Capacity Augmentation During COVID Pandemic Of A Tertiary Care Institute Of North India

Dr. Haroon Rashid[1*], Dr. Shahnawaz Hamid[2], Dr. Samina Mufti[3], Dr. Meenakshi Koul[4]

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Introduction

The 2019 coronavirus pandemic also known as COVID-19[1] is an example of large scale public health emergency. The covid-19 disease was detected first in December, 2019, and linked to direct exposure to Huanan seafood wholesale market ofWuhan, Hubei Provience, China[2]. On January 30, the world health organization(WHO) declared the Covid-19 situation as a public health emergency of international concern[3]. Covid-19 is an infectious disease; infected people mostly experience mild to moderate respiratory illness, high grade fever, sore throat, nasal congestion, malaise, headache, muscle pain[4]. Older people who suffer from underlying diseases like cardiovascular disease, diabetes, chronic respiratory disease, and cancers, are more likely to develop severe illness[5].

The Covid-19 pandemic has caused unprecedented hardships and put tremendous pressure on the hospital sector around the world. Unlike, previous pandemics[6], daily Covid-19 cases were surpassing the infrastructure capacity at a highly rapid pace, in hospitals worldwide. Hospitals had to face an unpredictable rise in daily infections due to Covid-19[7,8], placing them under extreme strain due to lack of sufficient infrastructure and equipments[9]. Many countries struggled, for example, with shortages of personal protective equipment (PPE), health professionals, intensive care unit beds, and mechanical ventilators,and especially the virus testing capacity[17]. In case of ventilators, there is evidence that the problem was not necessarily shortage of actual numbers, but rather a lack of information infrastructure[18]. In the United Kingdom, in the first wave of pandemic, occupancy of beds compatible with mechanical ventilation never exceeded 62% at the national level, yet 30% of hospitals across England reached full saturation at some point[18].

Appropriate response was needed to tackle this situation, with primary goal to support failing hospital capacity. For this goal, a technique was successfully executed in China[10], where Fangcang shelters were initially constructed in Wuhan to help formal hospitals offer care to diseased and potentially exposed patients, was practically supported[11]. Thus Fangcang hospital facilities have been adopted in several other countries. Some countries, particularly in Europe and United States, did not use exactly the same facilities as Wuhan (hospitals primarily for isolation), but temporary field hospitals were extensively used[12,13]. At the same time, considerable efforts were being made behind the scenes to develop new strategies to ensure adequate public healthcare infrastructure and workplace capacities[13].

Hospitals had to repurpose existing facilities, reallocate internal spaces and redeploy resources in addition to installing new structures and other necessary equipments to manage Covid-19 patients. Countries, like Italy and Spain, discharged many patients from

***Corresponding Author:** Dr. Meenakshi Koul
Address:*Postgraduate Department of Hospital Administration
[1]Associate Professor, Department of Hospital Administration
[2]Assistant Professor, Department of Hospital Administration
[3]Assistant Professor, Department of Hospital Administration
[4]Postgraduate, Department of Hospital Administration

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hospitals to their homes and postponed non-critical treatment and elective procedures[12,14]. Also, Spain, Italy, and Portugal converted their rehabilitation facilities, hotels, public halls, and other suitable facilities into temporary Covid-19 hospitals, clinics, and laboratries[12,13]. This strategy was proposed in a reflection on "fever hospitals"[15,16], that were used earlier to isolate and treat people suffering from infectious disesases[15].

Most importantly, the Covid-19 pandemic has revealed the urgent need to establish health facilities that can handle large number of patients requiring thorough medical care, in case another outbreak strikes. Many existing hospitals face challenges in making improvements[17], as their designs are inflexible and difficult to change. However, there are examples of hospitals that were created with the intention of being easily adaptable for providing care in such emergency situations. One such example is the Rush University Medical Centre (Chicago)[18,19], with flexible capacity, that can boost ED and isolation room capacity as needed. It is essential to have foresight in hospital design for being more prepared in the face of evolving health-care emergencies. The need for strong inter-sectoral collaboration is one of the undisputable requirements to manage the Covid-19 pandemic. Clinical and non-medical personnel such as architects and engineers,working as an inseparable team, especially to convert the building into medical facilities and to build *de novo* structures[20,21].

Keeping in view the above mentioned facts and statements, it was decided to conduct a study in a hospital in North India, with the following objectives.

Objectives

To study workload and capacity up-gradation carried out to tackle increasing number of cases during first three years covid pandemic.

Material and Methodology

Study setting:

The study was conducted in Sheri Kashmir institute of Medical Sciences (SKIMS) a tertiary care hospital in North India. SKIMS is 1050 bedded hospital providing superspeciality care to the people of north india.

Study duration:

The study was conducted for a period of three years starting from January 2019 to December 2021.

Study design:

Retrospective research was undertaken to study the work load of skims and capacity augmentation carried out during the study period i.e 2019 to 2021.

Retrospective study.A detailed review of records was carried out to study the workload during the research period. it included survey of Medical records i.e daily ,weekly and yearly patient related statistics which included daily OPD registrations ,covid registrations, inpatient admissions,covid admissions ,chemotherapies and radiotherapies availed by patients. Capacityaugmentation carried out during the period was studied by carrying outby retrospectiveresearch which included retrospective study of records from stores ,wards icu's and theaters to find out the capacity augmentation undertaken during study period in the form logistics, equipment and new areas created to tackle the increasing number of covid cases during the study period. Records of specialized items like N-95 masks, PPE kits, hand sanitizers, and specialized equipment's like HFNO, etc., were taken from hospital stores. Records of oxygen cylinders, concentrator plants etc., were taken from hospital manifold services. Ward records were checked in addition to personal observation for presence or absence of oxygen beds, ventilator facilities, etc.

Observations

With the outset of pandemic, a massive surge in COVID-19 cases and deaths related to it, was seen all over the world. Health care institutions had to deal with this massive surge, but were constrained by limited resources and limited infrastructure. This placed a huge burden on healthcare facilities that had to cater to such a huge rush. Focus was shifted on to capacity building of the healthcare facilities, in order to improve their response to such unexpected and inevitable occurrences in future.

Tertiary care hospitals play a critical role in dealing with the pandemics. Such hospitals should be ready to adapt rapidly with evolving disease patterns and should be able to address the preparedness in terms of their infrastructure, workforce and other local or social influences, and response required for dealing with pandemics and other disasters alike.

In this context, this article describes the capacity building measures that were taken in the tertiary care institute, SKIMS.

	2019	2020	2021
OPD Registrations	1101380	820839	927332
COVID Registrations	-	16527	50785

Table 1: OPD registrations (including emergency and gynecology & obstetrics)

Table 1 depicts OPD registrations (including emergency and gynecology & obstetrics)- during the years of study i.e 2019 to 2021.Study revealed that there were 1101380 OPDregistrations in 2019, while in 2020 in addition to 820839 regular OPDregistrations a rise in number of covid cases was seen. A total of 16527 covid registration were recorded. A steep rise of 50785 covid registrations were recorded along with steady decline in regular OPD registrations i.e 927332 during the year 2021 (in comparison to 2019)

	2019	2020	2021
Regular Admissions	68377	57304	66024
COVID Admissions	-	1721	3183
Discharges	65518	54383	62609
Deaths	2859	2921	3415

Table 2 : Inpatient status including admissions, discharges and deaths

Study of Inpatient status(Table 2) i.e.admission, discharges, and deaths revealed thatthere were 68377 admissions, 65518 discharges, and 2859 deaths in 2019.During the year 2020 there were 57304 regular admissions, 54383 discharges, and 2921 deaths. There was steady increase of covid admissions during the year. A total of 1721 covid admissions were registeredin 2020. In the year 2021 a total of 3183 covid admissions were registered in addition to 66024 regular admissions. 3415 patients deaths were registered during2021.

	2019	2020	2021
New patients	4414	3696	4265
Follow-up patients	50682	42965	58704
Patients availing radiotherapy	2650	2629	2289
Patients availing chemotherapy	23048	21873	25082

Table :3 Cancer related statistics

Cancer statistics- included new and follow-up patients, and patients planned for radiotherapy and chemotherapy. New patient numbers were 4414 in 2019, 3696 & 4265 in 2020 and 2021 respectively. Follow-up patients were 50682 in 2019, and 42965 & 58704 in 2020 and 2021 respectively. Patients who availed radiotherapy in 2019 were 2650, while 2629 patients availed the service in 2020 and 2289 availed radiotherapy patients in 2021. Patients who availed chemotherapy in 2019 were 23048, while 21873 patients availed the service in 2020 and 25082 availed chemotherapy patients in 2021. (Table 3)

	2020	2021
Registrations	16527	50785
Admissions	1721	3183
Deaths	434	191

Table :4 COVID statistics – registrations, admissions and deaths

Covid pandemic led to a rise in the hospital admissions and deaths related to it. Table 4 depictsCovid cases- in 2020, there were 16527 covid registrations and 1721 covid admissions, while in 2021, a steep rise in the numbers to the extent of 50785 covid registrations, and 3183 covid admissions were observed. In 2020, 434 covid deaths were reported, while the number was 191 in 2021

	2020	2021
High flow oxygen	401	2189
Low flow oxygen	768	911
HFNO	13	725
Invasive ventilator	09	47

Table :5 Covid patients receiving high flow oxygen, HFNO and invasive ventilation

Table 5 shows that Number of covid patients who received high flow oxygen were observed to be 401 & 2189 in 2020 & 2021 respectively, depicting a huge rise in patients needing high flow oxygen. Number of covid patients who received low flow oxygen were observed to be 768 & 911 in year 2020 & 2021 respectively. Number of patients on HFNO was observed to be 13 in 2020, while a steep rise to 725 patients was seen in 2021. Number of patients who required invasive ventilation in 2020 was observed to be 09 patients, and the number rose to 47 in year 2021.

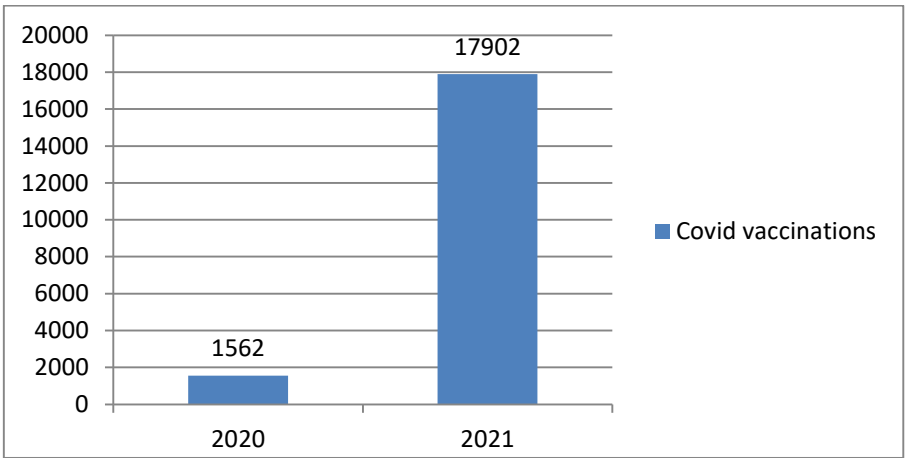
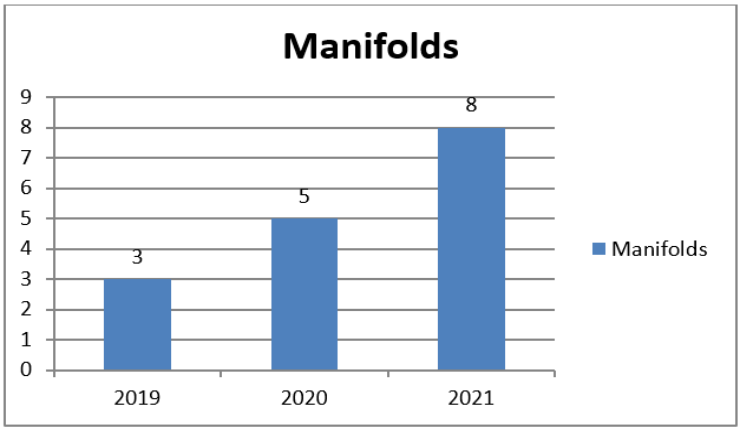


Fig 1 : Covid vaccinations

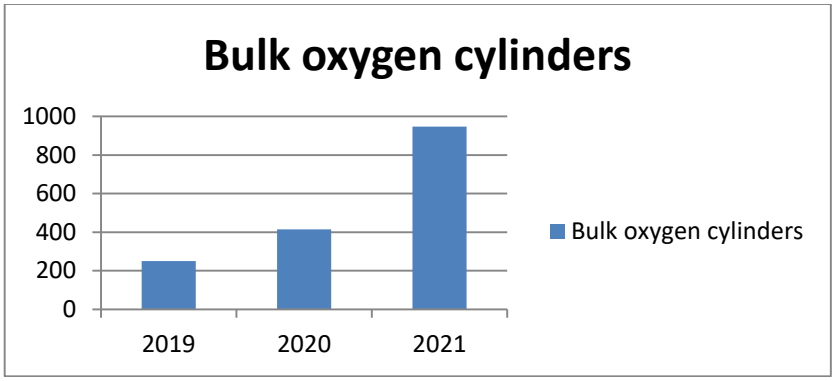
Vaccination for covid was made available within an year of its advent. Healthcare workers were particularly encouraged to receive vaccination in addition to general public.There were 1562 covid vaccinations done in 2020, and in 2021, covid vaccination was given to 17902 people (Fig 1)



	2019	2020	2021
Manifolds	3	5	8

Fig :2 Manifold augmentation during covid

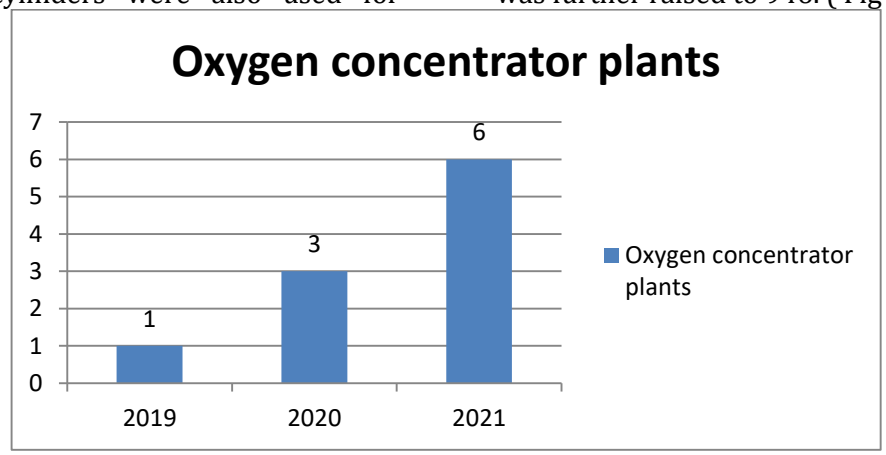
Manifold played a vital role in effective management of covid pandemic. Continuous supply of oxygen was made available through hospital manifolds that worked round the clock. Fig 2 depicts that the hospital had 3 manifolds in 2019, the number of which increased to 5 in 2020. In 2021, the hospital had installed 8 manifolds.



	2019	2020	2021
Bulk oxygen cylinders	250	414	946

Fig 3 : Bulk cylinder augmentation during covid

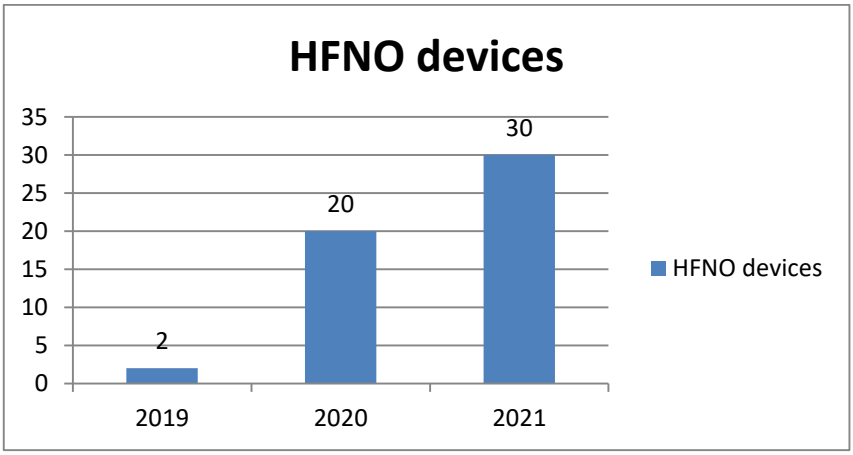
Oxygen was the cornerstone in the management of covid infection. In addition to supply of oxygen via central pipeline system, bulk oxygen cylinders were also used for treating the patients.In 2019 the hospital had 250 bulk oxygen cylinders, the number was raised to 414 in 2020, and in 2021, the number was further raised to 946. (Fig 3)



	2019	2020	2021
Oxygen concentrator plants	1	3	6

Fig 4: Oxygen concentrator plant augmentation during covid

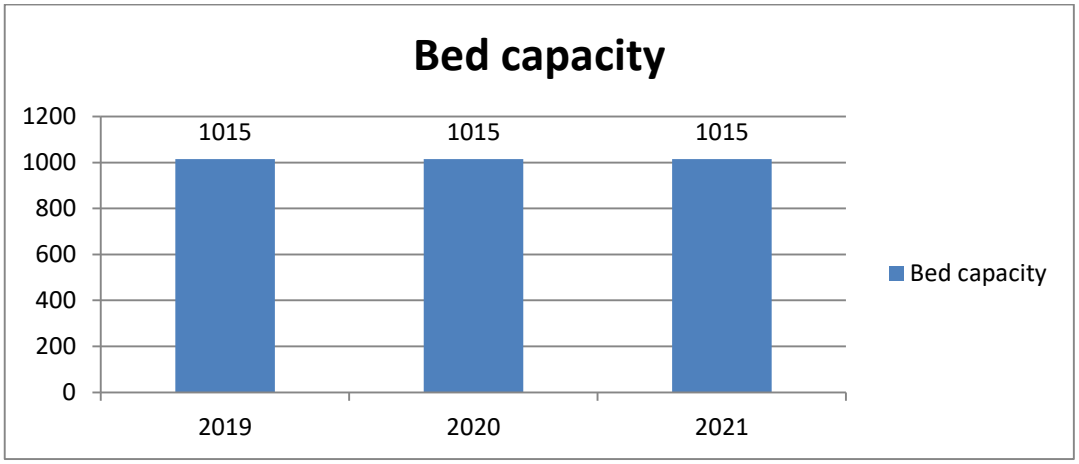
Oxygen concentrator plants were used in hospital for centralized supply of oxygen to the patients. Emergence of pandemic like covid laid emphasis on augmentation of such facilities within the hospital. Fig 4 depicts that In 2019 the hospital had only one oxygen concentrator plant, while in 2020 the number was raised to 3, and to 6 in 2021

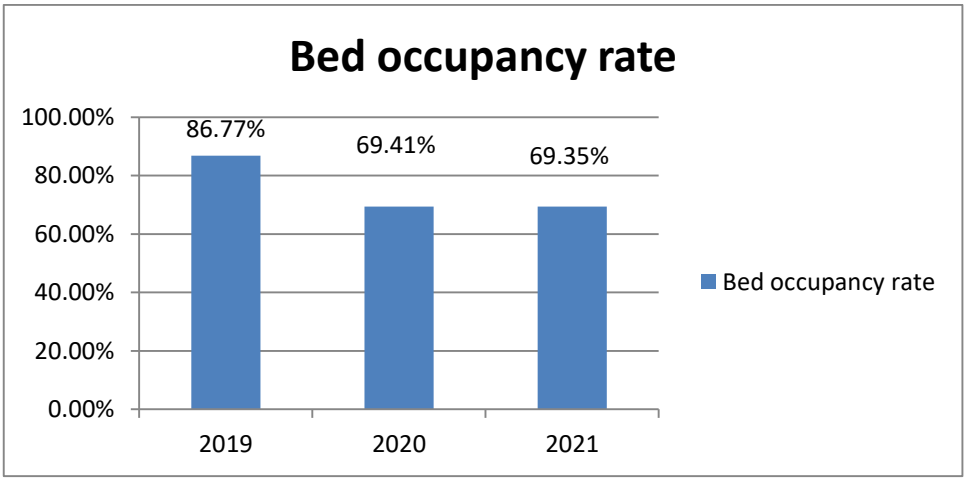


	2019	2020	2021
HFNO devices	2	20	30

Fig 5: HFNO device augmentation during covid

HFNO devices were used in covid patients having high oxygen requirement. Patients with severe covid infection and those with comorbidities required oxygen via HFNO devices. The hospital had 2 HFNO devices in 2019. In 2020 & 2021, the hospital procured more HFNO devices raising the numbers to 20 and 30 respectively. (Fig 5)

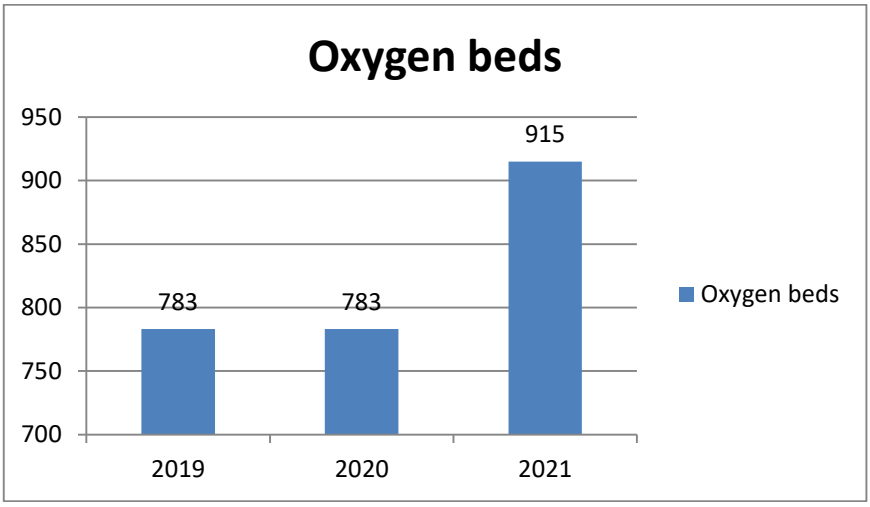




	2019	2020	2021
Bed capacity	1015	1015	1015
Bed Occupancy	86.77%	69.41%	69.35%

Fig 6 a, b : Bed capacity augmentation during covid

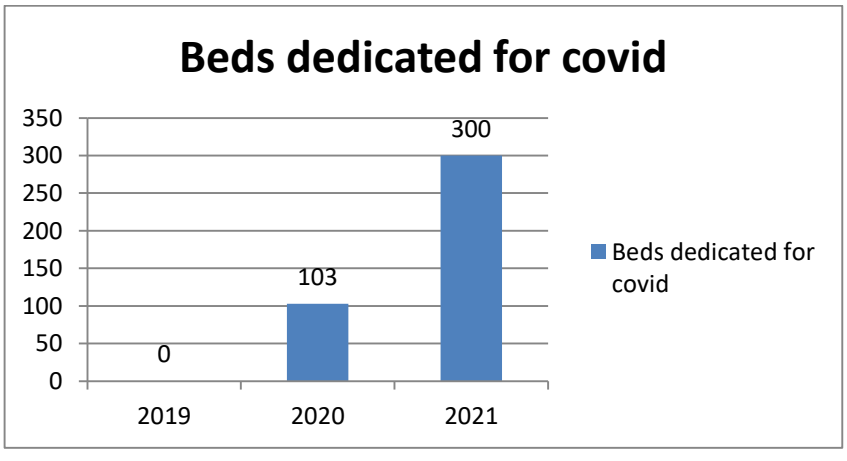
Bed capacity viz a viz occupancy- in 2019 bed capacity of the hospital was 1015 beds, with bed occupancy @ 86.77%. While the bed capacity of the hospital remained same at 1015 beds, bed occupancy was observed to be @ 69.41% and 69.35% in years 2020 and 2021 respectively. These figures indicate a drop in bed occupancy rate. (Fig 6a,b)



	2019	2020	2021
Oxygen beds	783	783	915

Fig 7 : Oxygen bed augmentation during covid

As the covid patients were acutely dependent on oxygen, there was a need to augment the oxygen beds in the hospital. In 2019, and 2020, there were 783 oxygen beds in the hospital. The number of oxygen beds was raised to 915 in 2021. (Fig 7)

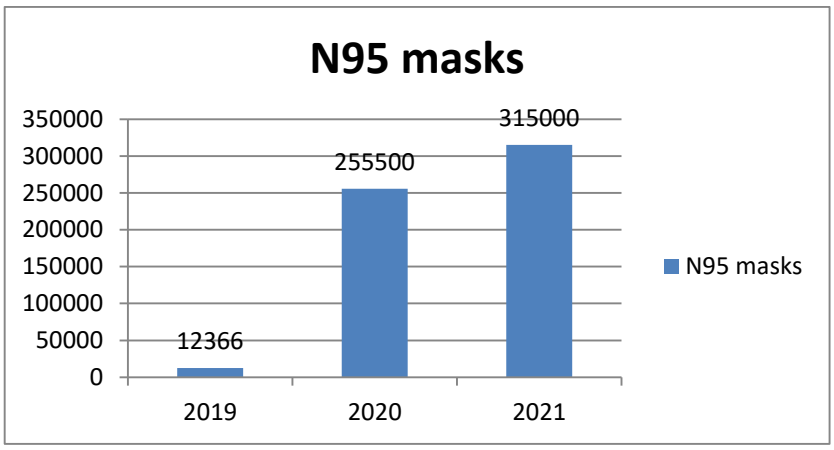


	2019	2020	2021
Beds dedicated for covid	-	103	300

Fig 8: covid bed augmentation during covid

With the advent of covid pandemic in 2019, some of the beds in hospital were dedicated

exclusively for covid patients. In 2020, beds dedicated for covid were 103, while the number rose to 300 in 2021. (Fig 8)

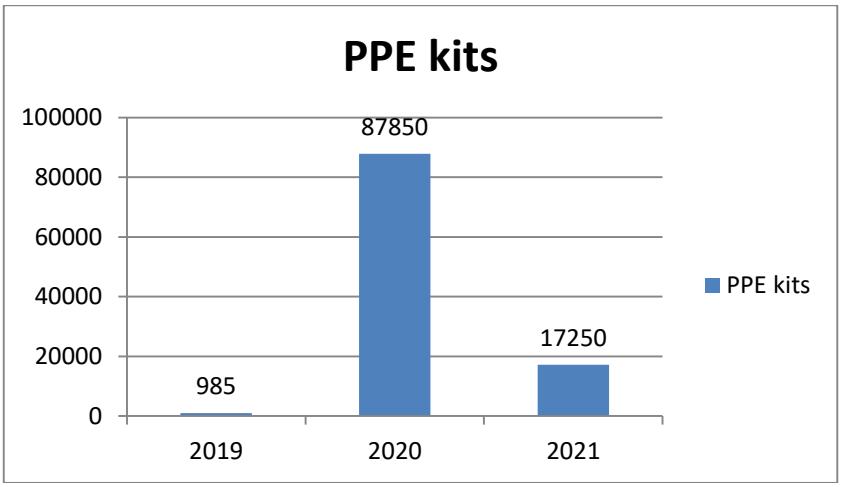


	2019	2020	2021
N95 masks	12366	255500	315000

Fig : 9 N95 mask availability augmentation during covid

N95 respirator masks played a crucial role in containing the spread of covid infection. Healthcare workers were at more risk of contracting the infection while treating the covid patients. N95 masks were made available to all healthcare staff working in the hospital.

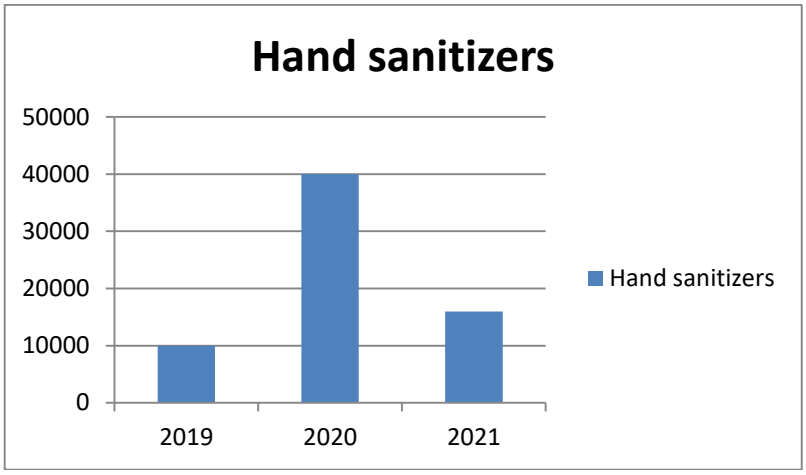
Fig 9 shows that In 2019, hospital procured 12366N95 masks and a steep rise in the number of N95 mask procurement, to the extent of 255500 & 315000 in 2020 and 2021 respectively.



	2019	2020	2021
PPE kits	985	87850	17250

Fig 10 : PPE kit availability augmentation during covid

Like N95 respirator masks PPE kits also were vital in controlling the spread if covid infection especially among the healthcare workers who worked in isolation wards. In 2019, PPE kits procured by hospital were 985, while in 2020 & 2021 the number of PPE kits procured by hospital was 87850 and 17250 respectively. (Fig 10)



	2019	2020	2021
Hand sanitizers	10000	40000	16000

Fig 11 : Hand sanitizer availability augmentation during covid

Covid pandemic revived the practice of hand hygiene using hand sanitizers. It led to increased use of hand sanitizers by both healthcare workers and general public.Hand sanitizers procured by hospital in 2019 were 10000, and the number rose to 40000 in 2020. In 2021, 16000 hand sanitizers were procured (Fig 11)

Discussion

Our study revealed that there is a huge gap in the demand and availability of required infrastructure needed to deal with pandemics. Thus it is imperative on the healthcare facilities to augment their capacities in order to deal with such pandemics in future. Capacity augmentation needs to be done in hospitals.

Our study showed that while primarily seeking to expand hospital infrastructure capacity during COVID-19 pandemic, the general idea was to find out ways to repurpose existing facilities, create new structures, and employ various remote strategies. These findings are consistent with those of other studies, notably Witcher[20], who shows that the US has rapidly increased the number of beds to serve a health care system that was expected to stretch its limits by converting a number of medical and non-medical buildings, as well as through the construction of new buildings.

Raith et al.[22] discussed repurposing a neuro-critical care unit in the UK to manage severely ill COVID-19 patients, and Deep et al.[23], described the experience of pediatric units at two tertiary hospitals in London and New York running a hybrid model of pediatric and adult critical care during the 2019 coronavirus disease. The complete repurposing is also covered by a few researchers, such as Chen et al.[24], who showed how Zhejiang University Hospital (FAHZU) accomplished the transformation from general hospital to an infectious disease hospital in response to coronavirus epidemic, and Kim et al.[25], who documented the experiences of converting a general hospital into a COVID-19 hospital (Keimyung Daegu Dongsan University Hospital, in Daegu, Republic of Korea).

The COVID-19 outbreak has also sparked the creation of some innovations integrating both concepts: hospital-at-home, telecare, and in-patient care options. The one we are interested in sharing is the “hospital without walls”. On 25 November 2020, the US Centers for Medicare and Medicaid Services (CMS) unveiled “Hospitals Without Walls”[26], as a comprehensive approach to increasing hospital capacity. This strategy entailed hospital-at-home units, ambulatory facilities, and inpatient service options. This strategy entailed hospital-at-home units, ambulatory facilities, and inpatient treatment services, which allowed patients to stay longer than usual when needed.

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