Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Transmission of infection among health care personnel performing surgical tracheostomies on COVID-19 patients

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Title

Transmission of infection among health care personnel performing surgical tracheostomies on COVID-19 patients.

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Key-words:

Tracheostomy, COVID-19, pandemic, transmission, health personnel, protocol, aerosol, high risk, surgical procedure, operative, SARS-CoV-2, disease transmission, infectious.

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Short title:

Surgical tracheostomy and transmission of COVID-19 among healthcare personnel.

Highlights

Tracheostomy in COVID-19 patients puts healthcare staff at risk of the infection.

Adherence to tracheostomy protocol is essential to minimise aerosol contamination.

Personal protective equippment helps in mitigating cross infection among healthcare personnel.

COVID-19 transmission among staff during 71 tracheostomy procedures

Surgery

Surgical Tracheostomy(ST) — 55

Tube change — 16

Demographics

Males :65.5%
Mean age - 58 yrs

COVID Positivity

- 85.5% (47/55)
- 79% males
- 6 non surgical deaths

Key findings

- 67% direct ICU admission
- 16.7% intubated at admission
- 15 days median Intubation to ST (IQR=9)
- 17 days median COVID-19 positive to ST(IQR=9)
- Mean ICU stay: 40 days

Outcome

15 still in hospital

1- on table arrest (revived successfully)

4 - bleeding

2 - tube slippage

6 - deaths(non-surgical)

Tracheostomy Team

24

16

83

Role & Responders

Anaesthetics (6)

Surgeons(11)

Nurses, Assistants(55)

Health Assessment

1- self isolation, C-19-Neg.

All healthy

10 – symptoms , self Isolation
3 - Tested Positive

Overall 15 % in self isolation.
No staff hospitalisation

Title

Transmission of infection among health care personnel performing surgical tracheostomies on COVID-19 patients.

Abstract

Background:

Staff and patient safety are of paramount importance while performing a surgical tracheostomy(ST) during the corona virus disease(COVID-19) pandemic. The aim was to assess the incidence of COVID-19 infection among the healthcare personnel(HCP) performing ST on COVID-19 patients.

Methods:

One hundred and twenty-two HCP participating in 71 ST procedures performed at our institution between 26th March 2020 and 27th May 2020 were identified. A COVID-19 health questionnaire was distributed among staff with their consent. Data related to the presence of COVID-19 symptoms(new onset continuous cough, fever, loss of taste and/or loss of smell) among HCP involved in ST as well as patient related data were collected.

Results:

Of the HCP who responded, eleven(15%,11/72) reported key COVID-19 symptoms and went into self-isolation. Ten members from this group underwent a COVID-19 swab test and three tested positive. Only one HCP attended hospital for symptomatic treatment, none required hospitalisation. Sixty percent(43/72) of the responders had a COVID-19 antibody test with a positive rate of 18.6%(8/43).

Among the patients undergoing a ST, 67%(37/55) required a direct intensive care unit(ICU) admission; the mean age was 58 years(29-78) with a male preponderance(65.5%). The median time from intubation to ST was 15 days (range 5-33,IQR=9). The overall mortality was 11%(6/55).

Conclusions: ST can be carried out safely with strict adherence to both, personnel protective equipment and ST protocols which are vital to mitigate the potential transmission of COVID-19 to the HCP.

Key-words:

Tracheostomy, COVID-19, pandemic, transmission, health personnel, protocol, aerosol, high risk, surgical procedure, operative, SARS-CoV-2, disease transmission, infectious

Introduction

Novel corona virus disease (COVID-19) that originated in the Wuhan city, Hubei province, China in December 2019 has evolved into a pandemic[1]. The infection caused acute respiratory failure secondary to viral pneumonitis[1]. Another reason for respiratory failure could be the higher occurrence of pulmonary embolism in COVID-19 patients when compared to pre-COVID patients(37%vs14.5%)[2]. About 20% of those infected with the COVID-19 virus seem to need in-patient hospital admission and a quarter of these needed intensive care admission[1]. Need for ventilation varied from 42% to 100%[3,4]. Many of these ventilated patients have required tracheostomies to help easier management of the airway especially in those

requiring proning, to wean them off the ventilators or to continue prolonged ventilation[1,4].

There are numerous publications outlining the protocol for tracheostomy and head and neck procedures in COVID-19 positive patients, mostly based on previous experience with ST in severe acute respiratory syndrome (SARS) patients[1,3-5]. We adopted these recommendations and modified to suit our local needs (Appendix-1). In a systematic review by Tran K et al, the odds ratio of an HCP developing an infection when involved with tracheostomy procedure in patients with SARS was 4.2 (95% CI 1.5-11.5)[6].

COVID-19 infection, predominantly an aerosol or droplet based respiratory transmission, meant that PPE, risk stratification based on procedure type, and compliance with donning and doffing would be vital to limit the spread to and among healthcare providers[5,6]. These along with re-organisation of the operating theatre layout in the past during the SARS outbreak and the current COVID-19 pandemic[1] were pivotal in safeguarding the HCP involved in these procedures.

At our institution, a tertiary care hospital, a tracheostomy protocol was designed and implemented with strict adherence and co-operation of the entire team. This study is aimed at assessing incidence of COVID-19 infection among HCP involved in ST.

Methods

The key inclusion criteria were invasively ventilated adult patients managed in the ICU as COVID-19 cases (CT consistent with COVID-19 and/or a positive COVID-19 RT-PCR test) who were referred for a ST (during the period between 26th March 2020 and 27th May 2020) and the staff who were part of the ST team. The exclusion

criteria were staff who did not consent for completing the questionnaire and HCP who tested positive for COVID-19 prior to the start of the study. Emergency ST were excluded from the study to reduce the potential bias of increased risk compared to a planned ST. All HCP adhered to the local tracheostomy protocol(Appendix-1) and personal protective equipment (PPE) guidelines.

A questionnaire (Appendix-2) was designed, bearing in mind the proven factors that influence the potential transmission of COVID-19 among HCP[4]. The key symptoms of new onset persistent cough, fever, loss of smell and/or taste as described by NHS England were also included.

On 25th May 2020, antibody testing against COVID-19 for NHS staff was advised by NHS England. This was implemented at our institution from 1st June 2020. After a two week period (to accommodate the incubation period), on 12th June 2020, all personnel were contacted either by email or in person. A pre-formatted questionnaire (Appendix-2) was given after seeking their consent for participation in the study. Two further reminders were sent to non-responders; two weeks later, the survey was closed.

All patients undergoing tracheostomy procedures between 26th March 2020 to 27th May 2020 were identified and analysed. The parameters studied included demographics, date of ICU admission, time interval from intubation to ST, COVID-19 status, complications and the outcome factors (step down, discharge or death). We did not perform percutaneous tracheostomy during the COVID-19 pandemic because of the increased risk of aerosolisation, need for bronchoscopy and to free the critical care consultants to manage COVID-19 ICU patients.

OR modifications and Staff education

Our first COVID-19 positive patient was admitted on 28th Februrary 2020. The trust implemented donning and doffing training along with mask fitting sessions for all HCP. The first tracheostomy was performed on 26th March 2020.

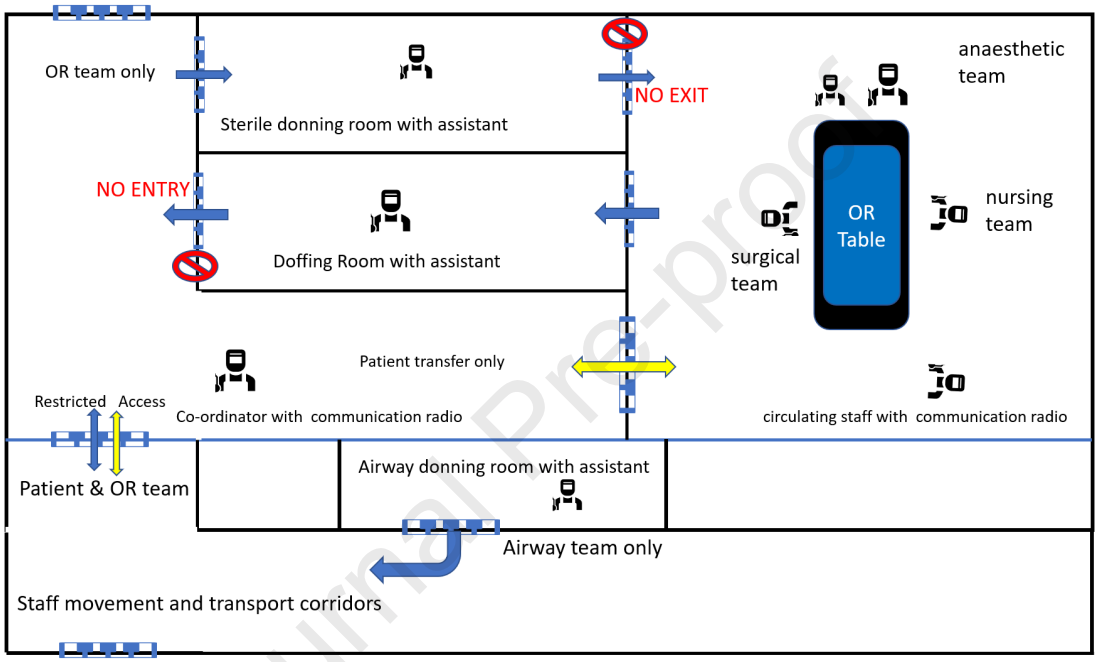

Fig:1 Theatre traffic flow regulation during COVID-19 pandemic

Theatre access and layout were modified as recommended by the infection control team to minimise potential spread by direct contamination and aerosolisation (Figure:1). All staff entering and leaving the designated tracheostomy OR had to follow the mandatory trust donning and doffing protocol based on Public Health England guidelines.

Tracheostomy protocol

The tracheostomy protocol was drafted based on the experience of our tracheostomy team and guidelines described by national and international experts[4-

[6]. Monopolar and bipolar diathermy were used judiciously. An agreed sequence of ST steps and clear communication between anaesthetist and surgeon were stressed upon and practiced in each case to ensure adequate oxygenation and to minimise aerosolisation, particularly during advancement of endotracheal tube (ET), tracheotomy, withdrawal of the ET tube and insertion of the tracheostomy tube.

Results

At the end of the study period, 27th May 2020, one hundred and twenty-two HCP who were members of the ST team were identified from a prospectively maintained operation room (OR) database. This included 23 anaesthetists,16 surgeons, 83 theatre staff (anesthetic assistants, scrub and circulating nurses). We had 74 responders (7 anesthetists, 12 surgeons and 55 theatre staff) and 48 non-responders. From the pool of 74 responders, we excluded one member each from the anaesthesia and the surgery teams because they had tested positive for COVID-19 before their involvement with ST and had returned to work following trust occupational health guidelines.

Among the final 72 responders included in the data analysis, 6 were anaesthetists, 11 were surgeons and 55 were theatre staff. Age and ethnicity were not disclosed by 15 and 17 of the 72 responders respectively. Bearing this in mind, the mean age was 40 years

Among the 72 respondents, a total of 232 individual exposures to ST procedure were recorded yielding a mean of 3.1 cases/HCP. On further stratification, 86% (62/72) had participated in 1-5 cases, 10% (7/72) in 6-10 cases and 4% (3/72) in 11-25

cases (all HCP in the last group were the surgeons performing the ST). Overall 15%(11/72) developed COVID-19 symptoms and went into self-isolation.

(range 18-61), 57% of responders were women.

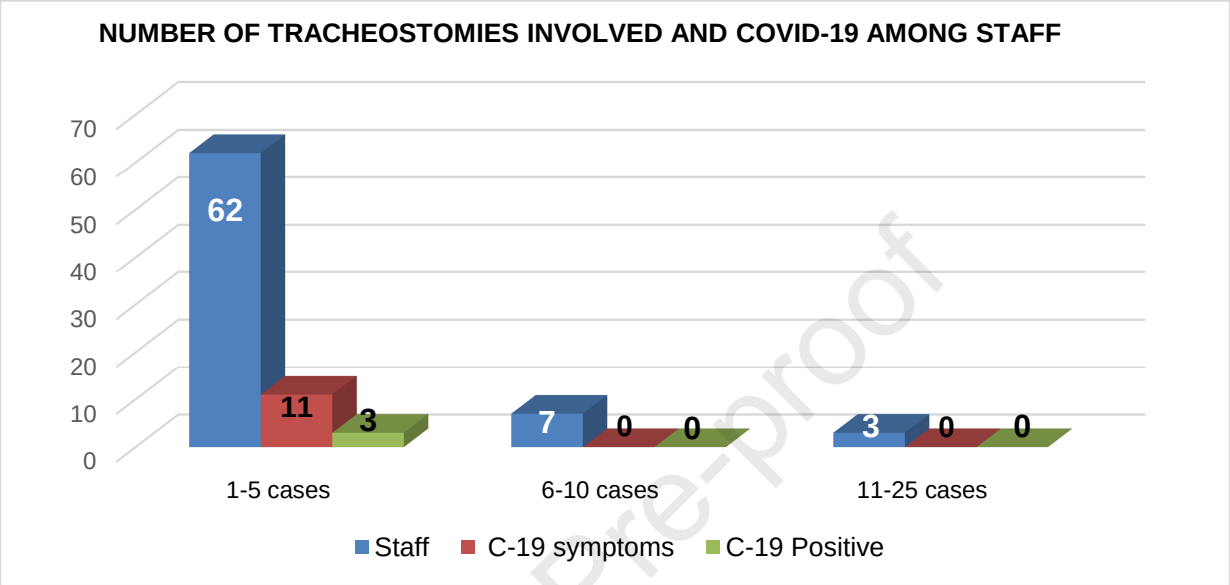

Fig 2 Distribution of tracheostomy staff based on number of cases participated and occurrence of COVID-19.

None from the maximum exposure groups (6-10 and 11-25 cases) reported the key symptoms of COVID-19, nor did they have to take any time off work. Eighteen percent (11/62) of HCP involved in 1-5 ST cases developed key symptoms and went into self-isolation; 10 of 11 from this group had a COVID-19 swab test of which three were positive.

Ninety percent (65/72) of the staff involved in ST had exposure to other patients (COVID-19 suspected or positive) in the OR, ward, accident and emergency or ICU as part of their work schedule and re-deployment. Only ten percent (7/72) were not involved with any other COVID-19 positive or suspected patients; among these, two reported mild non-key symptoms and went into self-isolation but not tested.

Overall, 15% (11/72) of the staff developed key COVID-19 symptoms. Only one HCP presented to the emergency department and was managed symptomatically, none were hospitalised. Sixty percent of the responders (43/72) had had antibody testing done until 24th June 2020. Among these, 18.6% (8/43) had tested positive for antibodies against COVID-19.

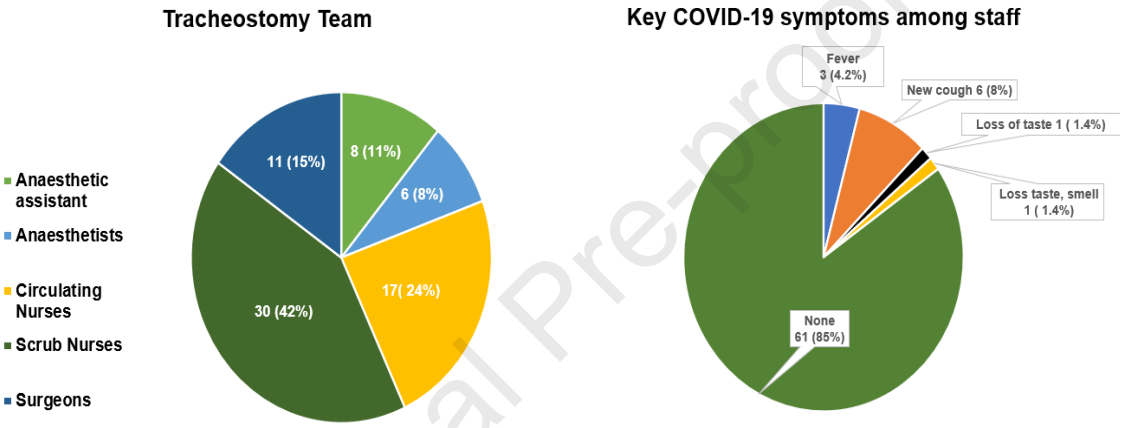

Fig:3a and 3b: (a) composition of the tracheostomy team. (b) occurrence of key COVID-19 symptoms among the staff.

During the study period, 71 tracheostomy procedures were performed of which 77.5% (55/71) were primary tracheostomies and 22.5% (16/71) were tracheostomy tube change procedures. 65.5% were men (36/55) and the mean age was 58 years (range 29-78). Sixty seven percent of patients (37/55) were admitted directly to ITU at initial presentation with nine patients (16.7%) needing intubation and ventilatory support at admission. All the fifty-five patients who underwent a ST, had CT features of COVID-19 and 85.5% (47/55) were COVID-19 RT-PCR positive.

The median time interval between intubation and tracheostomy was 15 days (IQR=9). The median time interval between a positive test to tracheostomy was 17 days (IQR=9). As of 12th June 2020, the mean ICU stay of the patients undergoing tracheostomy was 40 days (range 4-77 days); twenty patients were still hospitalised. Among the tracheostomy change procedures, one patient needed two tube changes.

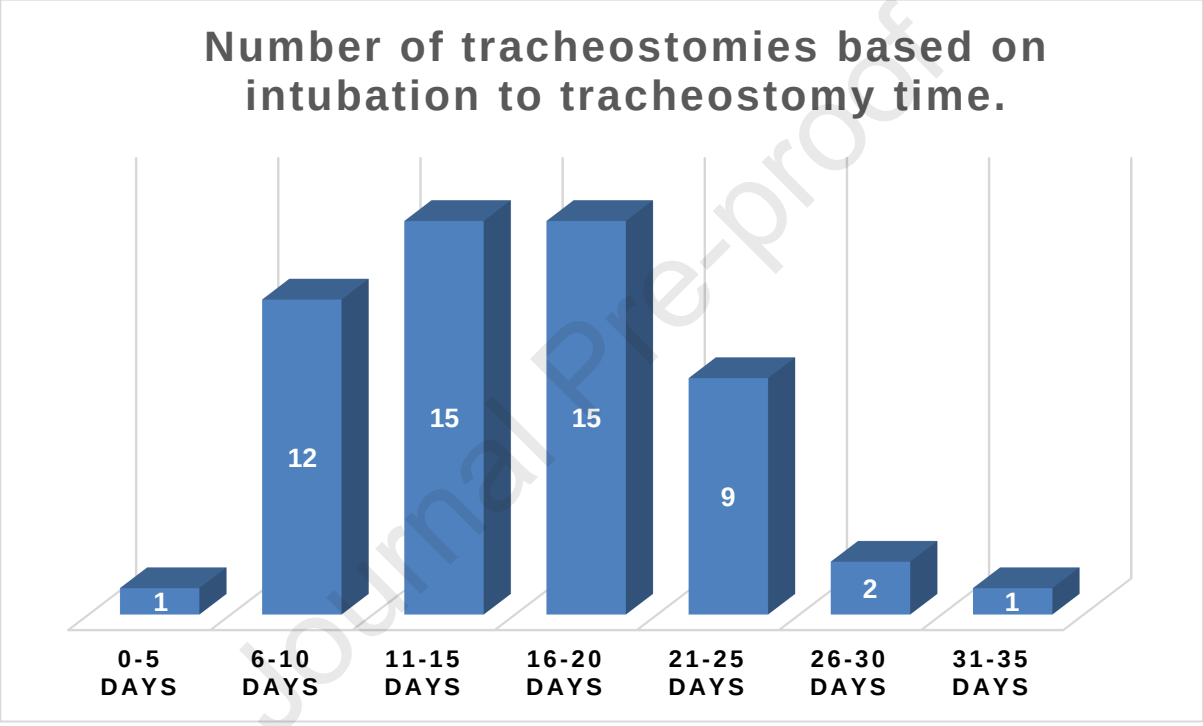

Fig 4 : Case groups based on time interval (in days) from Intubation to ST.

A morbidity rate of 11% (6/55) was noted; 2 patients had slippage of tube, 4 patients had bleeding that needed an OR visit for haemostasis. One patient had a cardiac arrest at the time of the initial tracheostomy who was resuscitated successfully on table and the procedure completed. No tracheostomy related mortality was noted, however the overall mortality rate was 11% (6/55).

Discussion

As the world is coming to grips with COVID-19 pandemic, it has been a formidable challenge for healthcare providers to keep the services running and yet safe-guard the very people providing it. Clinical and experimental studies have proven that transmission of COVID-19 is via respiratory droplets, fomite or contact[7]. ST is integral in providing continued respiratory support of critically ill COVID-19 patients. At the same time, it is also one of the procedures with highest risk of aerosolisation with a high potential for transmission to HCP[6].

The two valuable aspects that can be tailored or optimized with an aim to reduce the risk of transmission include, a mandatory step-wise protocol of the procedure and an appropriate level of personnel protection for the staff providing the service[4,5]. Along these lines, we adopted a tracheostomy protocol(Appendix-1) based on our experience, local resources during the pandemic and existing guidelines. The theatre traffic flow was modified (figure:1) and trust donning and doffing guidelines were implemented. Planning and prioritisation of the patients needing a ST was done on a daily basis depending on the time and theatre constraints dictated by emergency surgical cases from other specialties.

In a recent meta-analysis[8], during the early phases of COVID-19 spread, a 44% nosocomial infection rate was noted in comparison to 36% with SARS. Both in SARS and COVID-19 outbreaks, doctors (30-33%) and nurses (50-56%) were most commonly affected among all HCP[8].

In, our series, HCP exposed to 6-25 tracheostomies did not develop any key COVID-19 symptoms and did not need time off work. However, all the eleven symptomatic HCP needing self-isolation were from the least exposed group of HCP who had

participated in 1-5 tracheostomies. In addition to the 15% of HCP developing COVID-19 symptoms or testing positive on RT-PCR, 18.6%(8/43) had tested positive for antibodies against COVID-19. Our findings raise the potential possibility of other modes of COVID-19 exposure among HCP. Our view is supported by a report from three hospitals in Netherlands[9]; 15% (1796/12022) of HCPs were symptomatic on screening for COVID-19, on further testing, 5% (96/1796) were positive. However, when linked to epidemiological data and genomic sequencing, the results did not support widespread nosocomial transmission, this meant that community acquired infections are feasible among HCP.

In a study of COVID-19 from Wuhan, staff working in high risk areas involved in aerosol generating procedures(AGP) had a 2.13 times higher risk of developing COVID-19 when compared to their counterparts in low risk areas[10]. A systematic review looking at risk of developing respiratory infection specifically related to AGPs, reported an increased odds ratio of 6.6 for tracheal intubation and 4.2 to 6.2 for tracheostomy[6].

In our report,15% of the HCP were self-isolating due to key COVID-19 symptoms. None of the staff participating in the ST team needed hospitalisation or prolonged time off work. During this pandemic, the nationwide NHS staff absenteeism either due to self-isolation or COVID-19 related illness was around 10% for nurses and 6.7% for doctors[11].

In a review published before the COVID-19 pandemic of 2377 patients with ARDS from 50 countries[12], 13% (309/2377) of them needed a tracheostomy during their ICU stay. The median time of tracheostomy was 14 days with 75% after their first

week of illness. The 28-day crude mortality rate in tracheostomised patients was 23.4%. In our study, the overall mortality rate was 11%, none being related to ST.

It is agreed in general that the period of maximum infectivity is during the relatively high viral load phase of COVID-19 which is around 9 to 15 days of the infection[5]. In a systematic review[13], focussing on viral load and infectivity of SARS-Cov-2 reported that the viral load in respiratory secretions is highest around onset of symptoms and declines within one to three weeks. Viral RNA generally becomes undetectable in about two weeks from onset of symptoms. Detection of viral RNA does not translate to infectivity because the virus is rarely cultured beyond two weeks, hence patients may not be infective for the full duration of viral shedding and detection[13]. In yet another study, viral RNA was detected for a mean of 17 days from onset of symptoms but viral cultures from PCR positive samples were rarely positive beyond nine days of illness[14].

Liu et al[15], analysing the viral load in mild and serve cases of COVID-19 found that, while 90% of mild cases tested RT-PCR negative at day 10 of onset of illness, all patients with severe COVID-19 had a positive RT-PCR result at or beyond day 10.This study implied that severe COVID-19 is associated with a higher viral load and a longer virus shedding period. Hence, it is prudent to exercise caution and delay tracheostomy, if at all possible. In our series, the median time interval between a positive test to tracheostomy was 17 days (IQR=9).

Wei et al, in a report of SARS illness, reported that 14-20% of SARS patients would need invasive ventilation[16]. In a total of eight tracheostomies from three other case series on SARS patients, no transmission to HCP was reported[16-18].

D'Souza A et al[19], in a survey of surgeons performing tracheostomy in COVID-19 patients, reported a 9.7% tracheostomy rate among 3403 ventilated patients. A mean of 14.4 days was noted from time of intubation to tracheostomy. Floyd et al[20], reported no sero-conversion among ten surgeons performing 38 ST in COVID-19 patients. Chao et al[21] reported 53 tracheostomies without transmission to HCP. The average time from intubation to tracheostomy was 19.7 days. In our series, none of the three surgeons involved in fifty-five ST and 16 tracheostomy tube change procedures had COVID-19 symptoms and were COVID-19 antibody negative.

Finally, it is worthwhile to consider the key limitations of our study. COVID-19 swab and antibody testing among the participants were not done in all HCPs. The reasons for this was because it was neither mandatory, nor was it available to all during the period of study. We have considered presence of key symptoms of COVID-19 as laid down by the NHS as indicators of COVID-19 infection among the ST team members.

One could argue about the quality of our data based on the fact that ninety six percent of the HCP included in this study were also working in other areas with COVID-19 suspected or proven patients. Given the pandemic situation, it would not be easy or even ethical to have a formal randomised study or have a team performing or caring exclusively for tracheostomy patients. We believe that if we had a dedicated ST team, their exposure to other potential sources of COVID-19 would be reduced significantly and hence the group of HCP with key COVID-19 symptoms would be even less than the 15% reported by us. According to the literature available[5,13,19,21], we also strongly believe that timing of tracheostomy beyond 14 days also had a positive impact on limiting staff infection rates.

In conclusion, COVID-19 will be around in the near future. Many critical care units around the world will need to manage COVID-19 patients with invasive ventilation and perform tracheostomies to expedite weaning and to facilitate airway management. Our report highlights the safe delivery of a tracheostomy service during the peak of the pandemic in England, with strict adherence to local ST tracheostomy protocol and PPE use resulting in 15% staff self-isolation due to suspected COVID-19 symptoms without any HCP being hospitalised.

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Legend for Illustrations

Figure:1 Theatre traffic flow regulation during COVID-19 pandemic

Figure:2 Distribution of tracheostomy staff based on number of cases participated and occurrence of COVID-19.

Figure:3a and 3b: (a) Composition of the tracheostomy team. (b) Occurrence of key COVID-19 symptoms among the staff.

Figure 4 : Case groups based on time interval (in days) from Intubation to ST.

Questionnaire for Healthcare professionals involved in Tracehostomy procedure at the Royal Free Hospital

I consent for completing the survey & use of data for research publication. Yes/No.
Signature: _____. Date:_____

Q.1:Name:	Q.2:Age:
Q.3:Gender:	Q.4:Ethnicity:
Designation	☐ Anaesthetic Consultant ☐ Anaesthetic ODP ☐ Anaesthetic Registrar ☐ Anaesthetic SHO ☐ Circulating nurse ☐ Scrub Nurse ☐ Surgical consultant ☐ Surgical registrar
Q.5:Number of cases you have been involved in and the date range (if possible list out each date you were involved and time, if more than one a day).	☐ Total No: ☐ From date _____ ☐ To date _____ ☐ >1 case/day: Yes/No
Q.7:Did you do other cases in theatre during this period	☐ Yes ☐ No ☐ If yes Covid positive/ negative / suspected.
Q.8:Have you been working in other areas of the hospital during this period	☐ Yes ☐ No ☐ If yes _____
Q.9:Have you been re-deployed or do you work in other hospitals within the same trust	☐ Yes ☐ No If yes _____
Q.10:Have you worked in any other hospital during this period.	☐ Yes ☐ No If yes _____

Q.11:Have you had any contact with a COVID-19 proven or suspected patient apart from the theatres where you work.	☐ Yes ☐ No If yes _____
Q.12:Have you used the PPE as per the advice of Royal Free Hospital guidance	☐ Yes ☐ No If No _____
Q.13:Any incidence wherein you were without a particular item of PPE while being involved with a tracheostomy procedure in the theatre complex	☐ Yes ☐ No If yes _____
Q.14:Did you have training in PPE donning and doffing before you scrubbed for the first tracheostomy case.	☐ Yes ☐ No If No, _____
Q.15:During any case of tracheostomy surgery did you have. If no, please go to Q.16.	☐ wet mask? ☐ Unguarded exposure to oral secretions, respiratory secretions and or blood? ☐ During any case of tracheostomy did you have accidental injuries with sharps? ☐ None of the above
Q.16:During this period did you travel to places other than your normal routine?	☐ Yes ☐ No If yes _____
Q.17:During this period did you visit or care for anyone who was/is suspected or diagnosed to have COVID-19?	☐ Yes ☐ No If yes _____
Q.18:During this period did you have any family member / housemate suspected/having or being in isolation due to COVID-19?	☐ Yes ☐ No If yes _____
Q.19:Since your involvement in the first case, have you had any key symptoms of Covid-19. If no, please go to Q.20.	☐ Dry cough ☐ Productive cough ☐ Fever (>38 degrees Centigrade)

	□ Shortness of breath □ Running nose □ Sore throat □ Chills □ Loss of taste □ Fatigue □ Nasal Congestion □ Any other symptoms □ None of the above □ Others
Q.20:Since your involvement in the first case, have you	□ taken time off work □ reported to occupational health feeling unwell □ had a test for COVID-19, if yes the results □ had a visit to A&E feeling unwell □ had an admission to hospital □ have you gone into self-isolation. □ None of the above.

Thankyou for your valuable time.

Appendix-1

Tracheostomy protocol

1. Referral to the tracheostomy team (surgeons and anaesthetists) who review the patient well in advance.
2. The intensivist ensures there is no cuff leak form the endotracheal tube (ETT) and if present either changes the tube or checks the cuff is intact and optimally inflated.
3. Availability of the appropriate tracheostomy tube and the equipment e.g. inline suction catheter mount is confirmed with the operating theatre.
4. Consent is completed by the surgeon or the intensivist (usually consent 4)
5. Patient booked for Tracheostomy in theatres
6. In theatres:
    1. Standard donning protocol based on guidelines issued by the trust for high aerosol generating procedures was followed
    2. WHO check list is completed.
    3. The steps of tracheostomy are reiterated to the entire theatre team giving particular importance to times of potential peak aerosol exposure, namely,
        1. It is important after pre-oxygenation the ventilation is stopped momentarily to facilitate advancing the endotracheal tube just prior to the tracheotomy
        2. Tracheotomy ensuring the cuff is not damaged thereby preventing aerosol contamination of the theatre environment
        3. Pre-oxygenation, cessation of ventilation, deflation of ETT cuff, withdrawal of the ETT under direct vision through the tracheotomy but not extubating
        4. Insertion of the tracheostomy tube, insertion of the inner cannula, inflation of the cuff, connecting the inline catheter mount and recommencing ventilation.

5. Monopolar and bipolar diathermy were used judiciously to minimise aerosol generation.
6. Bronchoscopy was avoided unless there was a problem with ventilation.

6. Tracheostomy procedure is standard as for non-covid cases but the above sequence is strictly adhered to.

7. Doffing technique was followed as the trust guidelines in the doffing area.

Useful references for Donning and Doffing.

1. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/879098/PHE_COVID-19_Donning_gown_version.pdf.
2. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/879105/PHE_COVID-19_Doffing_gown_version.pdf.

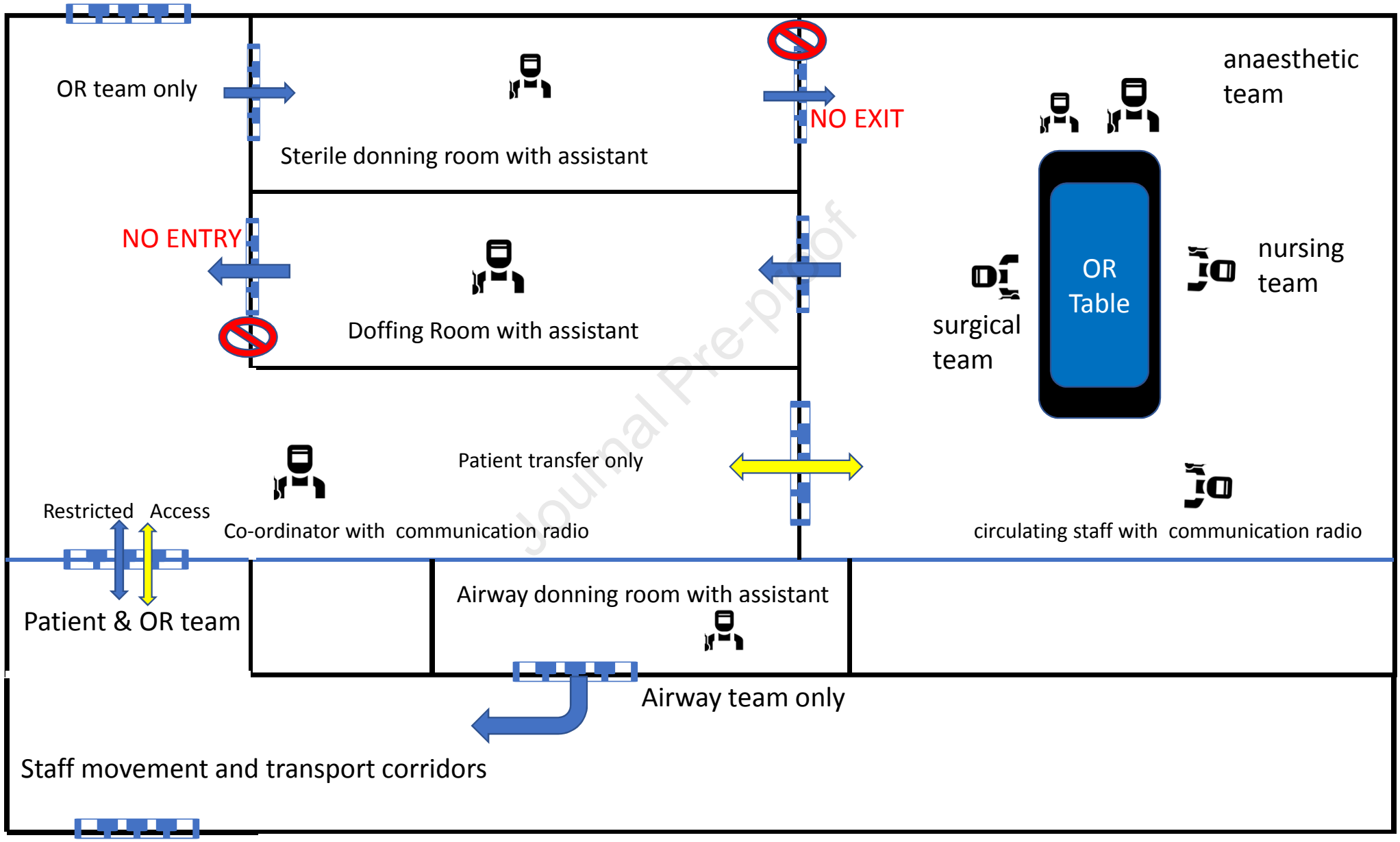
Legend for Illustrations

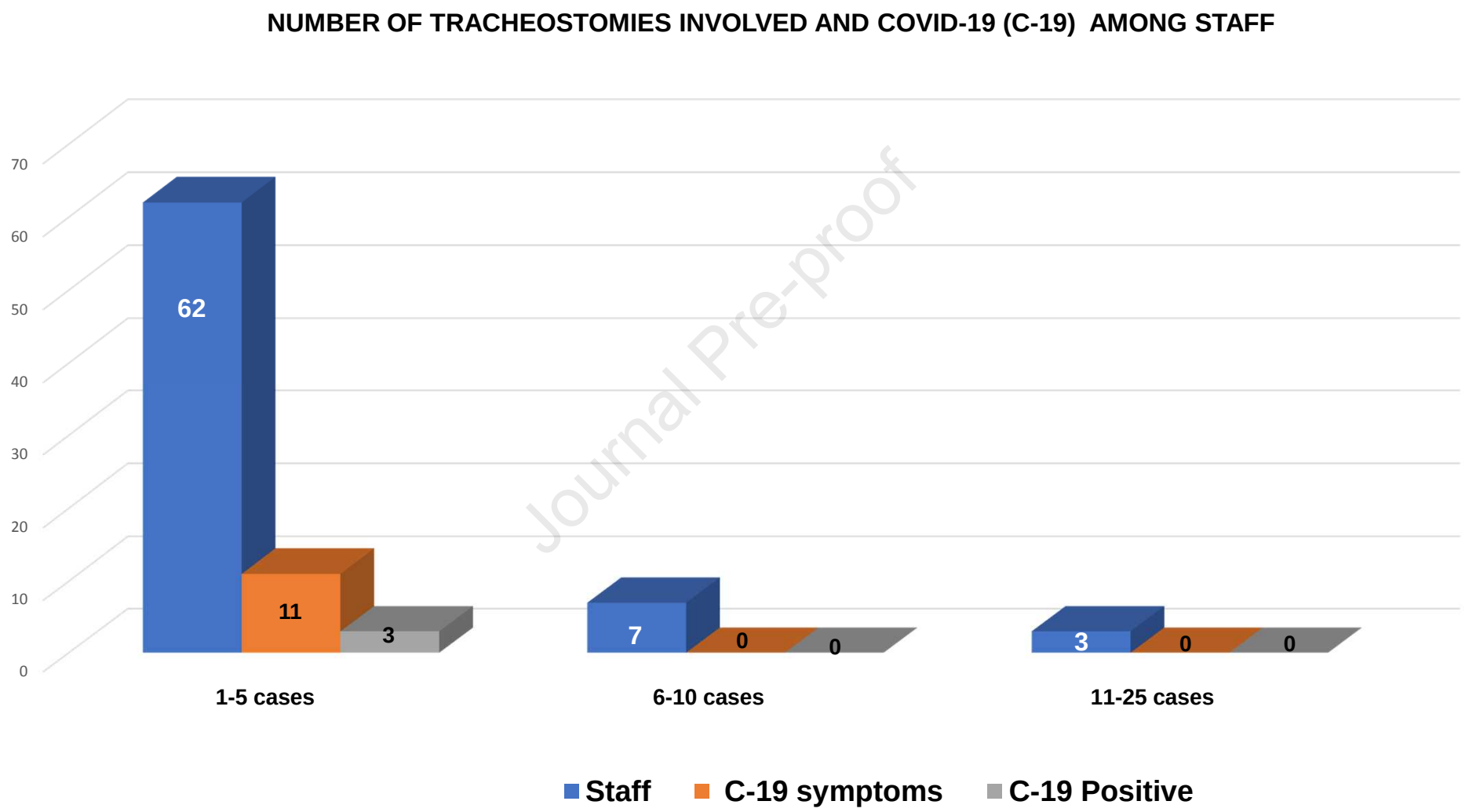
Figure:1 Theatre traffic flow regulation during COVID-19 pandemic

Figure:2 Distribution of tracheostomy staff based on number of cases participated and occurrence of COVID-19.

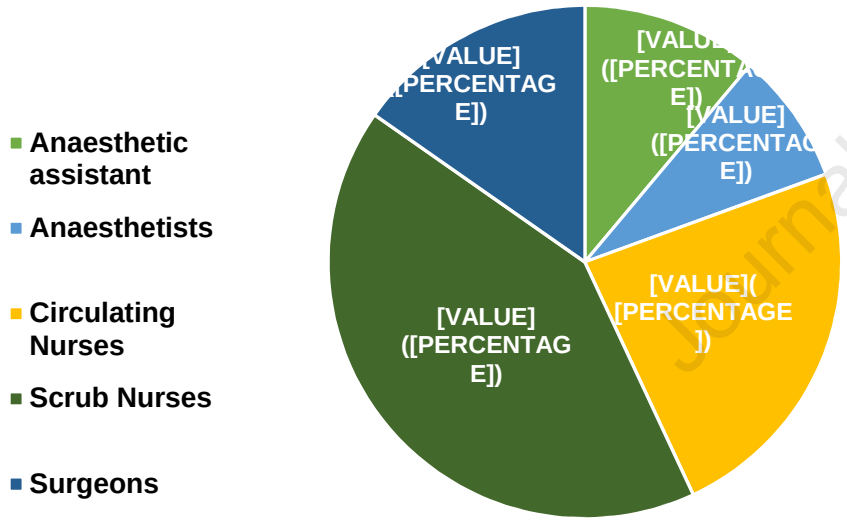
Figure:3a and 3b: (a) Composition of the tracheostomy team. (b) Occurrence of key COVID-19 symptoms among the staff.

Figure 4 : Case groups based on time interval (in days) from Intubation to ST.

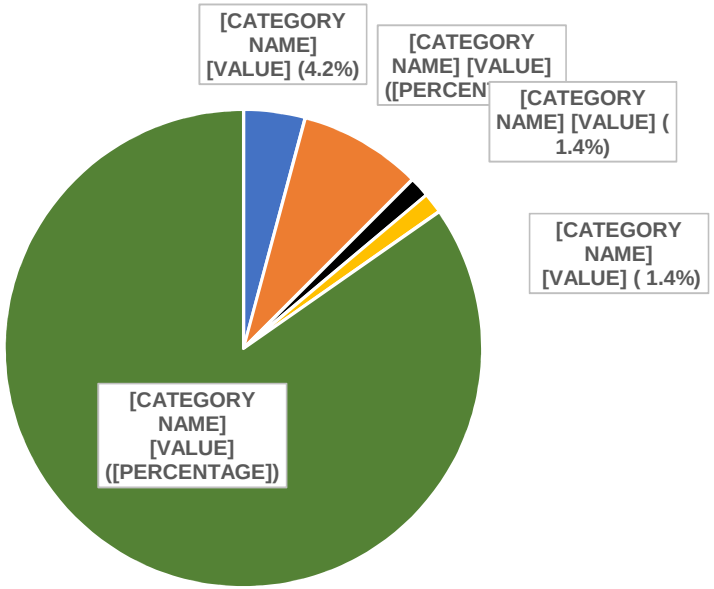


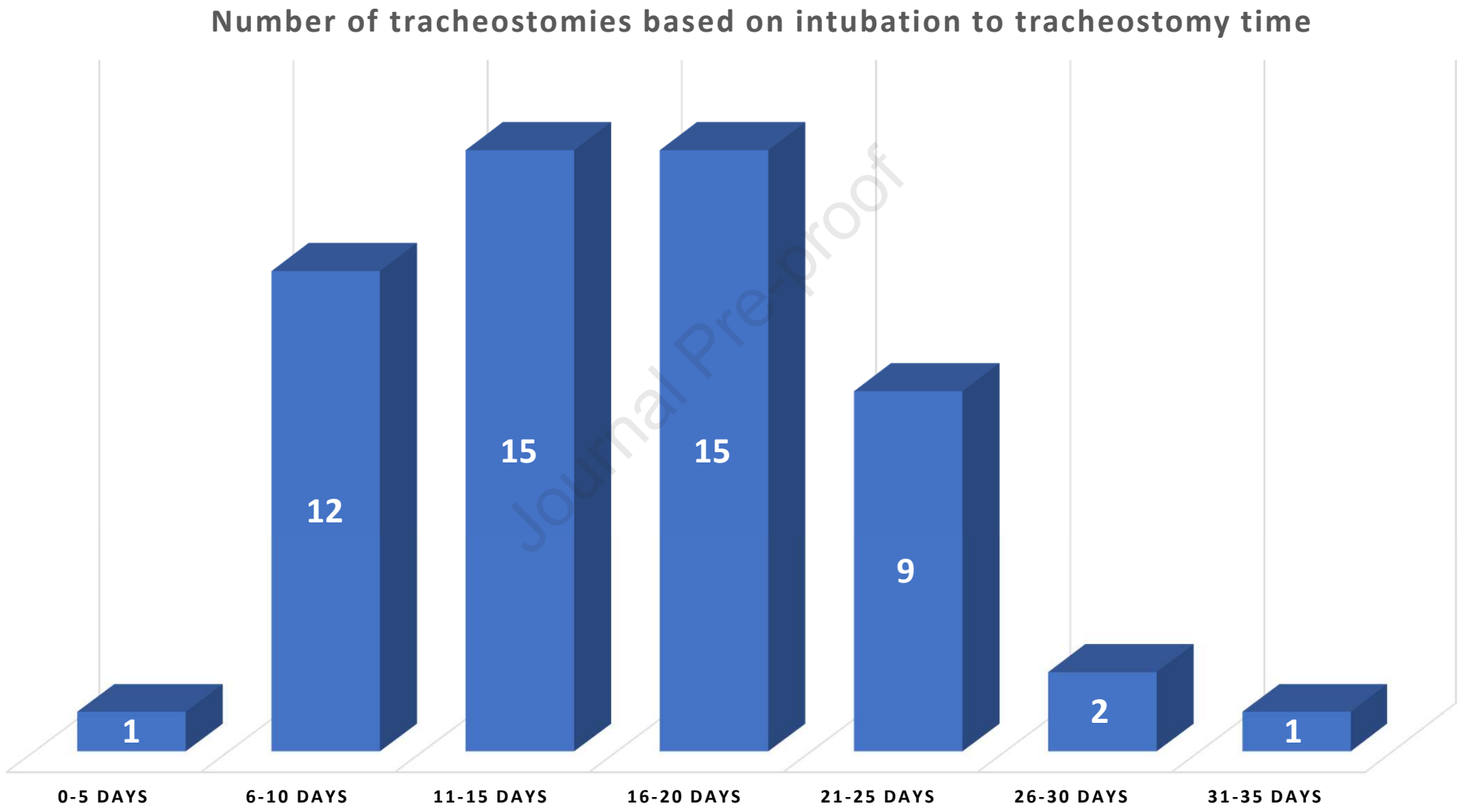


Tracheostomy Team



Key COVID-19 symptoms among staff





Highlights

Tracheostomy in COVID-19 patients puts healthcare staff at risk of the infection.

Adherence to tracheostomy protocol is essential to minimise aerosol contamination.

Personal protective equippment helps in mitigating cross infection among healthcare personnel.