21.2%), pulse-oximeter probe (15.4%), portable blood pressure cuff (15.4%) and balloon valve mask (48.1%) were polluted with patient's blood or body fluid. The humidifier liquid in 44.2% of ambulances had not been changed for a long time, even though turbidity and a sedimentary formation were observed in some humidifier liquid. It was determined that the oxygen nasal cannulas were not changed from patient to patient in 36.5% of the ambulances (Table 7).

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Table7. Decontamination of medical equipment in the ambulances (n=52)

		Yes		No	
	Medical equipment	**n**	**%**	**n**	**%**
Is there visible contamination with patient's blood and body fluids on medical equipment surfaces?	Main Stretcher	5	9.6	47	90.4
	Cervical Collar	21	40.4	31	69.6
	Back Board	5	9.6	47	90.4
	Portable aspirator (n=51)	22	43.1	29	56.9
	Immobile Aspirator	21	40.4	31	59.6
	Oxygen Moisturizer (Humidifier) [a]	23	44.2	29	55.8
	Nasal Cannula [a]	19	36.5	33	63.5
	Laryngoscope Set	11	21.2	41	78.8
	Defibrillator probes and electrodes	11	21.2	41	78.8
	Pulse-oximeter probe	8	15.4	44	84.6
	Ventilator Connection Tube (n=36) [a]	35	97.2	1	2.8
	Ventilator (Disposable) (n=36) [a]	7	19.4	29	80.5
	Immobile Blood Pressure Monitor (n=45)	4	8.9	41	91.1
	Mobile Blood Pressure Monitor	8	15.4	44	84.6
	Resuscitator (Balloon Valve Mask)	25	48.1	27	51.9
	Basic Medical Supplies Bag	3	5.8	49	94.2

[a] Contamination without patient's blood/body fluid

It was observed that in 3.8% of the ambulances disposable oxygen connection tubes were insufficient to meet needs. The aspirator connection tubes in 65.4% of the ambulances were not replaced. The sterile gauze and gas buffer in 26.9% of the ambulances were insufficient to meet needs (Table 8).

Table 8. Adequacy of the disposable medical equipment in the ambulance vehicles (n=52)

	Disposable medical equipment		n	%
Is the medical equipment sufficient to meet needs?	Nasal oxygen cannula	Yes	50	96.2
		No	2	3.8
	Suction connection tube	Yes	18	34.6
		[a]No	34	65.4
	Airway	Yes	52	100
		No	-	-
	Sterile gauze, gauze pad	Yes	38	73.1
		No	14	26.9
	Vomit bag	Yes	44	84.6
		No	8	15.4
	Stretcher cover	Yes	44	84.6
		No	8	15.4

[a] No replacement

There was no hand antiseptic in 25% of ambulances and no disinfectant in 23.1%. (data not shown).

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3.2.3. Medical Waste Management

It was observed that in 19.2% of the ambulances there were loose needles and sharp objects in the patient's cabin and that there were no infectious waste bags in the medical waste containers in 30.8% of ambulances. The medical waste containers in 50% of the ambulances were not immobilized and the rate of loose puncture resistant containers was 64.7% (Table 9).

Table 9. The practice of medical waste management in the ambulances (n=52)

Medical waste management practices		**n**	**%**
▪ Are there any loose contaminated needles and sharp objects in the patient's cabin?	Yes	10	19.2
	No	42	80.8
▪ Is there a medical waste container for infectious waste?	Yes	52	100
	No	-	-
▪ Is there an infectious waste bag in the medical waste container?	Yes	36	69.2
	No	16	30.8
▪ Is the medical waste container fixed to any part of the patient's cabin?	Yes	26	50.0
	No	26	50.0
▪ Does the medical waste container contain appropriate items?	Yes	34	65.4
	No	18	34.6
▪ Is there any contamination with or without patient's blood and body fluids on the medical waste container surface?	Yes	3	5.8
	No	49	94.2
▪ Is there a puncture resistant container for contaminated needles and sharp objects?	Yes	51	98.1
	No	1	1.9
▪ Does the puncture resistant container contain appropriate items? (n=51)	Yes	40	78.4
	No	11	21.6
▪ Is the puncture resistant container fixed to any part of the patient's cabin? (n=51)	Yes	18	35.3
	No	33	64.7

3.2.3. Personal Protective Equipment

In the majority of ambulances (98.1%) it was observed that gloves and masks were adequate. The respirator masks (HEPA/High Efficiency Particular Air) in 21.2% of ambulances were not sufficient to meet needs (Table 10).

Table 10. The Adequacy of PPE[a] in the Ambulances (n=52)

	Type of PPE		n	%
Is the PPE sufficient to meet needs?	Gloves	Yes	51	98.1
		No	1	1.9
	Mask	Yes	51	98.1
		No	1	1.9
	Respirator mask	Yes	11	21.2
		No	41	78.8
	Goggles[b]	Yes	32	61.5
		No	20	38.5
	Waterproof Apron[b]	Yes	2	3.8
		No	50	96.2
	Face Shield[b]	Yes	1	1.9
		No	51	98.1

[a] Personal Protective Equipment [b] Present, but inadequate in number

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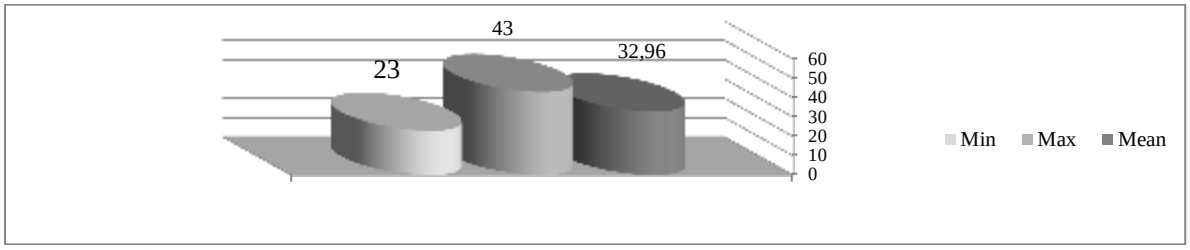
3.2.4. IPC Practices in the Ambulances

It was observed that none of ambulances met all of the IPC 50 criteria and at most 43 IPC criteria were met. The rate of ambulances meeting these 43 IPC criteria was very low (0.8%). The average number of IPC criteria that were met in the ambulances was 32.96±5.22. (Graph 2).

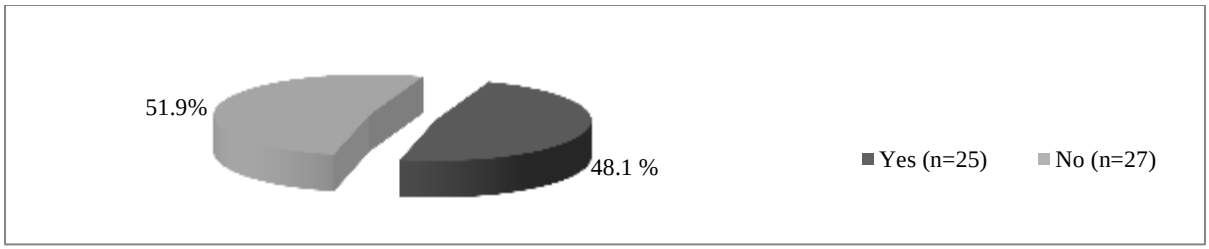


Graph 2. The average of infection prevention and control criteria that is required to be met for ambulances (n=52)

3.3. Results Obtained From Checklist Ii (Emergency Aid and Rescue Station)

3.3.1. Features of the EARS Buildings

51.9% of the EARS buildings did not meet the criteria required for IPC (Graph 3). 36.5% of the EARS buildings did not have an appropriate ventilation system. 53.8 % of the EARS buildings did not have a separate area for the storage of medical equipment and supplies. In addition, 80.8% of the EARS buildings did not have an appropriate area for the decontamination of contaminated medical equipment and %34.6 did not have an appropriate area for ambulance decontamination (data not shown).



Graph 3. Compliance of the emergency aid and rescue station buildings with infection prevention and control (n=52)

[a] Compliance Criteria:

- A sufficient number and size of rooms for the team
- Appropriate areas such as bathrooms and wash basins for personal hygiene
- An appropriate ventilation and building moisture control system
- Separate areas for storing medical supplies and decontaminating equipment
- A separate area for medical equipment decontamination
- An appropriate area for ambulance decontamination.

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3.3.2. The existence of guidelines to guide employees about IPC

It was observed that none of EARS buildings had guidelines which included all IPC procedures. Similarly, there was no recording form for use in reporting employees' occupational exposure in the EARS buildings (Table 11).

Table 11. The availability of IPC [a] guidelines in the EARS [b] buildings to guide employees (n=52)

Criteria		n	%
Are there any guidelines which include all IPC procedures?	Yes	-	-
	No	52	100
Is there any guideline for patient's cabin decontamination?	Yes	-	-
	No	52	100
Is there any guideline for medical equipment decontamination?	Yes	9	17.3
	No	43	82.1
Is there a recording system for use in recording the decontamination process for ambulances?	Yes	1	1.9
	No	51	98.1
Is there a recording system for use in recording the decontamination process for EARS buildings?	Yes	4	7.7
	No	48	92.3
Are there any guidelines which include procedures to guide employees in case of exposure?	Yes	-	-
	No	52	100
Is there an occupational exposure recording form?	Yes	-	-
	No	52	100

[a] Infection Prevention and Control; [b] Ambulance Service

3.3.3. Adequacy of Decontaminating Supplies in the EARS Buildings

The proportions of EARS buildings where there was no high-level disinfectant, medium to low level disinfectant, or antiseptic solution for hand hygiene were 53.8%, 7.7%, and 15.4 % respectively (Table 12).

Table 12. Adequacy of decontaminating supplies in EARS [a] buildings (n=52)

	Decontaminating supplies		n	%
Are the decontaminating supplies sufficient to meet needs?	Detergents for surface cleaning	Yes	44	84.6
		No	8	15.4
	Medium to low level disinfectant	Yes	48	92.3
		No	4	7.7
	High level disinfectant	Yes	24	46.2
		No	28	53.8
	Hand antiseptic	Yes	44	84.6
		No	8	15.4
	Liquid / soap for hand hygiene	Yes	41	78.8
		No	11	21.2

[a] Emergency Aid and Rescue Station

3.3.4. IPC Practices in the ERAS Buildings

It was observed that none of the EARS buildings met all of the 17 IPC criteria and at the most nine IPC criteria were met. The rate of EARS buildings where these 17 IPC criteria were met was very low: 43 (5.8%). The average number of IPC criteria that were met in the EARS buildings was 5.88±1.52 (Graph 4).

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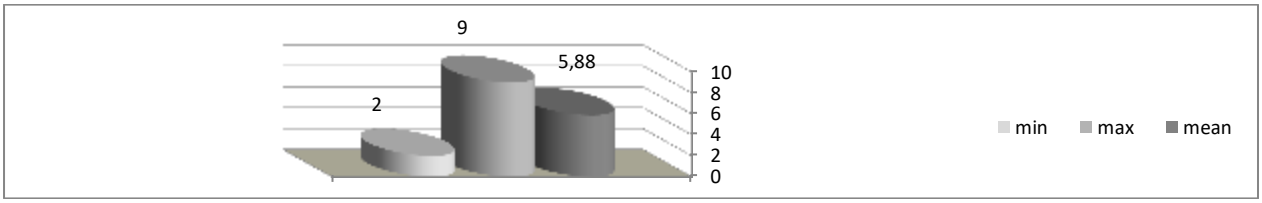

Graph 4. The average of infection prevention and control criteria that is required to be met for emergency aid and rescue station buildings (n=52)

4. Discussion

4.1. Standards and Procedures

More than half of the employees (58.4%) indicated that there were standards and procedures for IPC in the AS. 65% of the employees were not sufficiently informed about IPC standards and procedures and 95.9% of the employees stated that it was necessary to create IPC standards and procedures. Additionally, it was observed that there were no guidelines in the EARS buildings. Also, 46.5% of the 142 employees who said there were guidelines about IPC standards and procedures were not sufficiently informed about these standards and procedures (X^2=51.643, p=0.000) and 97.2% of them emphasized that IPC standards and procedures should be developed (X^2=1.459, p=0.327). Additionally, 94.1% of the employees who were sufficiently informed about IPC standards and procedures stated that these standards and procedures should be developed (X^2=1.035, p=0.326). There are two conflicting findings (58.4% of the employees stated that there was a guideline about IPC standards and procedures in their EARS buildings when in fact there were no guidelines). The reason for this paradox may include confusion with another guideline used for the decontamination of medical equipment, limited information about IPC standards and procedures, lack of work experience.

There is no guideline for IPC in the AS in Turkey. On the other hand, in some other countries the importance of the IPC practice of pre-hospital EMS is understood and EPC guidelines have been prepared to guide AS staff (Ro et al. 2012).

4.2. Decontamination Practices

It was observed that the patient's cabin filtration system in most ambulances (67.3%) was not appropriate. Ambulances could be a potential source of various microbial infections such as *Mycobacterium tuberculosis* and *Neisseria meningitidis*, or varicella-zoster virus and coronavirus which cause Severe Acute Respiratory Syndrome. Ro et al. found that the prevalence of tuberculosis in patients using the emergency and rescue service was between 0.3% and 0.7%. The presence of an appropriate ventilation system in the patient's cabin, which is a closed and confined area, and the integration of a HEPA filter in the ventilation system are very important for personal health as well as for patient health (Ro et al. 2012).

Nearly half of the employees (47.7%) reported that the patient's cabin interior surfaces did not have appropriate qualities for cleaning. It was observed that 59.6% of the ambulances did not meet decontamination criteria and there were problems that could affect decontamination of the patient's cabin including swelling of the cabin floor (21.2%), damp shelves (13.5), the presence of tears and holes on the seat (15.4%) and stretcher (30.8%), and missing waterproofing/plastic on the back board (11.5%).

48.1% of the employees stated that there were not enough cleaning materials to meet needs and 69.1% of the employees stated that no procedure for area separation in the cleaning materials was used. 75.5% of the AS workers who used different cleaning materials in each area (n=194) did not use any procedure for "area separation" (X^2=0.825, p=0.364). The patient's cabin and the EARS building are different in terms of microbial contamination and the microbial load in the ambulances vehicle was found to be more than in the EARS building. Therefore, the patient's cabin

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should be considered as a high-risk area, and the EARS building as a low risk area, area separation in the cleaning materials should be applied in both areas, and the standards and/or procedures should be improved.

Visible pollution and/or contamination with patient's blood or body fluid were determined on the floor, side walls and ceiling of 22 ambulances (42.3%). Likewise, 37.9% of the employees reported that they did not carry out periodic cleaning of the patient's cabin at regular intervals. The following factors may affect why this was not done.

The absence of a suitable area for decontamination: 42 EARS buildings (80.8%) did not have a suitable area for medical equipment decontamination and 18 EARS buildings (34.6%) did not have a suitable area for general cleaning of the patient's cabin.

Lack of cleaning materials: 44.6% of employees who stated that the cleaning materials in the EARS buildings were not enough (48.1%) did not carry out periodic cleaning of the patient's cabin (X^2=0.761, p=0.383).

Lack of decontamination material (surface cleaning detergent, disinfectant, etc.): 8 EARS buildings (80.8%) did not have surface cleaning detergent (15.4%), 4 EARS buildings did not have medium-low level disinfectant (7.7%) and 29 EARS buildings did not have high level disinfectant (53.8%). On the other hand, 90.1% of the employees who stated that disinfectant was enough to meet needs (n=210) carried out periodic cleaning of the patient's cabin (X^2=3.735, p=0.053). This result supports the idea that that lack of decontamination material may have an effect on the periodic cleaning of the patient's cabin.

83.2% of the employees who stated that medical equipment used with the patients was not cleaned before later use (n=95) cleaned the medical equipment only when it was contaminated with patients' blood or body fluids; others said there was not enough time for cleaning due to intensity of workload. Although 60.9% of the employees reported that the decontamination process was carried out after each case, in the majority of cases, it was observed that medical equipment that was used frequently in the AS had visible pollution including patients' blood or body fluids. In addition, 7% of the employees stated that medical equipment was not changed from patient to patient. It was observed that in 19 of 52 ambulances the nasal oxygen cannula was not replaced, and in 7 of 36 ambulances it was determined that the disposable ventilator was not replaced. The nasal oxygen cannulas (3.8%) and the aspirator connection tubes (65.4%) were not enough to meet needs and it is thought that this affected the amount of disposable medical equipment which was replaced from patient to patient.

More than half of the employees did not use the appropriate method* for medical equipment decontamination (*High-level disinfection for critical and semi-critical medical equipment; medium to low level disinfection for non-critical medical equipment (Noh et al. 2011b). In other words,

41.6% of the employees used high level disinfection for laryngoscope blade decontamination, while 56.4% used medium to low level disinfection.

47.3% of the employees did not use any procedure for ventilator connector tube decontamination [b].

58.4% of the employees used medium to low level disinfection for balloon valve mask decontamination and 60.5% used medium to low level disinfection for suction device decontamination [a].

63% of the employees did not carry out cervical collar cleaning [b].

It is thought that the following reasons may affect faulty decontamination procedures: absence of a standard for decontamination, absence or insufficiency of high level and medium to low level disinfectant, lack of an appropriate area for medical equipment decontamination, lack of information about decontamination practices, lack of the necessary sensitivity by AS staff, lack of periodic decontamination controls by the authorities.

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Some researchers have pointed out that microorganisms on the patient's cabin and medical equipment surfaces could become a serious source of infection transmission (Andersen et al. 2006; Kanz 1981; Nigam and Cutter 2003a). One study indicated that 13 out of 105 swab samples (12.4%) which were taken from different area of the ambulances were positive for MRSA (Kanz 1981). Similarly, it was shown by Alves et al. (2008) that MDR bacteria including *Stenotrophomonas maltophilia*, *Pseudomonas* spp., *Klebsiella* spp. and other rod strains were present in the ambulance (Alves and Bissell 2008). Nigam & Cutter (2003a) detected that the ambulances had considerable pollution before cleaning (60.97%), and that following decontamination, the microbial load in the ambulances were decreased serious levels (35.37%) (Nigam and Cutter 2003a). In another study bacterial contamination of ambulances was detected and MDR bacteria including MRSA, MRCoNS (Methicillin-Resistant Coagulase Negative *Staphylococcus*) and *Klebsiella pneumoniae* were isolated in the ambulances on critical medical equipment such as ventilator connection tubes and on semi-critical medical equipment such as laryngoscopes, airway tubes, suction water, oxygen masks, balloon valve masks (Noh et al. 2011a). Additionally, in a study investigating microbial colonization of patients who were transported to hospital by air ambulance, MRSA, *Klebsiella pneumoniae* and *Acinetobacter baumannii* which were highly antibiotic resistant were detected in 5 of 483 swab samples (Valenzuela et al. 1985). MRSA positivity was detected in 49% of the swab samples which were taken from different parts of the ambulance (Hochreiter and Barton 1988).

4.3. Medical Waste Management

Although 97.1% of employees stated that there were infectious waste bags in ambulances, it was found that the medical waste containers in 30.8% of ambulances did not have infectious waste bags. Also, the waste containers in 34.6% of ambulances did not have proper fullness and 50 % of them were not secured in place. Although 98.4% of the employees reported that there were puncture resistant containers in the ambulance, it was observed that one ambulance did not have a puncture resistant container. 4.5% of the employees stated that they did not use puncture resistant containers in case of need and loose infectious waste including contaminated needles and sharp objects were observed around the patient's cabin in 19.2% of cases by the researchers.

In one study it was reported that 31% of 110 contaminated needle injuries were caused by inappropriate disposal of needles (Boal, Hales, and Ross 2005). Hochreiter and Barton (1998) determined that 44 contaminated needle injuries were experienced during the 38-month study period and two workers were infected with hepatitis B (Hochreiter and Barton 1988). Reed et al. found that 5.5% of the exposures occurring in the AS were caused by contaminated needles (Reed et al. 1993). Merchant et al. (2009) reported that most percutaneous injuries occurred during injection or because of inappropriate disposal of needles, and 36% of the injuries had occurred while the ambulance was moving (Merchant et al. 2009).

4.4. Infection Prevention and Control For AS Staff

In the current study an evaluation was made of whether EARS buildings had appropriate properties for AS staff deployment including appropriate areas for medical equipment storage and medical equipment and ambulance decontamination, a sufficient number and size of rooms and bathrooms, or a washbasin for personal hygiene. Unfortunately, half of the EARS buildings did not meet these criteria.

In the majority of ambulances (98.1%) it was observed that there were enough gloves and masks to meet needs. Similarly, most employees (98%) reported that the gloves and masks in the ambulances were sufficient. On the other hand, the majority of workers (72.8%) stated that the respirator type masks in the ambulances were inadequate. It was observed that the respirator type masks in 78.8% ambulance were inadequate. Also, the proportions of AS workers who said that glasses, face shields and waterproof aprons were inadequate in the ambulance were 21%, 86.8% and 89.7% respectively. Also, 15.4% of the employees stated that there was no antiseptic solution

for hand hygiene in the ambulance and it was observed that 25% of ambulances did not have antiseptic solution.

More than 90% of employees stated that they used gloves and masks in case of need. On the other hand, the proportion of workers who did not use respirator type masks was 83.1%. 85.6% of the workers who stated that respirator type masks were inadequate in the ambulance did not use respirator type masks when they were needed (X^2=99.212, p=0.000). A large majority of workers reported that they did not use face shields and waterproof aprons when they were needed.

There are a limited number of studies related to the importance of using the PPE in the AS. Merchant et al. (2009) found that the proportions of AS workers who had received medical treatment due to percutaneous injury and exposure to blood or body fluids were 34.5% and 10.5% respectively (Merchant et al. 2009). In another study, 338 AS workers were examined for HBV markers, and 13% of them had HBV, and a strong relationship was determined between the HBV infection and the years of exposure (Pepe et al. 1986). Boal et al. (2005) calculated the anti-HCV prevalence of AS workers as 0.9-2.8% (Boal, Hales, and Ross 2005). In a study conducted with paramedics, it was detected that 13 of 36 hepatitis B cases occurred because of occupational exposure (Valenzuela et al. 1985).

5. Conclusions and recommendations

The questionnaire responses given by AS staff and the observations made in the ambulances and ERSB buildings by researchers suggest that the criteria which were determined for IPC practices in the AS were not met at a satisfactory level, and this meant the IPC practices were not sufficient. It is advised that an IPC guideline which includes standards and procedures to be followed by AS personnel should be prepared.

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