



COVID-19 Patenting Activity in Higher Educational Institutions

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In India, 2.93 crore people had been succumbed to COVID-19 on 5 June 2020.¹ Containing a series of unparalleled catastrophic event that required hedging on innovation and technologies developed by industry and academia. The purpose of the paper is to identify technologies developed at academia related to COVID-19 pandemic. The exploration by employing PATENTSCOPE COVID-19 functionality, 85 institutions were found to accumulate 1427 out of more than 6000 patents over 20 years COVID-19 technologies under 10 classifications entertained by the World Intellectual Property Organization. Finally, the reflection of COVID-19 in response to selected Indian higher educational institutions is inconclusive. The results imply policy makers to encourage the indigenous innovations in all the functionalities in combating the pandemic.

Keywords: COVID-19, Technologies, Patents, Higher Educational Institutions, Third Mission, Pandemic, PATENTSCOPE database, NIRF 2020

The novel corona virus was first reported in December 2019. By April 2020 almost half of the world population was in lockdown after it has been stated as pandemic by World Health Organization (WHO).² With the world joining together on a war, footing to counter the COVID-19 pandemic, scientists and technology developers are leveraging innovations to cement a scientific reply to counteract the novel corona virus. The government of India prioritized the progress of indigenous scientific innovations, which in turn, foster a culture of self-dependence and entrepreneurship in Indian laboratories.³ The interest of scientific community has turned towards flattening the curve, stopping the spread, racing to find more effective vaccine and in providing better health care support. The demand of the day is for the government, industry and academia to reinforce multitude of innovation efforts for a concentered response to COVID-19.

Indian higher education has also been affected due to lockdown and has encountered challenging decisions like reorganized teaching, learning and research. In the past decades universities had undergone changes driven by funding structures, increased competition addressing local needs,

geographical context which has led to development of entrepreneurial university embedded in university third mission such as engaging in academic entrepreneurship entailing patenting, licensing, spin-outs and knowledge transfer.⁴⁻⁶ University Third Mission is not the last page of evolution, since universities in emerging countries has constraints that prevent their ability to pursue third mission and had led to further extensions of mission by allowing implications at multi-level in response to contextual drivers to remain sustainable⁷ for example co-creation for sustainability and by leaving trace in environmentally sustainable technologies.^{8,9}

Given the COVID-19 situations, the university activities are further exposed to environmental influence which demands universities to demonstrate academic entrepreneurship resilience as a means to respond to the pandemic through their research efforts targeted at alleviating the economic and social impact of COVID-19 on business and communities. This dynamism stresses upon the need to identify, What kind of researches are conducted by universities to sustain amidst unforeseen shocks and a legitimate concern arises on the friction between COVID-19 and universities innovation pattern leading to ponder upon the technological responses and what type of research has been prioritized. The implication allows governing

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bodies to be prudent for laying down guidelines to scale up innovations to absorb current catastrophe that may persist probably beyond the pandemic.

It is obvious that studies concerning COVID-19 and universities are scarce. Earlier studies were focused on research publication pattern of scientific research community,¹⁰ perception of teachers and students on educational process¹¹ and COVID-19 impact on researchers.¹² Therefore, to fill the gap, it is vital to unearth research activities addressing COVID-19 through patents lens as a part of third mission.^{13,14} Patents being the measure of innovation, resource base and the tool for economic activity, acknowledging the pandemic, inadequate health infrastructure condition,¹⁵ it is prudent to disseminate information on innovative technologies that are ready to be exploited with vast potential in improving the reliability, trustability, usability, and explainability of healthcare services, thus we seek to address the gap by proving an overview of COVID-19 related patenting activity of Indian higher education system for providing a insights in on an activity that is crucial for the scientific and industrial organizations, policy makers to leverage the innovations carried at universities for accessing the intelligence for preventing, detecting and treatment of diseases.

The core idea is to capture the action of researchers on what kind of research has been prioritized and to observe measurable responses to COVID-19 reflected in university's patent filings on technologies related to artificial respiration, diagnostics, disinfections, informatics, medical equipment, medical facilities and transport, medical treatment, medical treatment/prophylactics, medical treatment/therapeutics and personal protective equipment¹⁶ facilitated by the World Intellectual Property Organization (WIPO)'s PATENTSCOPE database in 2020 to find location and retrieval of information contained in published patent documents that may be useful for innovators developing new technologies to fight the COVID-19 pandemic.¹⁶ For this study, 85 active Indian higher educational institutions are considered that has innovation reservoir for COVID related technologies. There has been an increase in records and among these, Amity University, Indian Institute of Madras and Indian Institute of Science are top applicants.

COVID-19 and Innovation

Across the world, innovations have resulted in vaccines, diagnostics test and therapeutics to control

the COVID-19. Successful conversion of research into vaccines has been appreciated and engulfed by policies through implemented vaccination programs.¹⁷ However, the current pandemic exhibits interconnected problems across multiple societal systems. In order to respond to the crisis many innovative projects are analyzed to address the fundamental human needs of consumptions, businesses and as a result several domains of innovations are addressed, especially the health sector has been concentrated.¹⁸ Further, the World Intellectual Property Organization has developed functionality related to identify COVID-19 and related technologies to fight against the pandemic.¹⁹

University Third Mission

In this technologically transforming the world University-Industry interaction plays a significant role in societal transformation. The role of universities changed from teaching, research and development activities to social engagement. The third mission is phenomena where universities socially engage with the surrounding unlike two traditional missions of education and research²⁰ and it is a vehicle to usher the collaboration with the industry.²¹ Collaboration imply formal and informal technology transfer, it involves the systematic exploitation of university resources and also associated with societal outreach.²² This pandemic has stressed the need for strengthening the blend of technology transfer and societal outreach through third mission of universities.

COVID 19 and Academia

The early research found that academia's response is always quick to public health care emergencies with a sharp increase in publications and research in areas of virology, infectious disease and immunology are focused.¹⁰ The early response from academic seems to solidify their values and allowed implication on third mission through collaboration with industry and government to develop vaccines, medical technologies and raised the question on how universities are impacted by the COVID-19.⁷ The academic researchers has revealed that there is an impact on future funding and attitude level of research sharing on pandemic and most respondents stated policy that makers had not sufficiently taken scientific advice into account to mitigate the pandemic.¹² Usually publication is the communication tool, however embracing entrepreneurial university for sustainability would transfer the knowledge through

patents also.⁸ Therefore acknowledging the social responsibility of universities and keeping the academic interest the crisis might have reflected and responded through innovation, which is still not explored in terms of generating patents on COVID-19 related technologies and is being addressed in this paper. It is believed that the information on patent volumes would aid the policy makers to identify prominent players in generating innovation and to gain interests in dissemination of scientific protected information on technologies.

World Intellectual Property Organization launched new search functionality for PATENTSCOPE database on April 2020 to facilitate retrieval of patent information for aiding scientists, policymakers, industry actors with easily accessible intelligence and to develop technologies in improving the detection, prevention and treatment of diseases such as fight against COVID-19 pandemic.¹⁹ The feature allows to access information on technologies related to artificial respiration, diagnostics, disinfections, informatics, medical equipment, medical facilities and transport, medical treatment, medical treatment/prophylactic, medical treatment/therapeutic and personal protective equipment specifying International Patent Classification (IPC) symbols.¹⁹ The patents filed in above mentioned areas were studied, with a view of providing broader landscape. For this, top 200 institutions ranked under NIRF 2020, participating in patenting activity were taken up since the frame work provides provision for accounting intellectual property rights.²³ Compromise is made to include institutions outside the scope of NIRF which prompted to search past research works dealing with the identification of institutions active in patenting,¹³ however, only few institutions were active outside the NIRF ranking thus those institutions were taken as sample as well leading 209 institutions as sample which allowed us to ascertained and narrow down institutions active in patenting activity. The rationale behind usage of specific name is that the database only allows downloading 10000 entries at time, just using the term university would retrieve institutions from all around the contracting states and entries would be more than 13 lakhs which is currently not allowed by PATENTSCOPE to download. The search results allows retrieving information on application identification number, application filing date, publication date, IPC codes, applicant and inventors names and abstracts.

Applications filed by a university is taken as unit of observation and application filed within the country, directly outside the country and filed under Patent Cooperation Treaty is considered during the years 2000-2021. A filing is considered as university patents if it is filed under the name of university or spelling variant or filed by technology transfer office of the university or co-applied with other parties. In order to ascertain if a patents falls under the scope of research, only IPC codes related to COVID-19 were counted. It should be noted that multiple IPC codes are assigned to a single patent leading to overlapping of technological areas, to address this we counted patents towards respective area of technologies leading to more entries than actual no of patents and same is adopted in case of co-applications indentified between universities. The study was conducted in following stages:

(i) Stage 1: Collection of the data of all the patents filed by the institutions. Each name of the 209 institutions was searched to obtain the results independently and consolidated for further process.

(ii) Stage 2: The consolidated information was processed to cluster spelling variant, eliminating duplicate entries, were cleaned using 'Open Refine' as in earlier research.⁹ The result arrived at around 6400 patents filing in almost in 20 years.

(iii) Stage 3: More than 100 IPC codes of COVID-19 related technologies were collected and cross verified with IPC provisions provided in the patent application entries, IPC entry with at least one COVID-19 code was considered for the count, leading to 1427 COVID-19 related patents filings with 40 % institutions were active.

(iv) Stage 4: The patents filing were classified according to institutions, areas of COVID-19 technologies, year on which application is filed and on filing within and outside the country.

It was found that very few patents were filed before 2010 (Fig. 1). However, immediately after 2019, a sharp decrease in filings is observed, the reason for the same might be reduced and constrained research activities in laborites and historic lockdown effects. To treat COVID-19 or unfortunate situations, only 85 institutions filed 1427 patents both nationally and internationally out of 6395 patent applications during the period 1 January 2000 and 31 May 2021. The patents filed by institutions in India's Regional Office and other participating National Office including PCT applications, around 20 % of filling was made outside

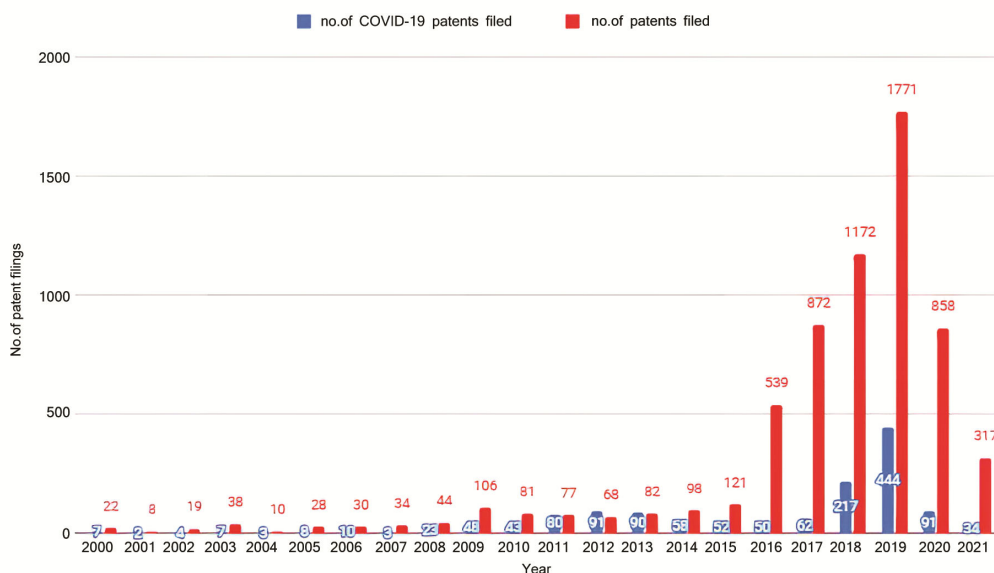


Fig. 1 — Institutions patent filings trend related to overall patents and COVID-19 during 2000-2021

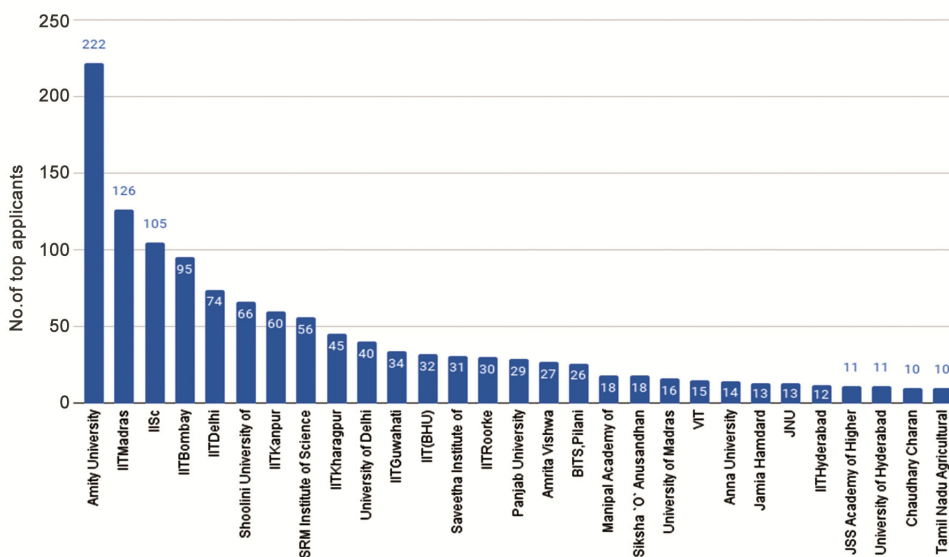


Fig. 2 — Top applicants related to COVID-19 during 2000-2021.

India and out of which 11% was for COVID-19 related technologies. Further, it was observed that better numbers of patents were filed within the country. The overall trend of patents filing and COVID-19 filing of institutions indicates towering trend from 68 in 2012 to 1771 filings in 2019 and rise in technologies related COVID-19 filings was noticed in 2016 from 50 to 444 in 2019 which is almost a 25 % to that years filings. It indicates response and importance shown by academia towards addressing health care related crisis or prioritized research subjects such as, the 2015–2016 Zika virus epidemic, the 2018–2020 Kivu Ebola epidemic, and the 2019–

2020 Corona virus outbreak worldwide.¹⁰ The highest no. of COVID related patents were recorded in 2019.

Figure 2 displays top Indian higher educational institutions which applied for securing technologies related to COVID-19. After accounting the co-applications the number arrived at 1441 respectively, Amity University placed great emphasis on filing the patents accounting to 222 (15%); followed by Indian Institute of Technology Madras 126 (8%) and Indian Institute of Technology Bombay 95 (6%) which are relatively closer. Institutions such as, Indian Institute of Technology Delhi, Shoolini University of Biotechnology and Management Science, Indian

Institute of Technology Kanpur and SRM Institute of Science and Technology filed more than 50 patents and other institutions up to Tamil Nadu Agricultural University are within the range of 3% to 0.6%. Among other 56 institutions, each filed below 0.6% and total count of remaining institutions is ascertained to 182.

The COVID-19 related technological distributions were further presented along with the IPC code and titles of the technologies with the view to provide glimpse on major themes associated with the corresponding technologies (Table 1). Word cloud highlight bigger words and shows most frequently touched theme of technologies and smaller words

represent less frequency, for example the word ‘measuring’, ‘testing’, ‘identification’, ‘micro organism’ are frequent words appeared in diagnostic related patents. Figure 3 shows COVID-19 related technologies that are distributed unevenly, most of them are skewed towards diagnostics technologies 658 (36.5%) and medical treatment 500 (28.2 %). The medially focused area are medical treatments/prophylactic 252 (15 %), medical treatments/therapeutic 195 (11.6%) and least concentrated area are medical equipment 111(6%), medical facilities and transport 27(1.4%), informatics 16(0.8%), disinfection 11(0.4%), artificial respiration 1(0.1%) and personal protective equipment 0(0%).

Table 1 — COVID-19 IPC codes and technology titles

Area of technology	IPC codes	Titles
Artificial respiration	A61H 31/00	Artificial respiration or heart stimulation, e.g. heart massage
	A61M 16/00	Devices for influencing the respiratory system of patients by gas treatment, e.g. mouth-to-mouth respiration; Tracheal tubes
Diagnostics	A61B	Diagnosis; Surgery; Identification
	A61B 1/00- A61B 16/00	Instruments for performing medical examinations of the interior of cavities or tubes of the body by visual or photographic inspection, e.g. endoscopes; Illuminating arrangements thereof
	A61B 5/00	Measuring for diagnostic purposes; Identification of persons
	A61B 5/01	Measuring for diagnostic purposes; Identification of persons + measuring temperature of body parts
	A61B 5/08	Measuring for diagnostic purposes; Identification of persons + measuring devices for evaluating the respiratory organs
	A61B 6/00	Apparatus for radiation diagnosis, e.g. combined with radiation therapy equipment
	C12Q	Measuring or testing processes involving enzymes, nucleic acids or microorganisms; Compositions or test papers thereof; Processes of preparing such compositions; Condition-responsive control in microbiological or enzymological processes
	C12Q 1/00	Measuring or testing processes involving enzymes, nucleic acids or microorganisms; compositions thereof; Processes of preparing such compositions
	C12Q 1/68	Measuring or testing processes involving enzymes, nucleic acids or microorganisms; Compositions thereof; Processes of preparing such compositions + involving nucleic acids
	C12Q 1/70	Measuring or testing processes involving enzymes, nucleic acids or microorganisms; Compositions thereof; Processes of preparing such compositions + involving virus/bacteriophage
	G01N	Investigating or analyzing materials by determining their chemical or physical properties
G01N 33/48	Investigating or analyzing materials by specific methods not covered by groups G01N1/-G01N31/131+ biological material, e.g. blood, urine; Hemocytometers	
G01N 33/569	Investigating or analyzing materials by specific methods not covered by groups G01N1/-G01N31/131+ biological material, e.g. blood, urine; Hemocytometers + chemical analysis of biological material, e.g. blood, urine; testing involving biospecific ligand binding methods; immunological testing + immunoassay; Biospecific binding assay; Materials thereof + for microorganisms, e.g. protozoa, bacteria, viruses	
Disinfection	A61L 2/00	Methods or apparatus for disinfecting or sterilizing materials or objects other than foodstuffs or contact lenses; Accessories thereof
	A61L 9/00	Disinfection, sterilization or deodorization of air

(Contd.)

Table 1 — COVID-19 IPC codes and technology titles (*Contd.*)

Area of technology	IPC codes	Titles	
	F24F 3/16	Air-conditioning systems in which conditioned primary air is supplied from one or more central stations to distributing units in the rooms or spaces where it may receive secondary treatment; Apparatus specially designed for such systems+ characterized by the treatment of the air otherwise than by heating and cooling+ by purification, e.g. by filtering; By sterilization; By ionization	
Informatics	G16B	Bioinformatics, i.e. information and communication technology specially adapted for genetic or protein-related data processing in computational molecular biology	
	G16C	Computational chemistry; Chemo informatics; Computational materials science	
	G16H	Healthcare informatics, i.e. information and communication technology specially adapted for the handling or processing of medical or healthcare data	
Medical equipment	A61B 50/00	Containers, covers, furniture or holders specially adapted for surgical or diagnostic appliances or instruments, e.g. sterile covers	
	A61B 50/39	Containers, covers, furniture or holders specially adapted for surgical or diagnostic appliances or instruments, e.g. sterile covers+ Containers specially adapted for packaging, protecting, Dispensing, collecting or disposing of surgical or diagnostic appliances or instruments+ for collecting or disposing of used articles+ the containers containing antimicrobial, antiviral or disinfectant agents	
	A61M	Devices for introducing media into, or onto, the body; Devices for transducing body media or for taking media from the body; Devices for producing or ending sleep or stupor	
	A61M 1/00	Suction or pumping devices for medical purposes; Devices for carrying-off, for treatment of, or for carrying-over, body-liquids; Drainage systems	
	B25J	Manipulators; Chambers provided with manipulation devices	
	B25J 9/00	Programme-controlled manipulators	
	C12M	Apparatus for Enzymology or Microbiology	
	C12M 3/00	Tissue, human, animal or plant cell, or virus culture apparatus	
	Medical facilities and Transport	A61G	Transport, personal conveyances, or accommodation specially adapted for patients or disabled persons; Operating tables or chairs; Chairs for dentistry; Funeral devices
		A61G 3/00	Ambulance aspects of vehicles; Vehicles with special provisions for transporting patients or disabled persons, or their personal conveyances, e.g. for facilitating access of, or for loading, wheelchairs
A61G 10/00		Treatment rooms for medical purposes	
A61G 12/00		Accommodation for nursing, e.g. in hospitals, not covered by groups A61G1/-A61G11/120; Prescription lists	
Medical treatment	A61K	Preparations for medical, dental, or toilet purposes	
	A61K 35/00	Medicinal preparations containing materials or reaction products thereof with undetermined constitution	
	A61K 45/00	Medicinal preparations containing active ingredients not provided for in groups A61K31/-A61K41/132	
Medical treatment/therapeutics	C07K	Peptides	
	A61K 31/00	Medicinal preparations containing organic active ingredients	
	A61K 33/00	Medicinal preparations containing inorganic active ingredients	
	A61K 36/00	Medicinal preparations of undetermined constitution containing material from algae, lichens, fungi or plants, or derivatives thereof, e.g. traditional herbal medicines	
	A61K 39/395	Medicinal preparations containing antigens or antibodies+ antibodies; Immunoglobulins; Immune serum, e.g. anti-lymphocytic serum	
	A61K 39/42	Medicinal preparations containing antigens or antibodies+ Antibodies; Immunoglobulins; Immune serum, e.g. anti lymphocytic serum + viral	
	A61K 39/44	Medicinal preparations containing antigens or antibodies+ Antibodies; Immunoglobulins; Immune serum, e.g. anti lymphocytic serum+ Antibodies bound to carriers	
	C07	Organic chemistry	

(Contd.)

Table 1 — COVID-19 IPC codes and technology titles (*Contd.*)

Area of technology	IPC codes	Titles
	C07D	Sugars; Derivatives thereof; Nucleosides; Nucleotides; Nucleic acids
	C07H, C07H 21/00	Compounds containing two or more mononucleotide units having separate phosphate or polyphosphate groups linked by saccharide radicals of nucleoside groups, e.g. nucleic acids
	C07K 16/10,	Immunoglobulins, e.g. monoclonal or polyclonal antibodies+ against material from viruses + from RNA viruses
	C12P	Fermentation or enzyme-using processes to synthesize a desired chemical compound or composition or to separate optical isomers from a racemic mixture
	C12P 19/34	Preparation of compounds containing saccharide radicals+ Preparation of nitrogen-containing carbohydrates + N-glycosides+ Nucleotides+ Polynucleotides, e.g. nucleic acids, oligoribonucleotides
Medical treatment/ Prophylactic	A61K 35/76	Medicinal preparations containing materials or reaction products thereof with undetermined constitution + microorganisms or materials thereof + Viruses; Sub-viral particles; Bacteriophages
	A61K 38/00	Medicinal preparations containing peptides
	A61K 39/00	Medicinal preparations containing antigens or antibodies
	A61K 39/12	Medicinal preparations containing antigens or antibodies + Viral antigens
	A61K 39/215	Medicinal preparations containing antigens or antibodies+ Viral antigens+ Coronaviridae, e.g. avian infectious bronchitis virus
	C07K 14/165	Peptides having more than 20 amino acids; Gastrins; Somatostatins; Melanotropins; Derivatives thereof+ from viruses+ RNA viruses+ Coronaviridae, e.g. avian infectious bronchitis virus
	C12N	Microorganisms or enzymes; Compositions thereof; Propagating, Preserving, or maintaining microorganisms; Mutation or genetic engineering; Culture media
	C12N 7/00	Viruses, e.g. bacteriophages; Compositions thereof; Preparation or purification thereof
	C12N 15/00	Mutation or genetic engineering; DNA or RNA concerning genetic engineering, vectors, e.g. plasmids, or their isolation, preparation or purification; Use of hosts thereof
	C12N 15/50	Mutation or genetic engineering; DNA or RNA concerning genetic engineering, vectors, e.g. plasmids, or their isolation, preparation or purification; Use of hosts thereof + Recombinant DNA-technology + DNA or RNA fragments; Modified forms thereof+ Genes encoding microbial proteins, e.g. enterotoxins + Genes encoding viral proteins+ Proteins from RNA viruses, e.g. flaviviruses+ Coronaviridae, e.g. infectious bronchitis virus, transmissible gastroenteritis virus
Personal protective equipment	A41D 13/11	Professional, industrial or sporting protective garments, e.g. surgeons' gowns or garments protecting against blows or punches+ protecting only a particular body part + protective face masks, e.g. for surgical use, or for use in foul atmospheres
	A41D 13/12	Professional, industrial or sporting protective garments, e.g. surgeons' gowns or garments protecting against blows or punches+ surgeons' or patients' gowns or dresses
	A61B 42/00	Surgical gloves; Finger-stalls specially adapted for surgery; devices for handling or treatment thereof
	A61F 9/04	Methods or devices for treatment of the eyes; Devices for putting in contact-lenses; Devices to correct squinting; Apparatus to guide the blind; Protective devices for the eyes, carried on the body or in the hand+ Eye-masks
	A62B 7/00 -A62B 33/00	Respiratory apparatus
	A62B 18/02	Breathing masks or helmets, e.g. affording protection against chemical agents or for use at high altitudes + Masks
	A62B 23/00	Filters for breathing-protection purposes
	A62B 23/02	Filters for breathing-protection purposes + for respirators
	A62D 5/00	Composition of materials for coverings or clothing affording protection against harmful chemical agents
	A62D 7/00	Composition of materials for transparent parts of gas-masks, respirators, breathing bags, or helmets
	A62D 9/00	Composition of chemical substances for use in breathing apparatus

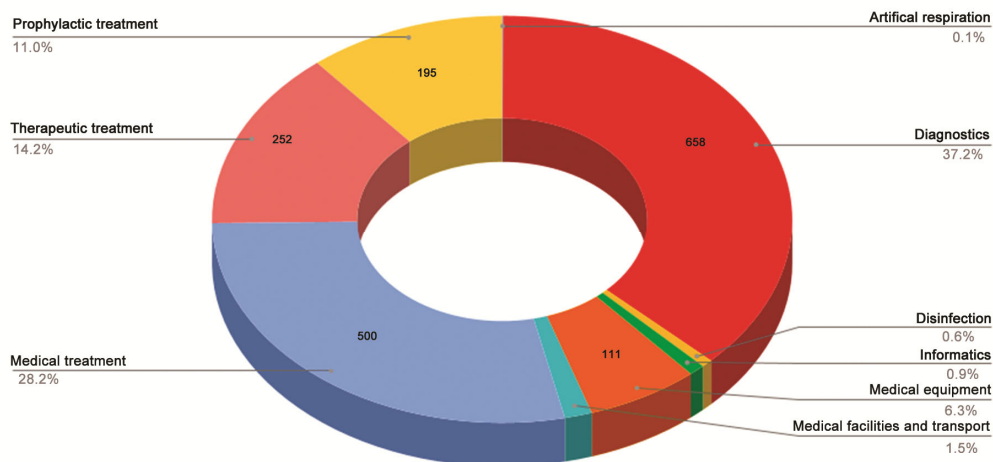


Fig. 3 — Top technologies related to COVID-19 during 2000-2021

The ongoing COVID pandemic has spread in unprecedented speed and spurring the researcher's consideration.¹⁰ The sharp increase in patents substantiates the response of limited top academia to public health crises in any variants. The technologies developed at universities substantially different across the units, word cloud provide a purview of mostly conceived technologies to measure, to prevent, to treat the COVID-19. None of the selected institutions have developed any technologies in the line of personal protective kit and least concentrated area of filings were medical facilities and transport, informatics, disinfection 11, artificial respiration which require more attention.

On the other hand, it is premature to decide that the filings are response to COVID-19, since the filing related to COVID-19 is high before the announcement of outbreak and plausibility that it might be response of earlier outbreak. Usually a research dimension gets momentum once the announcement is made and a growth is expected for two to three years and the idea of academic¹⁰ response might be misplaced if we thought sudden filing is because of COVID-19. In this case, it assumed other outbreaks or foresights in the trends pandemic might have led to sharp increase in filing and it is acknowledge that the filing would have increased if it is not for lockdown, as most of the researchers in India reported the regular flow of work was disturbed and lacuna in funding for academic research.¹² The core of academic entrepreneurship is to fund the research; therefore filing of patents can be leveraged by licensing or startups and it seems institutions adjusting to transformation by responding to the environment through generating patents as part

of academic entrepreneurship paving ways for strengthening third mission. Since, this study was conducted at micro level, the scope may be widened by including the research institutions, industries, few more countries would provide clearer picture and findings. The mapping of transferred patents to industry is major drawback. The future study may confirm the academia response to COVID-19 and post COVID-19 innovation efforts in a scientific way. Insights on comparisons of worst affected countries could be observed patent filings.

Conclusion

It was observed the patent was the base of top higher educational institutions in relation to COVID-19 technologies in terms of filings in areas of artificial respiration, diagnostics, disinfection, informatics, medical equipment, medical facilities and transport, medical treatment, medical treatment therapeutics, medical treatment/prophylactic, personal protective equipment's using PATENTSCOPE COVID-19 functionality and evidence response at early stage of COVID-19 pandemic. The work testimony institutions have accumulated technologies to counter unexpected crisis to limited extent, however, response to COVID-19 is somewhat inconclusive since there was dip in filing COVID related technologies in 2020. Certain institutions have placed notable emphasis on areas graphed by WIPO. However, limited institutions only have engulfed developing patents and many institutions relativity to patents in the theme of the study is low. The primarily focused area is diagnostics and medical treatments. sustained attention is necessary from such kind of institutions for possible

technologies to cover up unprecedented future outbreaks especially in India, being one of the worst affected in second wave and fear of third wave is in the air, therefore identifying, inflating technologies would aid policy makers to make strategic decision and acknowledge the efforts put forth by top academia as efforts of third mission.

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