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KNOWLEDGE AND EVALUATION OF CONTROL OF EXPOSURE TO SURGICAL PLUME: THE SOUTH/SOUTH NIGERIAN EXPERIENCE

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1. Introduction

Electro-surgery technology involves the use of high frequency electrical current to denature tissue protein molecules, resulting in coagulation and closing of the affected blood vessels. This as well as laser surgeries and ultrasonic devices generate smoke/plumes [4,6]. The plumes are made up of 95% water and 5% debris, these debris are chemicals, blood, tissue particles, viruses and bacteria [8].

The particulates measure approximately 0.07-6.5 micron [5]. Studies have shown that these particulates are quite capable of being deposited in the walls of any part of the respiratory system while smaller ones about 2 microns can even go as deep as the bronchioles and alveoli [7]. It is an established fact 77% of particles found in plumes are less than 1.1 micrometer with mean diameter being 0.07 and a mean diameter of 0.22 to 0.056 micrometer in the inspiration range [8]. This means that plumes can easily penetrate the pores of surgical masks making it a poor protective gadget against the exposure as a result, operating theatre personnel using only face masks do not stand a chance against surgical plume exposure hazards.

Furthermore, International Agency for Research on Cancer [10], listed some of the constituents as being carcinogenic and mutagenic.Little wonder most developed countries have put measures in place to curb unnecessary exposure of their operating room staff to surgical fumes. Many have enacted laws, regulations and policies to check exposures to these toxic plumes. Some others places standards and guidelines to be followed during smoke generating procedures while some other use technological control measures to protect their operating theatre personnel [11,5,12].

Despite overwhelming evidence that exposure to surgical smoke is harmful to humans, many developing nations in Africa are yet to have any meaningful policy or even worthwhile measures towards elimination of surgical plumes from their operating rooms.This study is therefore aimed at evaluating measures put in place by various operating theatre personnel and management in curbing continuous exposure to surgical plumes in South-South Nigeria.

The objective of this study is to assess measures used in curbing exposure to surgical plumes in Nigeria

Specifically, the study aims to assess knowledge level of preventive measures and availability of surgical smoke elimination measures in operating theatres in South-South Nigeria.

2. Materials and Methods

2.1 Participation and setting

The study is aimed at assessing the knowledge level of preventive measures and availability of preventive measures used in curbing exposure to surgical plumes in Nigeria.The study was conducted among various professionals in the operating theatres located in South-South Nigeria.These professionals were Surgeons, Anaesthesiologists, Perioperative Nurses, Nurse Anaesthesists and operating theatre technicians.The target population of this study was 520 professionals in South South Nigeria, of these Krejie Morgan's sample size formula was used to determine the sample size of 225.

2.2 Inclusion criteria

Those who will volunteer to participate in the online survey as well as those willing to fill the questionnaire forms hard copies.

2.3 Exclusion criteria

Those who refused to participate and those on leave during period of the study.

2.4 Data collection and data analysis

Data was collected by using modified Surgical Smoke Safety Questionnaire (SSSQ). Responses which were from online survey and written questionnaires were stored in a safe data pack and coded.

The questions were arranged three major sections. Section A comprised of 8 items namely age, gender, marital status, educational level, place of work, level of healthcare facility, profession and years of experience. Section B comprised of 8 items testing knowledge level of preventive practices. Section C comprised of 12 items on the availability of preventive measures.

Data collected was analysed by using SPSS package programming. Analysis included numbers, percentages, means and logistic regression analysis, all presented in tables.

Ethical consideration

Institutional Ethical committee approval was obtained from one of the three tertiary health institutions to avoid duplication of efforts. Participants' consent was sought and confidentiality assured. Only those in the inclusion criteria were allowed to participate in the survey.

Basic Characteristics of Respondents

As presented in table 1, the operating theatre personnel in this study comprised of more males (59.1%) than females (40.9%). Majority of these workers have at least a university degree (88.5%), government hospital was more reflected (74.7%) than the private (24.9%) counterparts. More of these workers are surgeons (35.6%) and anesthesiologists (27.1%).

Table 1 Basic Characteristics of operating theatre personnel

Basic Characteristics	Frequency	Percent
Sex		
Male	133	59.1
Female	92	40.9
Marital Status		
Single	13	5.8
Married	202	89.8
Widowed	10	4.4
Highest level of Education		
OND	16	7.1
HND	10	4.4
BNSc	47	20.9
MSc	87	38.7
PhD	65	28.9
Place of Work		
Private Hospital	57	25.3
Government Hospital	168	74.7
Level of Health Care Facility		
Secondary	8	3.6
Tertiary	217	96.4
Profession		
Surgeon	80	35.6
Anesthesiologist	61	27.1
Nurse Anesthetist	8	3.6
Perioperative Nurse	54	24
Anesthetist Technician	22	9.8

Knowledge of Preventive Measures among Operating Theater Personnel

Table two shows that most of the personnel have poor knowledge of preventive measures of surgical smoke in the operating theater (64.4%) while about a quarter (35.6%) has good preventive knowledge.

Table 2 Knowledge of Preventive Measures Among Operating Theater Personnel

Knowledge of Control Measures	**No**	**Yes**
Currently, air conditioning systems are assured to protect OR staff from hazards of exposure to SS?	171 (76)	54 (24)
Currently, surgical face mask/laser mask are assured to protect OR staff from hazards of SS?	163 (72.4)	62 (27.6)
Emerging technologies like use of local exhaust ventilation (LEV) system can be used to eliminate SS?	35 (15.6)	190 (84.4)
Emerging technology like unidirectional air flow can be used to eliminate SS?	171 (76)	54 (24)
Personal protective equipment (PPE) like theatre attires including face shield can protect OR staff from SS impacts?	179 (79.6)	46 (20.4)
PPE like N95/N100 respirators and eye goggle can protect OR staff from SS impacts?	53 (23.6)	172 (76.4)
Training and educating OR staff is one of National Institute of Occupational Safety and Health (NIOSH) recommendation for OR staff protection?	35 (15.6)	190 (84.4)
Use of modular theatre is one of NIOSH's recommendations for protecting OR staff from SS impacts?	60 (26.7)	165 (73.3)

Poor knowledge 145(64.4%), Good Knowledge 80(35.6%)

Availability of technological control measures

Technological control measures were specifically measured using six items. Result shows the level of adoption of technological control measures was generally low, with less than 15% categorized as good while over 80% are categorized as having poor technology adoption.The measure of technological control measures as practiced by the OR staffs are listed in table 3.

Table 3 Availability of technological control measures

Technological Control Measures	No	Yes
Use of unidirectional airflow ventilation system?	76 (33.8)	149 (66.2)
Use of Suction system?	159 (70.7)	66 (29.3)
Use of LEV system?	168 (74.7)	57 (25.3)
Use of Smoke Evacuator?	163 (72.4)	62 (27.6)
Use of Modular Operating Theatre?	167 (74.2)	58 (25.8)
Use of Air conditioning system?	36 (16)	189 (84)

Very Good 27(12%), Good 4(1.8%), Fair 112(49.8%), Poor 82(36.4%)

Organizational Control Measures

Organizational control measures identified in this study were four, as show in table 4. Respondents were classified as having very good level of organizational control measures (2.2%), good (7.6%), fair (9.3%) and poor (80.9%).

Table 4 Availability of organizational control measures

Organizational Control Measures	No	Yes
Have you ever been trained or given instruction on prevention of exposure to SS?	179 (79.6)	46 (20.4)
Is there any protocol for preventing exposure to surgical smoke in your Operating theatre?	200 (88.9)	25 (11.1)
Are you aware of any legislation on elimination of SS in your State?	200 (88.9)	25 (11.1)
Is there any plan by your local NAPON chapter to lobby for elimination of SS from your OR?	207 (92)	18 (8)

Very Good 5(2.2%), Good 17(7.6%), Fair 21(9.3%), Poor 182(80.9%)

Availability of personal protective equipment measures

The study identified use of personal protective level of adoption as very good (1.3%), good (84.9%) and poor (13.8%). This definition is presented in table 5.

Table 5 Availability of personal protective equipment measures

PPE Control Measures	No	Yes
During laser surgery, electro-surgery and ultrasonic procedures, we are provided with surgical/laser masks, eye goggle and theatre attires only	16 (7.1)	209 (92.9)
During laser surgery, electro-surgery and ultrasonic procedures, we are provided with N95/N100 Respirators only	204 (90.7)	21 (9.3)
During laser surgeries, electro surgeries and ultrasonic procedures, we are provided with surgical mask, eye goggle and theatre attire only	163 (72.4)	62 (27.6)

PPE control: V.Good 3(1.3%), Good 191(84.9%), Poor 31(13.8%), General Control Measures – Poor 185(82.2%), Good 40(17.8%)

Association between attributes and technological control Measures of SSH

The results of these Chi-square test of associations is presented in table 6.

Age, years of experience, sex of personnel and marital status had no significant association with technological control measures for surgical smokes (p-values are 9.191, 12.022, 4.589, 6.714 respectively).

Table 6 Association Between Attributes and Technological Control Measures

		Tech Control Measure					
		Very Good	Good	Fair	Poor	χ^2	P-value
Age	<=30yrs	0 (0)	0 (0)	8 (61.5)	5 (38.5)	9.191	0.163
	31-50yrs	9 (7.6)	2 (1.7)	62 (52.5)	45 (38.1)		
	>50yrs	18 (19.4)	2 (2.2)	42 (45.2)	31 (33.3)		
Experience	1-10yrs Exp	6 (5.9)	2 (2)	52 (51.5)	41 (40.6)	12.022	0.061
	11-25yrs Exp	21 (19.6)	2 (1.9)	50 (46.7)	34 (31.8)		
	>25 yrs Exp	0 (0)	0 (0)	9 (60)	6 (40)		
Sex	Male	20 (15)	1 (0.8)	65 (48.9)	47 (35.3)	4.589	0.204
	Female	7 (7.6)	3 (3.3)	47 (51.1)	35 (38)		
Marital Status	Single	0 (0)	0 (0)	8 (61.5)	5 (38.5)	6.714	0.348
	Married	27 (13.4)	4 (2)	96 (47.5)	75 (37.1)		
	Widowed	0 (0)	0 (0)	8 (80)	2 (20)		
Education	OND	0 (0)	0 (0)	11 (68.8)	5 (31.3)	40.031	0.000
	HND	1 (10)	0 (0)	6 (60)	3 (30)		
	BNSc	2 (4.3)	0 (0)	14 (29.8)	31 (66)		
	MSc	7 (8)	3 (3.4)	51 (58.6)	26 (29.9)		
	PhD	17 (26.2)	1 (1.5)	30 (46.2)	17 (26.2)		
	School	0 (0)	0 (0)	0 (0)	1 (100)	31.175	0.000

Place of Work	**Private Hospital**	17 (30.4)	1 (1.8)	15 (26.8)	23 (41.1)		
	Government Hospital	10 (6)	3 (1.8)	97 (57.7)	58 (34.5)		
Health Care	**Secondary**	2 (25)	2 (25)	1 (12.5)	3 (37.5)	28.648	0.000
	Tertiary	25 (11.5)	2 (0.9)	111 (51.2)	79 (36.4)		
Profession	**Surgeon**	15 (18.8)	2 (2.5)	46 (57.5)	17 (21.3)	49.132	0.000
	Anaesthesiologist	0 (0)	0 (0)	34 (55.7)	27 (44.3)		
	Nurse Anaesthesist	0 (0)	0 (0)	5 (62.5)	3 (37.5)		
	Perioperative Nurse	4 (7.4)	2 (3.7)	16 (29.6)	32 (59.3)		
	Anaesthesist Technician	8 (36.4)	0 (0)	11 (50)	3 (13.6)		
knowledge of preventive measures	**Poor Knowledge**	10 (6.9)	4 (2.8)	75 (51.7)	56 (38.6)	11.899	0.008
	Good Knowledge	17 (21.3)	0 (0)	37 (46.3)	26 (32.5)		

Associations with Organizational Control Measures of SSH

The chi square was used to test association between some attributes of the OR staffs and their preventive measures of SS hazards at 95% confidence level. The results of these Chi-square test of associations is presented in table 7.

Experience also has significant association with organizational preventive measures of SS hazards among the OR staffs (χ^2 = 24.998, p = 0.000). Personnel with very high years of experience (at least 25 years) have the highest good level of organizational preventive measures of SS hazards.Knowledge of preventive measure was significantly associated with organizational control measures (χ^2 = 8.054, p = 0.045).

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Table 7 Associations with Organizational Preventive Measures

		Org. Control Measure					
		Very Good	Good	Fair	Poor	χ^2	P-value
Age	<=30yrs	1 (7.7)	0 (0)	1 (7.7)	11 (84.6)	8.28	0.218
	31-50yrs	4 (3.4)	11 (9.3)	8 (6.8)	95 (80.5)		
	>50yrs	0 (0)	6 (6.5)	12 (12.9)	75 (80.6)		
Experience	1-10yrs	5 (5)	5 (5)	7 (6.9)	84 (83.2)	24.998	0.000
	11-25yrs	0 (0)	7 (6.5)	11 (10.3)	89 (83.2)		
	>25 yrs	0 (0)	5 (33.3)	3 (20)	7 (46.7)		
Sex	Male	3 (2.3)	5 (3.8)	12 (9)	113 (85)	6.907	0.075
	Female	2 (2.2)	12 (13)	9 (9.8)	69 (75)		
Marital Status	Single	1 (7.7)	0 (0)	0 (0)	12 (92.3)	5.597	0.47
	Married	4 (2)	17 (8.4)	20 (9.9)	161 (79.7)		
	Widowed	0 (0)	0 (0)	1 (10)	9 (90)		
Education	OND	0 (0)	0 (0)	1 (6.3)	15 (93.8)	19.282	0.082
	HND	0 (0)	1 (10)	2 (20)	7 (70)		
	BNSc	2 (4.3)	5 (10.6)	7 (14.9)	33 (70.2)		
	MSc	3 (3.4)	11 (12.6)	6 (6.9)	67 (77)		
	PhD	0 (0)	0 (0)	5 (7.7)	60 (92.3)		
Place of Work	School	1 (100)	0 (0)	0 (0)	0 (0)	62.519	0.000
	Private Hospital	2 (3.6)	7 (12.5)	12 (21.4)	35 (62.5)		
	Government Hospital	2 (1.2)	10 (6)	9 (5.4)	147 (87.5)		
Health Care Facility	Secondary	0 (0)	4 (50)	2 (25)	2 (25)	25.347	0.000
	Tertiary	5 (2.3)	13 (6)	19 (8.8)	180 (82.9)		
Profession	Surgeon	1 (1.3)	4 (5)	1 (1.3)	74 (92.5)	29.805	0.003
	Anaesthesiologist	1 (1.6)	6 (9.8)	4 (6.6)	50 (82)		
	Nurse Anaesthesist	0 (0)	0 (0)	0 (0)	8 (100)		
	Perioperative Nurse	2 (3.7)	7 (13)	12 (22.2)	33 (61.1)		
	Anaesthesist Technician	1 (4.5)	0 (0)	4 (18.2)	17 (77.3)		
knowledge of preventive measures	Poor Knowledge	4 (2.8)	16 (11)	14 (9.7)	111 (76.6)	8.054	0.045
	Good Knowledge	1 (1.3)	1 (1.3)	7 (8.8)	71 (88.8)		

Association with PPE measures

The Chi square test was also carried out on the PPE control measures. Age ($\chi^2 = 0.365$, $p = 0.985$), Years of Experience ($\chi^2 = 0.741$, $p = 0.946$), Sex ($\chi^2 = 1.154$, $p = 0.562$), Marital status

(χ^2 = 0.503, p = 0.973), and Knowledge of preventive measures (χ^2 = 2.225, p = 0.329) were not significantly associated with PPE control measures implementation.

Table 8 Association with PPE measures

		PPE Control Measure				
		Very Good	Good	Poor	χ^2	P-value
Age	<=30yrs	0 (0)	11 (84.6)	2 (15.4)	0.365	0.985
	31-50yrs	2 (1.7)	100 (84.7)	16 (13.6)		
	>50yrs	1 (1.1)	79 (84.9)	13 (14)		
Experience	1-10yrs	1 (1)	87 (86.1)	13 (12.9)	0.741	0.946
	11-25yrs	2 (1.9)	89 (83.2)	16 (15)		
	>25 yrs	0 (0)	13 (86.7)	2 (13.3)		
Sex	Male	1 (0.8)	115 (86.5)	17 (12.8)	1.154	0.562
	Female	2 (2.2)	76 (82.6)	14 (15.2)		
Marital Status	Single	0 (0)	11 (84.6)	2 (15.4)	0.503	0.973
	Married	3 (1.5)	171 (84.7)	28 (13.9)		
	Widowed	0 (0)	9 (90)	1 (10)		
Education	OND	1 (6.3)	15 (93.8)	0 (0)	22.436	0.003
	HND	1 (10)	7 (70)	2 (20)		
	BNSc	1 (2.1)	34 (72.3)	12 (25.5)		
	MSc	0 (0)	81 (93.1)	6 (6.9)		
	PhD	0 (0)	54 (83.1)	11 (16.9)		
Place of Work	School	0 (0)	0 (0)	1 (100)	43.195	0.000
	Private Hospital	1 (1.8)	34 (60.7)	21 (37.5)		
	Government Hospital	2 (1.2)	157 (93.5)	9 (5.4)		
Health Care Facility	Secondary	1 (12.5)	4 (50)	3 (37.5)	25.347	0.000
	Tertiary	2 (0.9)	187 (86.2)	28 (12.9)		
Profession	Surgeon	0 (0)	73 (91.3)	7 (8.8)	40.391	0.000
	Anaesthesiologist	0 (0)	61 (100)	0 (0)		
	Nurse Anaesthesist	0 (0)	8 (100)	0 (0)		
	Perioperative Nurse	2 (3.7)	35 (64.8)	17 (31.5)		
	Anaesthesist Technician	1 (4.5)	14 (63.6)	7 (31.8)		
knowledge of preventive measures	Poor Knowledge	3 (2.1)	124 (85.5)	18 (12.4)	2.225	0.329
	Good Knowledge	0 (0)	67 (83.8)	13 (16.3)		

Association with General Control Measures

The general control measure is a combination of the three control measures earlier discussed, their associations are presented in the table below using the Chi-square test of association. The associations showed that Age ($\chi^2 = 1.443$, $p = 0.486$), experience ($\chi^2 = 0.507$, $p = 0.776$), sex ($\chi^2 = 0.88$, $p = 0.348$), marital status ($\chi^2 = 2.361$, $p = 0.307$), and knowledge of preventive measures ($\chi^2 = 1.894$, $p = 0.169$), had no significant associations with general control measure.

Table 9 Association with General control Measures

		Poor Control Measures	Good Control Measures	χ^2	P-value
Age	**<=30yrs**	11 (84.6)	2 (15.4)	1.443	0.486
	31-50yrs	100 (84.7)	18 (15.3)		
	>50yrs	73 (78.5)	20 (21.5)		
Experience in the operating theatre	**1-10yrs Exp**	84 (83.2)	17 (16.8)	0.507	0.776
	11-25yrs Exp	86 (80.4)	21 (19.6)		
	>25 yrs Exp	13 (86.7)	2 (13.3)		
Sex	**Male**	112 (84.2)	21 (15.8)	0.88	0.348
	Female	73 (79.3)	19 (20.7)		
Marital Status	**Single**	11 (84.6)	2 (15.4)	2.361	0.307
	Married	164 (81.2)	38 (18.8)		
	Widowed	10 (100)	0 (0)		
Education	**OND**	15 (93.8)	1 (6.3)	10.043	0.04
	HND	8 (80)	2 (20)		
	BNSc	33 (70.2)	14 (29.8)		
	MSc	78 (89.7)	9 (10.3)		
	PhD	51 (78.5)	14 (21.5)		
Place of Work	**School**	0 (0)	1 (100)	65.005	0.00
	Private Hospital	27 (48.2)	29 (51.8)		
	Government Hospital	158 (94)	10 (6)		
Level of Health Care Facility	**Secondary**	3 (37.5)	5 (62.5)	12.335	0.002
	Tertiary	182 (83.9)	35 (16.1)		
Profession	**Surgeon**	66 (82.5)	14 (17.5)	29.983	0.000
	Anesthesiologist	61 (100)	0 (0)		
	Nurse Anesthetist	8 (100)	0 (0)		
	Perioperative Nurse	34 (63)	20 (37)		
	Anesthetist Technician	16 (72.7)	6 (27.3)		

knowledge of preventive measures	**Poor Knowledge**	123 (84.8)	22 (15.2)	1.894	0.169
	Good Knowledge	62 (77.5)	18 (22.5)		

Knowledge of preventive measures was not significantly associated to general control measures when subjected to logistic regression analysis hence the null hypothesis that the knowledge of preventive measures is not associated to general control level is accepted ($p>0.05$). From the logistics regression, other factors were not significantly associated with general control measures of surgical smoke hazards are shown in table 10.

Table 10 Logistic Regression of correlates on general Practice of Control Measures

	B	**S.E.**	**Wald**	**df**	**Sig.**	**Exp(B)**
Sex(Female)	0.078	0.623	0.016	1	0.900	1.081
Place of Work (Government Hospital)	2.888	0.615	22.074	1	0.000	17.952
Level of Health Care Facility (Tertiary)	1.128	1.05	1.153	1	0.283	3.089
Profession			2.963	4	0.564	
Anesthesiologist	1.301	0.787	2.737	1	0.098	3.674
Nurse Anesthetist	-17.415	4966.967	0	1	0.997	0.00
Perioperative Nurse	-17.96	15485.612	0	1	0.999	0.00
Anesthetist Technician	1.172	0.869	1.818	1	0.178	3.227
Age			0.291	2	0.865	
31-50yrs	0.173	1.354	0.016	1	0.899	1.188
>50yrs	-0.245	0.554	0.196	1	0.658	0.782
Years of Experience in OT			1.245	2	0.536	
11-25yrs Exp	1.006	1.186	0.72	1	0.396	2.735
>25 yrs Exp	1.231	1.125	1.197	1	0.274	3.423
knowledge of surgical smoke hazards(**Good Knowledge**)	1.783	0.671	7.053	1	0.008	0.168
knowledge of preventive measures(**Good Knowledge**)	0.049	0.494	0.01	1	0.921	1.05
Constant	-4.212	1.482	8.076	1	0.004	0.015

Conclusion

In conclusion, the study luminated the pivotal role of education, workplace and professional characteristics in shaping the adoption of technological control measures for surgical plumes within the operating rooms (OR). The identified significant associations between various factors—namely, education, place of work, level of health care facility, profession, knowledge

of surgical smoke hazards (SSH), and knowledge of preventive measures—underscored the multifaceted nature of influences on general control measures. These findings emphasized the imperative for targeted interventions and educational programs aimed at enhancing awareness and facilitating the implementation of safety measures among OR staff. Moreover, the outcomes of the Chi-square analysis and subsequent logistic regression highlight the central importance of practitioners' understanding of SSH and their knowledge of preventive measures. Practitioners equipped with a strong comprehension of these aspects are more likely to embrace and implement effective control measures, underscoring the critical role that knowledge plays in fostering a safer operating environment. This study contributes valuable insights that can inform strategies to optimize safety practices in the OR, ultimately enhancing the overall quality of healthcare delivery.

References

1. Michaelis, M., Hofmann, F.M., Nienhaus, A., Eickmann, U. Surgical smoke-hazards perceptions and protective measures in German operating rooms. International Journal of Environmental research and public health 17.515; (2020). https://doi:10.3390/ijerph17020515
2. Karjalainen, M., Kontunen, A., Saari, S., Ronkko, T., Lekkala, J., Roine, A., Oksala, N. The characterization of surgical smoke from various tissues and its implications for occupational safety.PLoSONE13(4):e0195274. (2018)
3. European Operating Room Nurses Association (EORNA). Recommendation on prevention and protection of surgical plumes. Available online at https://EORNA.eu/wp-content/uploads/2019/09.Prevention-and-Protection-of-Surgical-Plume-PNCEORNA.pdf (2018). (accessed September 29, 2022).
4. Massarweh, NN., Cosgriff, N., Slakey, DP.Elecyrosurgery, history, principles and current and future uses. Journal of America College of Surgeons,202(3):520-530.2016.
5. Love, A. Surgical smoke in operating room, changing of the air for safe operating room. Special report pp 3-9. Global business media limited. Available online at http://www.Hospitalreports.eu. (2022). Accessed 28 September 2022.
6. Liu, Y., Song, Y., Hu, X., Yan, L., Zhu, X., Awareness of surgical smoke hazards and enhancement of surgical smoke prevention among the Gynaecologists. Journal of cancer, 10(12)2788-2799(2019).
7. 7.Occupation Safety and Health Agency (OSHA) Surgical 'smoke hazardous', but HCWs must report to stir action. Available online at https://www.reliaamedia.com/articles/138063-osha-surgical-smoke-hazardous-but-hcws-must-report-to. (2016). Accessed 5 May 2022.
8. Schramm, MMJ., Sheikh, AJ., Chave-Cox, R.McQuald, J., Whitty, RCW., Ilynskaya, E. Surgically generated aerosols and mitigation strategies: combined use of irrigation, respirator and suction massively reduces particulate matter aerosol. Neurosurgery general, 163:1819-1827(2021).