Potential Markets

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In this project, we are going to explore some potential markets in United States and intend to discover some critical opportunities for Panasonic ventilation production

Motivation

According to EPA (https://www.epa.gov/coronavirus/ventilation-and-coronavirus-covid-19), an important approach to lowering the concentrations of indoor air pollutants or contaminants including any viruses that may be in the air is to increase ventilation – the amount of outdoor air coming indoors. Ensuring proper ventilation with outside air can help reduce the concentration of airborne contaminants, including viruses, indoors.

The ventilation rate should be based on the number of people that occupy an indoor space (and a few other factors), people should give special consideration to increased ventilation when occupancy increases and for areas with high-traffic. Improving ventilation also benefits indoor air quality by reducing exposure to products used for cleaning and disinfecting potentially contaminated surfaces.

When used along with other best practices recommended by CDC and others, increasing ventilation can be part of a plan to protect people indoors.

Initial Research for Potential Markets

- Elderly Care Facilities, Day Care Centers
- Hotel Rooms
- College Dormitories, School Classrooms
- Multifamily Housing
- Doctor Office, Dentist Clinic
- Hospital Rooms

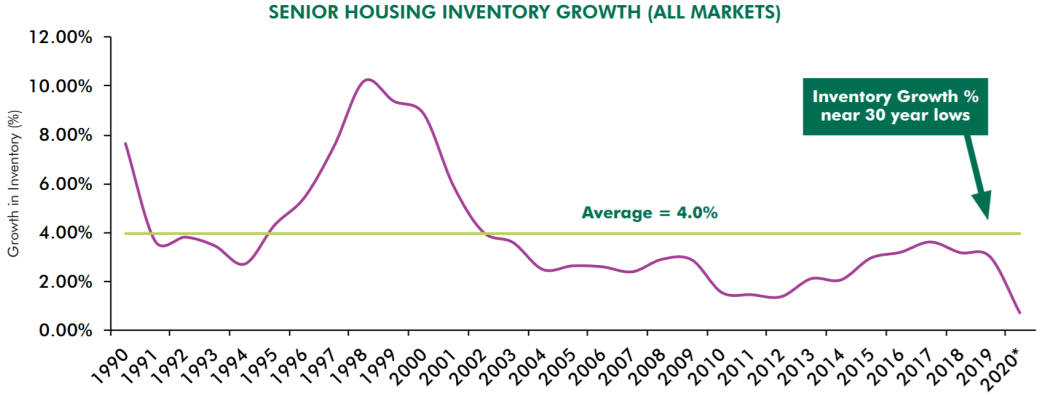
Elderly Care Facilities, Day Care Centers

Elderly Care Facilities

This market has had steady growth while year over year varies. While the segment may not have significant growth trajectory, one key component to note is the attention ventilation will receive due to virus transmission.

With a year-over-year growth rate of 2.9% in 2020 (annualizing Q1 data), inventory growth has contracted below the 30-year average annual growth rate of 4.0%.[5]

The Senior Housing pipeline (rolling four quarters construction versus inventory) was 2.48% in Q1 2020, dipping 73 basis points from the 2019 average of 3.21%. In Q1 2020 there were approximately 3,481 units/beds of new construction starts for Primary and Secondary Market areas.[5] The COVID-19 pandemic has caused a construction in debt to fund new construction. Q2 2020 new construction is expected to be at low levels not seen



*Source: NIC MAP Data & Analysis Service, Q1 2020 Supply Report; All Markets. *2020 is YTD through Q1.*

(https://www.cbre.us/-/media/cbre/countryunitedstates/media/files/services/senior-housing/senior-housing-market-insight-q1-2020.pdf)

Opportunity

1. Pragmatic steps for long-term care facilities

Acoording to the recent publication (https://www.jamda.com/article/S1525-8610(20)30320-0/pdf) by The Society for Post-Acute and Long-Term Care Medicine(AMDA), the Ventilation should follow these standards,

- Control of airflow essential, for instance, A 2400 cubic feet room should receiving approximately 80 cubic feet per minute (cfm) of outdoor air.
- Install supplemental exhaust ventilation through dedicated exhaust portals, for example, a 250-cfm booster fan would increase the air exchange rate by approximately 6.5 ACH.
- Increase efficiency of filtration, All rooms are typically equipped with MERV (minimum efficiency reporting value) 7 prefilters and MERV 14 final filters, which remove up to 98% of airborne particles as small as 0.3 to 1.0 mm in diameter (typical diameter of respiratory droplets)
- Keep doors to hallways closed and follow infectious disease prevention guidelines(CDC)

2. ANI/ASHRAE/ASHE Standard 170-2017

Following is the most up to date standard for senior-caring facilities and has a strong focus on the filtration requirements, which could be utilized under pandemic scenario.

Table 6-1 Minimum Filter Efficiencies

Space Designation (According to Function)	Filter Bank Number 1 (MERV)[a]	Filter Bank Number 2 (MERV) [a]
Resident care, treatment and support areas in Inpatient Hospice Facilities	13	N/R
Resident care, treatment and support areas in Assisted Living Facilities	7	N/R

(https://www.nafahq.org/wp-content/uploads/Moeller.pdf)

3. Researchers alarm the outbreak

There are multiple independent researchers (https://www.ahcancal.org/News-and-Communications/Fact-Sheets/FactSheets/Analysis-COVID-Outbreaks-in-Nursing-Homes.pdf) indicates that community spread is linked to outbreaks in nursing homes. In early March, the alarming outbreak in senior living complex, Seattle, shows the vulnerability of long-term care facilities.

Day Care Centers

In year 2020, there are 643,538 existing Day Care centers in US with a total of 1,519,664 industry employment. Through year 2015-2020 the industry has a stable growth of 2.4% in revenue annually.

Although some day care centers are required to stay open,these facilities are expected to experience increased purchase costs as they must increase spending on sanitizing facilities(Toys) and personal protective equipment for employees, thus leading to an expected 8.1% decline in 2020 alone.

US Day Care (https://www.ibisworld.com/united-states/market-research-reports/day-care-industry/) has four major divsions and includes following:

- In-home day care
- Center-based day care
- Pre-primary grade instructional programs
- Other services and programs

Opportunity

1. Provide support for essential workers

On the child care market report of Federal Reserve Bank of Minneapolis (https://www.minneapolisfed.org/article/2020/covid-19-challenges-the-child-care-market), majority of the healthcare workers strived with a huge burden, about a quarter of the health care and first responder workforce would require child care.

Nevertheless, the potential child day care market may increase as in the later period of reopening, 34 to 43 percent of the total U.S. workforce hold jobs in industries that the Department of Homeland Security designates as critical infrastructure.

2. Designed ventalation for children

National resouce center has published Caring for Our Children(CFOC) (https://nrckids.org/CFOC/Database/5.2.1) suggested that day care center for kids would keep a draft-free temperature of 68°F to 75°F with 30%-50% relative humidity during the winter months.

The study focus on building an asthma friendly environment (http://www.nhlbi.nih.gov/health/public/lung/asthma/chc_chk.pdf) because of the high prevalence rates of allergic and respiratory symptoms among young children, whose immune system is still under-developed. CFOC suggests that filters in forced-air heating and cooling system equipment should be checked and cleaned or replaced according to the manufacturer's instructions on a regular basis, at least every three months and more often if necessary.

- 5.2.1.2 (https://nrckids.org/CFOC/Database/5.2.1.2) Indoor Temperature and Humidity
- 5.2.1.3 (https://nrckids.org/CFOC/Database/5.2.1.3) Heating and Ventilation Equipment Inspection and Maintenance
- 5.2.1.4 (https://nrckids.org/CFOC/Database/5.2.1.4) Ventilation When Using Art Materials
- 5.2.1.5 (https://nrckids.org/CFOC/Database/5.2.1.5) Ventilation of Recently Carpeted or Paneled Areas
- 5.2.1.6 (https://nrckids.org/CFOC/Database/5.2.1.6) Ventilation to Control Odors

3. Special-designed ventilation implementation

In Oregon, such implementation has already taken in place according to **Goddard Childcare**, a nationwide childcare provider. The Organization released "Operational Blueprint for School Rentry saftey guidelines (https://www.oregon.gov/ode/students-and-family/healthsafety/Documents/thegoddardschoolbethany.pdf)

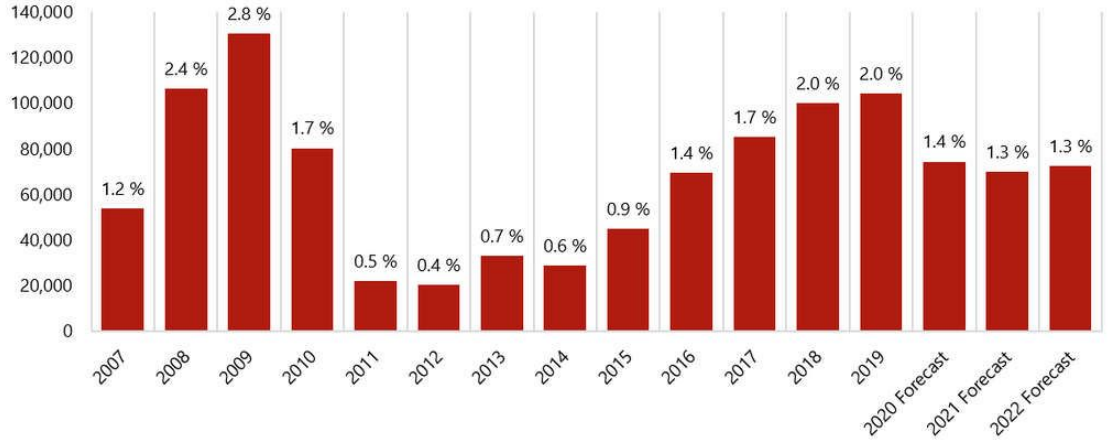
U.S. General Services Administration (https://sftool.gov/learn/about/502/child-care-centers#classroom) also recommend to implement a whole-system approach to the design of new or replacement building systems in a child care center will maximize energy conservation while balancing the necessities of child safety and health. **A child care center's HVAC system is generally independent from the rest of the building, including separate controls.** Include careful balancing and commissioning to accommodate the need for fresh air with specific ventilation requirements, especially in restrooms and food preparation areas. Supply air systems include automation controls that pull the system back to pre-determined set points when the spaces are not in regular use. Energy loads can be further reduced by using glass for windows and doors that has a high insulative value while maintaining a high visible light transmittance (VLT). Proper lighting design, including occupancy sensors, will limit the heat generated by electric lights, often left on in child care centers through the entire day, other than nap times.

Hotel Rooms

Hotel Rooms

According to the American Hotel & Lodging Association (AHLA),there is a 2.0% increase in supply in 2019 representing approximately 104,000 new hotel rooms; new supply growth resulting from new hotels is projected to increase by 1.4% by year-end 2020, and then to moderate to 1.3% in 2021 and 2022, per STR. Prior to the onset of COVID-19, STR had initially projected new supply to grow by 2.0% in 2020; the revised forecast for 2020 suggests that a number of hotel developments will not reach completion this year.

As of July 2020, 217,000 new hotel rooms were under construction across the country, reflecting hotels likely to open in the next 18 months. Additionally, at the same time, 260,000 rooms were in the final planning stages and expected to begin construction within the next twelve months. Similar to the last recession of 2008/09, lower revenue, NOI, and estimated values may result in some projects being placed on hold until revenues levels once again support the feasibility of development.



(https://www.ahla.com/dreams)

Opportunity

1. Improve air quality in the public space for high risk worker

WHO (https://www.who.int/news-room/q-a-detail/coronavirus-disease-covid-19-ventilation-and-air-conditioning-in-public-spaces-and-buildings) would recommend on enhance the current ventilation standards for tourist accommodation and hotel workers who are considered as individuals at a medium or high risk of exposure to COVID-19. It is important to keep the air recirculation according to HVAC professional's standards.

- Generate clean-to-less-clean air movements by re-evaluating the positioning of supply and exhaust air diffusers and/or dampers and adjusting zone supply and exhaust flow rates to establish measurable pressure differentials.
- Increase central air filtration to as high as possible without diminishing design airflow. Regular inspection for filters is required for housing and racks to ensure appropriate filter fit and check for ways to minimize filter bypass
- Ensure exhaust fans in restroom facilities are functional and operating at full capacity when the building is occupied.

2. Consider seprated ventilation between hotel rooms

For hotels, imporved ventilation has become a feature to promote to bring customers back. Major chains, including MGM Resorts International and the Four Seasons, have advertised that they are enhancing ventilation systems, and smaller companies have gotten in on the movement as well.

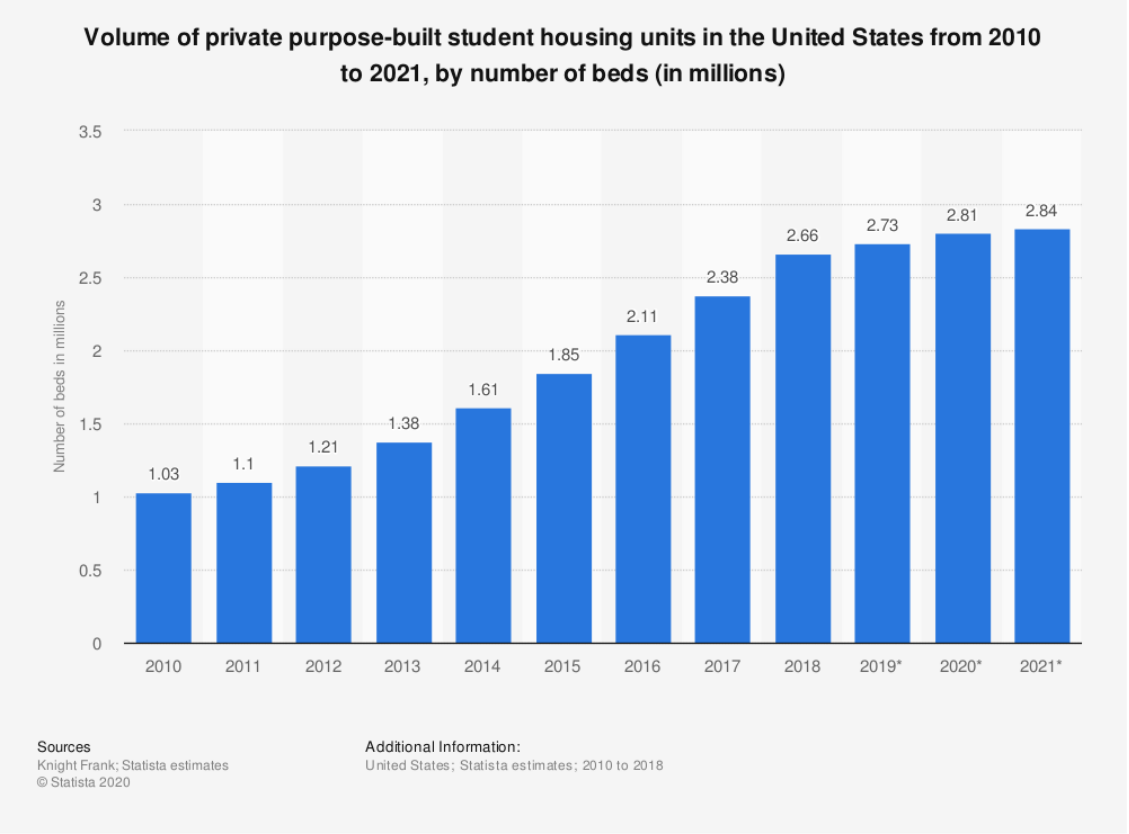
Washington Post (https://www.washingtonpost.com/travel/tips/hotel-ac-ventilation-covid/) interviewed with several epidemiologists and lised their suggestions,

- Opening the window to increasing the exchanging airflow
- Holding a room vacant between guests and spacing out for air circulating
- Bringing a personal air filter could help mitigate the risk.

College Dormitories,School Classrooms

College Dormitories

This statistic shows the volume of student housing units in the United States from 2010 to 2021. In 2018, there were 2.66 million student beds in the United States, which is set to increase to 2.84 million by 2021 with the annual growth approximately 45,000 bed per year.



*Forecast: beds under construction and planned.

Opportunity

1. Dilute potential contaminants in campus buildings

CDC (https://www.cdc.gov/coronavirus/2019-ncov/community/colleges-universities/considerations.html) has certified an detail guidelines for the operation of univeristy buildings from ASHRAE.

- Increase total airflow supply to occupied spaces, when possible.
- Disable demand-controlled ventilation controls that reduce air supply based on occupancy or temperature during occupied hours.
- Further open minimum outdoor air dampers to reduce or eliminate HVAC air recirculation.
- Use portable high-efficiency particulate air fan/filtration systems

2. Guidance for building operations during the COVID-19

Additional notes by ASHRAE (https://www.ashrae.org/file%20library/technical%20resources/ashrae%20journal/2020journaldocuments/72-74_ieq_schoen.pdf) showed that During covid-19, HVAC is essential for improving the indoor air quality and even more significant are social distancing, hygiene and the influence we can have on personal behavior

• Increase outdoor air ventilation (use caution in highly polluted areas); with a lower population in the building, this increases the effective dilution ventilation per person. • Disable demand-controlled ventilation (DCV). • Further open minimum outdoor air dampers, as high as 100%, thus eliminating recirculation (in the mild weather season, this need not affect thermal comfort or humidity, but clearly becomes more difficult in extreme weather). • Improve central air filtration to the MERV-13 or the highest compatible with the filter rack, and seal edges of the filter to limit bypass. • Keep systems running longer hours, if possible 24/7, to enhance the two actions above. • Consider portable room air cleaners with HEPA filters. • Consider UVGI (ultraviolet germicidal irradiation),

Classrooms for PK–12 Education

One perspective would be projection on the number of educational institutions (https://nces.ed.gov/fastfacts/display.asp?id=372#PK12_enrollment) including special education, alternative, and other schools not classified by grade span.

Opportunity

1. Poor ventilation inside schools, especially in older buildings

In fact, the U.S. Government Accountability Office said in a report (https://www.nea.org/advocating-for-change/new-from-nea/school-ventilation-must-be-addressed-reopening-plans) in June that to prevent the spread of the coronavirus among schooling students, more than 41% of school districts need to update or replace their heating, ventilation, and air conditioning systems in at least half of their buildings.

Some major problem would be fresh air vents were blocked with insulation, zone valves were removed or defective, and fresh air dampers that allow outside air in to circulate had been disconnected or were defective.

2. Prioritizes and renovate the system with existing standards

ASHRAE EPIDEMIC TASK FORCE (https://www.ashrae.org/file%20library/technical%20resources/covid-19/ashrae-reopening-schools-and-universities-c19-guidance.pdf) suggested following the instruction for renovation for K-12, Higher education institutions opened, with the extended implementation period and the ventilation system can be improved by

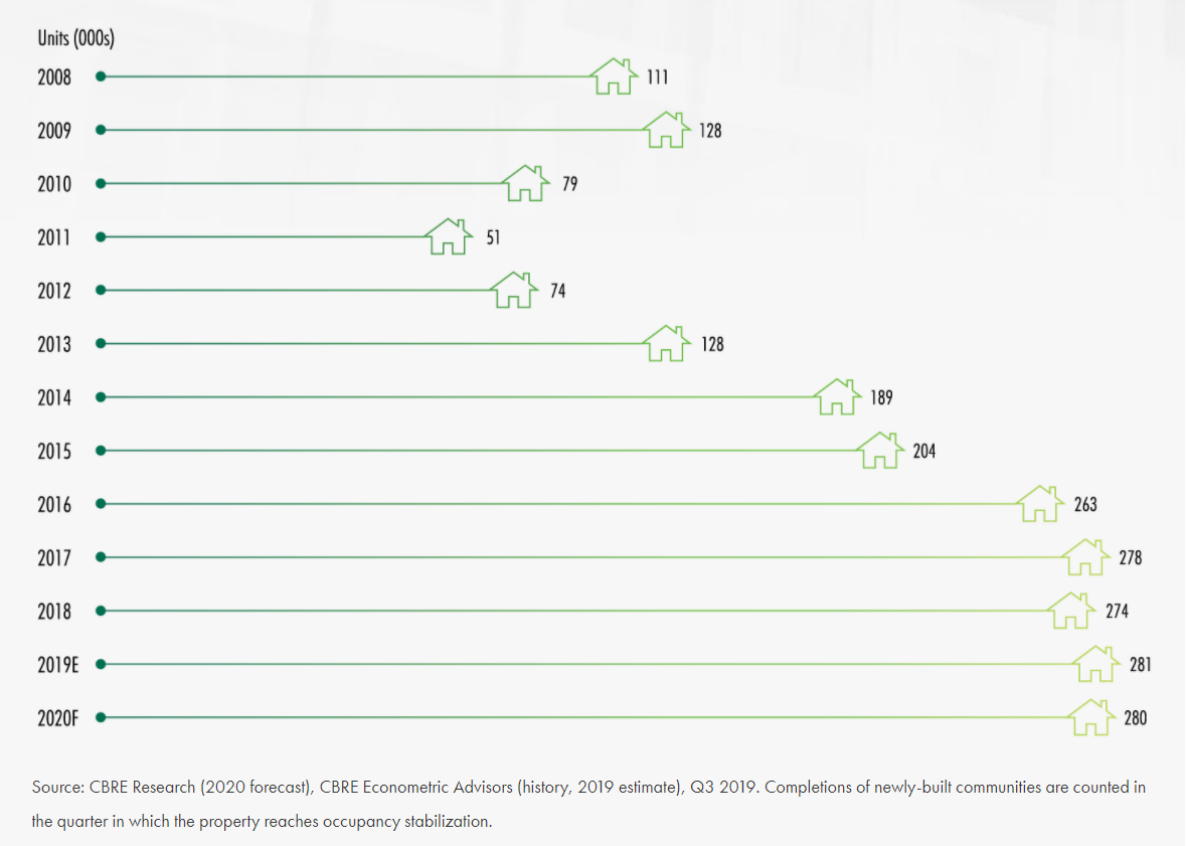
- Installing portable High Efficiency Particulate Air (HEPA) filters in rooms.
- Flushing air two hours before and after occupation.
- Upgrading MERV-8 to MERV-13 filters where appropriate.

Multifamily Housing

Multifamily Housing

For the multifamily housing market in 2020, CBRE Research predicted that permits and starts likely will fall, but not deliveries. Thus the completion amount still remain substantia. In 2020, multifamily completions will total 280,000 units, on par with 2019's estimated 281,000 units.

Permits, starts and completions were all at or near this cycle's highest levels in 2019.Development will continue in both urban and suburban locations next year and no doubt, multifamily developers will remain very active in 2020.



(https://www.cbre.us/research-and-reports/2020-US-Real-Estate-Market-Outlook-Multifamily)

Opportunity

1.Ensure adequate ventilation

According to CDC (https://www.cdc.gov/coronavirus/2019-ncov/community/multifamily-housing.html#GuidingPrinciples)'s latest guideline, multifamily housing need to be aware of following standards and more:

- Disable demand-controlled ventilation (DCV) controls that reduce air supply based on occupancy or temperature during occupied hours.
- Use portable high-efficiency particulate air (HEPA) fan/filtration systems to help enhance air cleaning, especially in higher risk areas such as common spaces.
- Generate clean-to-less-clean air movement by re-evaluating the positioning of supply and exhaust air diffusers or dampers, especially in higher-risk areas such as common spaces.
- Consider using ultraviolet germicidal irradiationpdf iconexternal icon (UVGI) as a supplement to help inactivate SARS-CoV-2, especially if options for increasing room ventilation are limited.
- Consider running the HVAC system at maximum outside airflow for 2 hours before and after the space is occupied.

2.Multihousing settings in common arear

ASHRAE Standard 62.2-2016 requires a continuous ventilation rate of 45 cfm for a onebedroom enclosure of 1,000 ft2 floor area. ASHRAE Standard 62.2-2016 only allows credit for infiltration in horizontally attached (i.e., low-rise) multifamily units

However, the current standards may be improved with accommodation with corridors, elevator shafts, and trash chutes

- Individual corridor supply fans should be replaced by a central rooftop system that supplies ventilation air to each corridor
- Elevator shafts should be equipped with an exhaust flow fan which is controlled by a constant airflow regulator to compensate for seasonal stack-effect variation.
- Trash chute should be maintained at a negative pressure

3.Dilution Ventilation vs. Displacement Ventilation

Displacement ventilation leads to cleaner air comparing to the mixing ventilation, as contaminants are removed from the occupied zone in a room towards the ceiling, as well as minimizing drafts.

With displacement ventilation, air is introduced at low velocity into a room at a low level and is exhausted at the ceiling. The flow of air is maintained by convective forces, which also have the effect of the concentration of pollutants rising from floor to ceiling.

For now, displacement ventilation is used mostly in Europe, and rarely in residential applications.

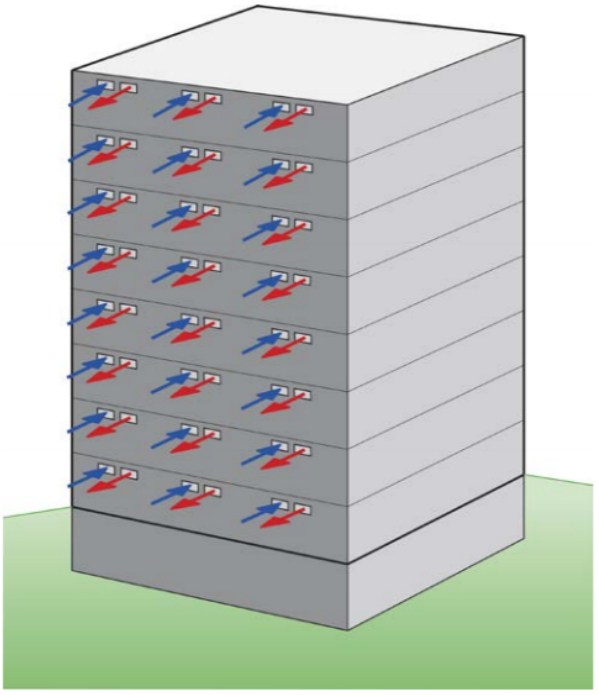


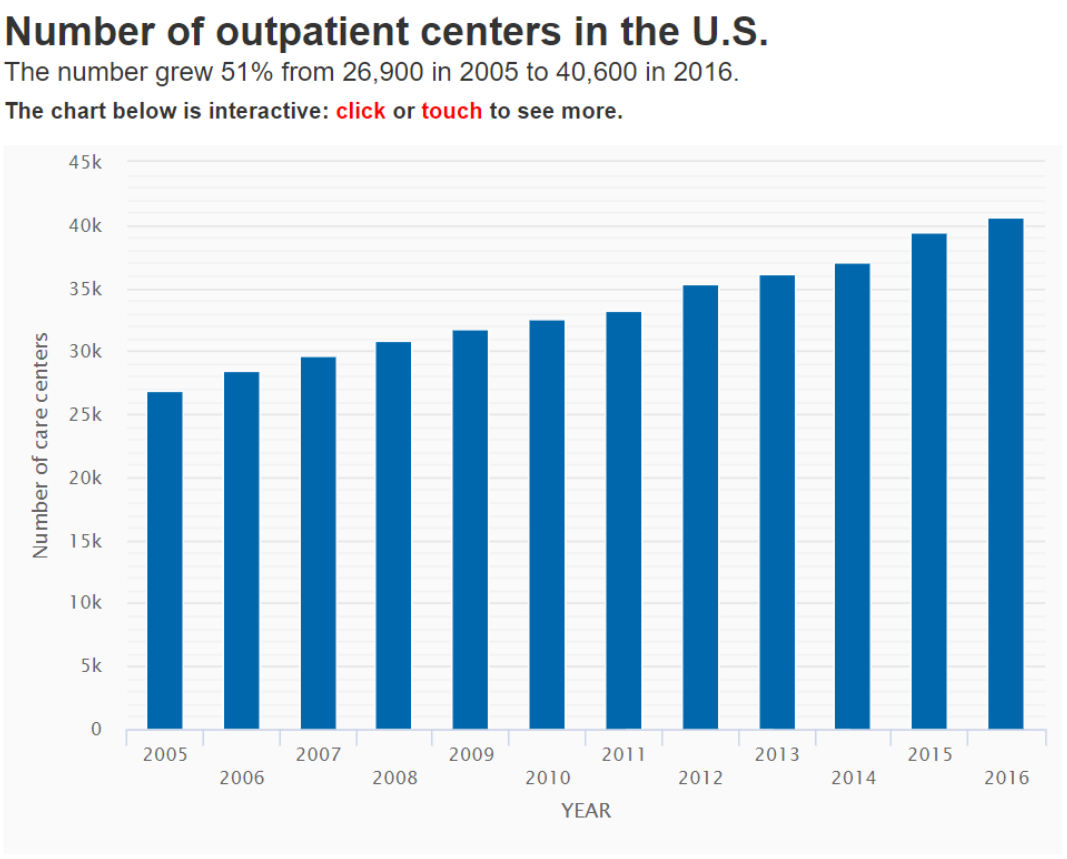
Figure 1. Only balanced ventilation strategies are recommended for most multifamily construction

(https://www1.eere.energy.gov/buildings/publications/pdfs/building_america/67581.pdf)

Doctors' Office, Dentist Clinic

Doctors' Office & Outpatient Clinic

Centers for Disease Control(CDC) has published statistics on the Office-based Physician Visits, 2016 (https://www.cdc.gov/nchs/products/databriefs/db331.htm), in 2016, there were an estimated 883.7 million office-based physician visits in the United States and there were an estimated 278 office-based physician visits per 100 persons.



Source: CBRE analysis of U.S. Census data

Modern Healthcare

(https://www.modernhealthcare.com/article/20181220/NEWS/181229992/number-of-outpatient-facilities-surges-as-industry-values-more-convenient-affordable-care#:~:text=Number%20of%20outpatient%20centers%20in,2005%20to%2040%2C600%20in%202016)

As one doctor would treat approximately 4 patients who would visit 3 times annually, the doctor offices in United States would be at least 73,641,666 in 2016.

However, the prediction for doctor offices would also be affect by the numbers of hospital, the budget and growth of full time equivalent for doctors.

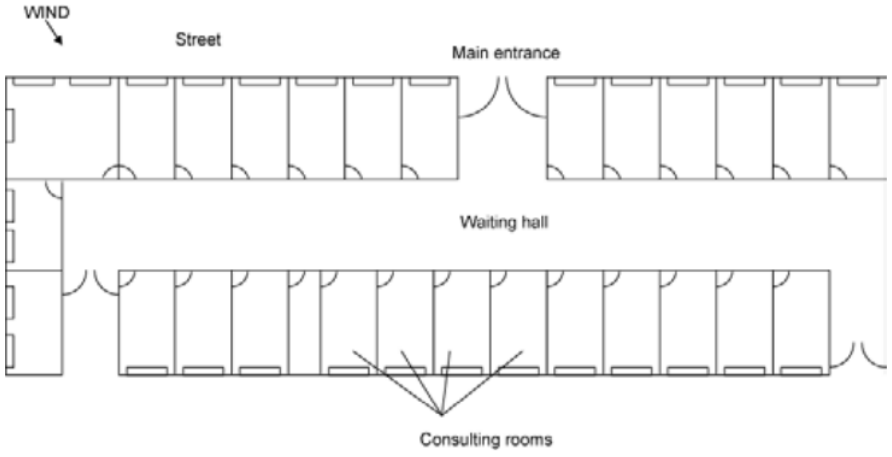
Opportunity

1. Sepical designs to tackle patient flow issues

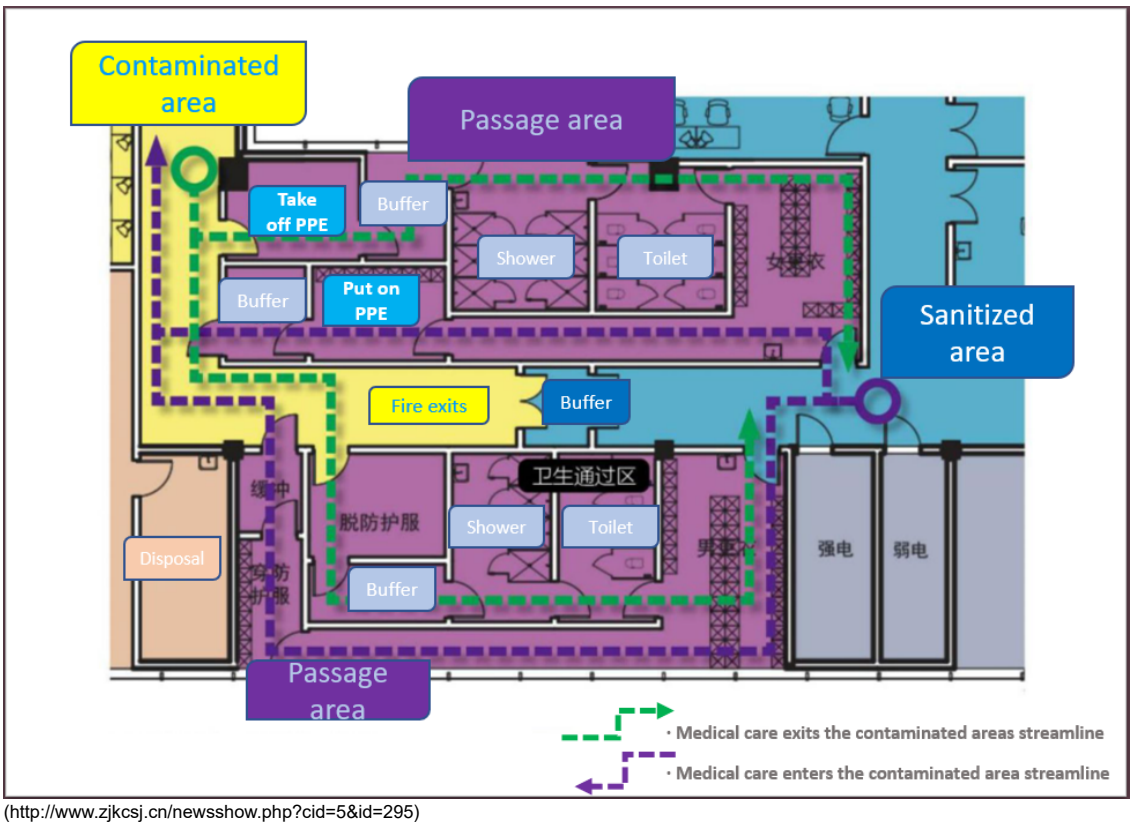
According to WHO (https://www.who.int/water_sanitation_health/publications/natural_ventilation.pdf)'s Natural Ventilation for Infection Control in Health-Care Settings

Usually, there will be up to 300 patients share this room during consulting hours in the mornings and afternoons. The current outbreak of Covid-19 has already burden the medical system, which remarks the importance of a frequently ventilated and disinfected public areas. The ventilation rate should increase from a mean of 6.5 ACH to 15 ACH with the new design in the general outpatient waiting room.

- The waiting area for general outpatients (including most medical specialties, surgery and psychiatry) is located in the large hall shown in the photograph.
- The consulting rooms lead off from both sides of this waiting hall.



2. Prevent cross-infection between doctors and patients



(http://www.zjkcsj.cn/newsshow.php?cid=5&id=295)

- Hospitals should set up mechanical ventilation systems in different zones. (clean areas, contaminated areas, buffer rooms)
- Admission inspection in contaminated areas (negative pressure) and the mechanical ventilation system of the discharge disinfection treatment area (positive pressure) should be set up independently, and should not be used in combination with the ward.
- Adopt positive pressure buffer isolation method, that is, set the air supply not less than 30 times/h in **passage area**. The compartment is equipped with a short D300 ventilation pipe, and the airflow flows from the clean area to the isolation area.

Dentist Clinic

The guidelines from US Oral Health Workforce Projections, 2017-2030 (https://bhw.hrsa.gov/sites/default/files/bhw/health-workforce-analysis/research/projections/oral-health-2017-2030.pdf) showed that the national demand for dentists is projected to increase by 9 percent acrossing the industry to 206,850 FTEs in 2030, while the demand for pediatric dentists (2 percent) and orthodontists (-1 percent) is expected to grow slowly or not at all (Exhibit 1).

The projection of the overall dentists'office in 2030 in the US would be 1,344,525

Adjusting for the number of offuce in practical, Current standards (https://blog.hjtdesign.com/how-many-dental-operatories) suggest that five to eight operatories may be the perfect and the number for any office with a single dentist and the working environment should include following features:

- 3 operation room per dentist at least
- 2 full-time hygienists' operating room
- 1 optional common office managing the flow of traffic

Opportunity

1. Guidance for Dental Settings, adding HEPA filtration

CDC and American Dental Association (https://www.cdc.gov/coronavirus/2019-ncov/hcp/dental-settings.html) have updated some of the dental setting in the recent article,

- Air movement must move in from adjacent areas.
- Minimum air changes of outdoor air per hour is two.
- Air may not be recirculated by means of room units.

Rather than just relying on the building's HVAC system capacity, use a HEPA air filtration unit to reduce aerosol concentrations in the room and increase the effectiveness of the turnover time.

Place the HEPA unit near the patient's chair, but not behind the DHCP. Ensure the DHCP are not positioned between the unit and the patient's mouth. Position the unit to ensure that it does not pull air into or past the breathing zone of the DHCP.

Moreover, considering dental offices have patients with different health histories and they may be more susceptible to infections from bioaerosols, it would be better to avoid aerosol generating procedures

Hospital Rooms

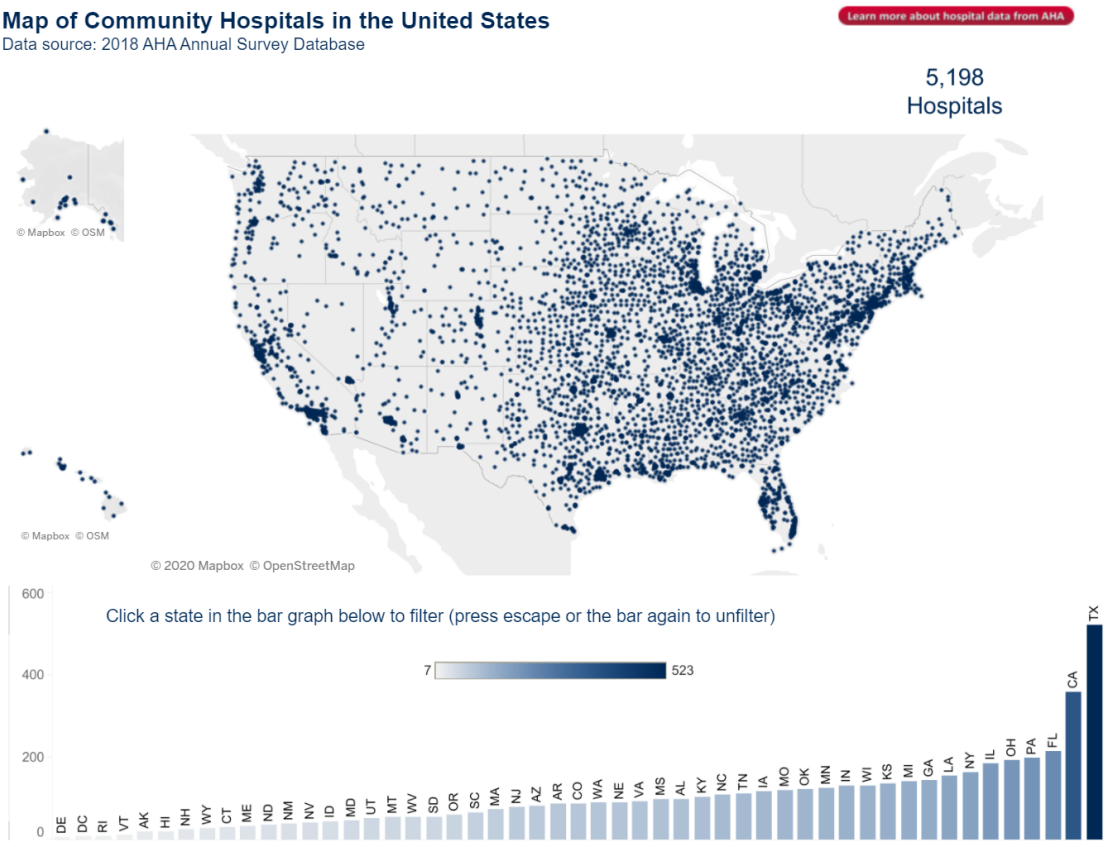
Hospital Rooms

US hospital system has four major divsions and includes following

- U.S. Community hospital —— 84.60%
- Federal Government Hospitals —— 3.40%
- Nonfederal Psychiatric Hospitals —— 10.00%
- Other Hospitals for nonfederal long term care hospitals and hospital units within an institution such as a prison hospital or school infirmary —— 2.00%

There are of total 6,146 US hospital from the AHA hospital statistic published 2018 statistics, where staffed beds could count up to 924,107.

Comapring to the total of 5,534 US hospital in 2016, the CAGR accounts for 5.376%



(https://www.aha.org/statistics/2020-01-07-archived-fast-facts-us-hospitals-2019)

Opportunity

1. Airborne Infections Isolation (AII) Room

AII room, also known as Negative pressure ward, has a restrctive setting (https://www.cdc.gov/tb/webcourses/course/chapter7/7_infection_control_7_infection_control_program_airborne_infection_isolation_aii_room.html) guide by CDC.

A special high efficiency air (HEPA) filter that removes most (99.97%) of the droplet nuclei before it is returned to the general circulation has to be implemented.

2. The Increment for Single Patient Rooms

“The Use of Single Patient Rooms versus Multiple Occupancy Rooms in Acute Care Environments” (https://www.healthdesign.org/sites/default/files/use_of_single_patient_rooms_v_multiple_occ._rooms-acute_care.pdf)strongly suggested that it is critical that infected patients or patients highly susceptible to infections need to be isolated in private rooms with proper ventilation.

What’s more, preliminary findings at Bronson Methodist Hospital in Michigan demonstrate that private rooms, with well-design air-flow have resulted in a 10 to 11 percent decline in overall nosocomial infections rates