CovidStats: Development and Implementation of a Daily COVID-19 Clinical Dashboard in an Urban Teaching Hospital

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Background and Objectives: Dashboards have been utilized in health care to improve quality and patient care. The purpose of our project was to create a concise, timely, and accurate dashboard for administrative and clinical leadership during the COVID-19 pandemic. Methods: Two authors collaborated to identify 14 metrics and design a comprehensive dashboard (CovidStats, CS) using Microsoft Excel. The dashboard was updated daily and distributed to leadership between December 2020 and April 2021. The utility of this quality measure was assessed by survey of hospital leadership. Results: The 14 metrics included were as follows: (1) elective surgery census threshold; (2) daily COVID admissions; (3) daily COVID discharges; (4) net COVID admissions; (5) ED (emergency department) bed holds; (6) COVID ED bed holds; (7) hospital census; (8) percent COVID census; (9) active COVID census; (10) COVID ICU (intensive care unit); (11) MICU (medical ICU) census; (12) ventilators in use; (13) high-flow oxygen devices in use; and (14) weekly hospital census. The leadership response survey revealed unanimous approval for CS, with a mean rating of 4.9 ± 0.3 (rated 1-5). Conclusions: Effective clinical dashboards can be created using affordable basic computer software. Implementation of the CS dashboard conveyed relevant and timely information, which influenced the decision making of hospital leadership during the COVID-19 pandemic.

Key words: coronavirus, COVID-19, dashboard, informatics

The coronavirus disease 2019 (COVID-19) pandemic has significantly strained the medical system for the past year. In March 2020, influxes of patients with hypoxemic respiratory failure began presenting to New York City hospital systems in unprecedented numbers. Our institution, which is an urban community teaching hospital in New York City that has 711 beds, about 125,000 emergency department (ED) visits per year, 34,000 adult admissions per year, and 5600 employees, was heavily affected by the initial surge of COVID-19 pandemic. During the COVID pandemic, our hospital expanded to accommodate an additional influx of COVID-positive patients, which included increasing our intensive care bed capacity to add a total of 10 intensive care units (ICUs). Relevant information relating to the management of both clinical and administrative operations needed to be disseminated to appropriate leadership throughout the medical center in a reliable, timely manner. Dashboards—tools adapted from the business sector—are used to summarize and integrate key information across an organization into a visual display in order to rapidly inform operational decision-making. Clinical dashboards have been utilized in health care to provide immediate access to information for clinicians, improve adherence to quality guidelines, and potentially improve patient outcomes. Relevant COVID dashboards were created at the national, state, and local levels to provide real-time data on numerous important, relevant variables, such as percent positivity in any given area as well as hospitalization rates, ICU, and ventilator use. Publicly available dashboards include the CDC COVID Dashboard, the COVID Tracking Project, NYC Health COVID Dashboard, the New York Times COVID Dashboard, and Johns Hopkins COVID Dashboard. Others have reported clinical dashboards created with advanced software during the COVID-19 pandemic, though their platforms were not particularly focused on augmenting decision-making capabilities for hospital operations.

Given what our organization learned during the first COVID wave regarding the crucial value of real-time information in decision making, during our second wave, we spearheaded a clinician-focused daily COVID dashboard designated “CovidStats” (CS). It was distributed not only to senior clinical and administrative leadership but also widely throughout the organization to help provide as much visibility, situational awareness, and lead time as possible to many of our associates. In this article, we present how and why we created CS—as well as the results of a survey of key members of our hospital leadership to demonstrate the value added by CS—so that others may consider our budget-neutral approach to enhance the ability of their...
Integrating the aforementioned data sources, all graphs were created utilizing a combination of Excel and PowerPoint (Microsoft Office, Microsoft Corporation, Redmond, Washington). Although hospital leadership distributed some of the described data in a tabular format, part of the value of CS was the rapid ability to visually detect potential concerning trends in any of our tracked variables (*vide infra*).

As a metric to evaluate the utility and value addition of CS, a survey was disseminated to the following members of our hospital leadership: (1) hospital president and CEO; (2) executive vice president and COO; (3) chair of the department of emergency medicine and vice president of medical affairs (VPMA); (4) chief nursing officer; (5) vice-chair of the Department of Medicine; (6) vice president of academic affairs (designated institutional official); (7) chair of the Department of Medicine; (8) senior vice president of operations and clinical programs; and (9) vice president of finance/supply chain. The survey itself consisted of 3 questions: (1) “Did you find the daily CS graphs to be of value in helping you run the organization?” (yes/no); (2) “On a scale of 1-5 (1 being least valuable, 5 being most valuable), how valuable would you say CS was during the second COVID surge?”; and (3) “Please provide free-text comments regarding the value of CS to you personally in your role as a leader running the organization.”

**RESULTS**

**Weekly hospital census**
The stratified hospital 7-day average census starting with the COVID surge in March 2020 is demonstrated in Figure 1. The graph clearly demonstrates the initial surge of COVID-positive patients from March to May 2020. Our second wave of COVID patients started in December 2020 and continued to rise to a peak in mid-February 2021. Some of the salient points from Figure 1 include the following: the difference in the volume of patients in the first wave versus our second wave, as well as the rapidity with which the first wave dissipated in contradistinction to our second wave that was more prolonged. In addition, we superimposed our 2019 week-for-week data to allow us to compare our total volumes with a recent—but COVID-negative—time frame. Finally, we would note that, for numerous complex reasons, during the first wave, there was a significant drop in COVID-negative patients, a phenomenon that was not observed during the second wave.

**Daily COVID admissions**
In Figure 2, we present our control chart for daily COVID admissions. Here we worked with our colleagues from the patient flow services department to determine at 8 AM each day how many patients had been admitted in the previous calendar day (midnight to midnight) with a primary admitting diagnosis of COVID (active via a test vs suspected). The
issue of suspected COVID arose from the first wave when we had limitations/bottlenecks regarding testing for COVID. Key important components of this chart include the following: (1) the 7-day running average, which was of particular value to our CEO, COO, VPMA, as well as our chief nursing officer; (2) as a control chart, when we had 7 points in a row below the average, we would realign the mean and 95% CI. This gave a clear visual presentation regarding changes in the average number of COVID admissions; (3) it was recommended by members of senior leadership that we add in relevant holidays to determine if any upticks in

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COVID admissions could be related to holiday-related disease-spreading events.

**Total active COVID patients in house**

Figure 3 was the initial graph that was created as part of CS. This represents patients who are on “active COVID isolation” in our hospital. The clear linear rise in active COVID patients from December 5, 2020, rising to a peak on January 16, 2021, should be noted. During this rise, it was extremely unclear when and at what point this peak would stop. There were numerous complex issues that were worked out among our Division of Infectious Disease, as well as our Section on Infection Control, in terms of how long patients needed to remain on our “COVID isolation status.” It is beyond the scope of this article to describe all of these issues in detail, but it was critical that all members of the team were speaking with a **lingua franca** regarding when a patient was considered “active COVID” or “no longer infectious.” It was difficult during the first wave to determine all these issues with certainty, given both the volume of admissions and lack of testing ability; during our second phase, this particular process was both fully agreed upon by all relevant stakeholders and implemented with greater facility.

**Medical intensive care unit capacity**

Another component of CS was the MICU bed capacity, and how many of those patients were COVID positive, in addition to maximum surge capacity. This chart helped inform administrators and clinicians of the current status of ICU beds and anticipate the potential need for additional ICU capacity. There was great concern that we might have to handle a potential “twindemic” of COVID respiratory failure and influenza. Although this did not come to pass, it was one of the reasons that we superimposed the COVID-positive ICU data on the total ICU data. We also utilized this chart to present how many patients in that unit were being managed with extracorporeal life support (ECMO) as they are a particularly resource-intensive group of patients, and our hospital had limited ECMO capacity.

**Respiratory care equipment utilization and capacity**

Total ventilator and high-flow utilization in the hospital are demonstrated in Figures 4A and 4B. These are vital metrics for the allocation of respiratory equipment during the pandemic as was demonstrated during the first wave of the pandemic. Specific comments regarding these graphs would include the following: (1) in Figure 4A, we clarified not only the total number of ventilators but also how many were our advanced (Servo-u) ventilators, to ensure optimal use of such equipment; (2) the leadership of our Department of Anesthesia (in charge of performing intubations throughout our medical center) was particularly interested in the COVID ventilator use metric as a leading indicator of overall burden of disease; (3) it was extremely critical that we knew exactly how many ventilators were in use at any given time since (as we learned during the first wave) our hospital oxygen system required external oxygen supplementation via mobile sources if the number of ventilators
increased beyond a certain critical threshold; (4) the use of high-flow nasal cannula oxygen was felt by the critical care leadership to be a leading indicator of severity of disease and also (somewhat paradoxically) a concerning sign if high-flow use decreased while ventilator use simultaneously increased.

**Census to potentially cease elective surgery**

A graphic of the modified total hospital census was created as a metric used to determine how close our daily hospital census was to an agreed-upon threshold (with state officials) that if exceeded would mandate action and potentially limit elective surgical...

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Figure 4. (A) Ventilators used and (B) high-flow oxygen devices used in the hospital.
Table. Results From the Hospital Leadership Survey

| Member | CovidStats of Value (Yes/No) | Rating (1, Being Least Valuable; 5, Being Most Valuable) | Comments |
|--------|-----------------------------|------------------------------------------------------|----------|
| 1      | Yes                         | 4                                                   | The stats were essential in judging the need for facility and staffing adjustments as well as for developing communications for the organization. They helped us understand the materiality of what we were reacting to and trying to stay ahead of. |
| 2      | Yes                         | 5                                                   | I happen to be a visual person and the Daily COVID Stats graphs provides all the information I need to know about the current state of the hospital in a simple format. If more detail is necessary, the graphs point out the area(s) for further examination. |
| 3      | Yes                         | 5                                                   | The availability of relevant, timely data and information to manage patient care delivery and patient throughput is a primary characteristic of a high performing organization—especially during a period of increased patient demand for care. Daily CovidStats consistently supported my need for real-time information to effectively make decisions regarding hospital operations with both clinical and executive teams. |
| 4      | Yes                         | 5                                                   | These graphs provided us with a daily insight into how the virus was affecting our organizational throughput and capacity concerns. It also gave us clarity in terms of usage of our ventilators/high flows and COVID trends in the MICU. |
| 5      | Yes                         | 5                                                   | A very useful summary of a large amount of data. The information is presented in a format that enables us to easily see trends, and to assimilate data quickly on a daily basis. |
| 6      | Yes                         | 5                                                   | Excellent daily account of the state of COVID patient census as well as recent/historical view. Valuable for planning the resource necessary to surge and respond to patient care needs. |
| 7      | Yes                         | 5                                                   | As VP of Supply Chain getting current concisely presented data enabled faster reaction to daily needs and anticipation of future requirements. |
| 8      | Yes                         | 5                                                   | The CovidStats graph has been instrumental in providing insight into the patient and disease trends, allowing us to plan ahead for necessary personnel and supplies. The graphs significantly complemented our usual organizational dashboards and provided COVID-specific insights that were not easy to pull out of the overall organizational data. The CovidStats graphs also provided a unified data source that painted a complete picture of the COVID operation at our institution. |
| 9      | Yes                         | 5                                                   | The CovidStats graph has been instrumental in providing insight into the patient and disease trends, allowing us to plan ahead for necessary personnel and supplies. The graphs significantly complemented our usual organizational dashboards and provided COVID-specific insights that were not easy to pull out of the overall organizational data. The CovidStats graphs also provided a unified data source that painted a complete picture of the COVID operation at our institution. |

Results of senior hospital leadership survey

The Table depicts the results of the survey of 9 members of senior hospital leadership. All responders stated that CS was of value to them. Their average response (1-5 scale as described earlier) was 4.9 ± 0.3. The following themes emerged from leadership’s free-text survey responses: the ability to anticipate future resource and operational demands, the importance of a shared and centralized dashboard with multidisciplinary input, and its ease of use. In terms of a germane free-text response from one hospital leader:

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From an operations standpoint, one member of senior leadership stated:

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DISCUSSION

In summary, our article describes the creation and implementation of CS, which was utilized as a tool at our institution to facilitate key clinical and operational decisions during our hospital’s second COVID surge. As demonstrated by feedback from our hospital leadership, CS became an essential resource for managing these unprecedented issues.

A crucial factor in the success of this platform was collaboration amongst a multidisciplinary team of clinicians and administrative leadership. In a review of the relevant literature, Kaplan et al13 described that, most consistently, team leadership, group climate, group process, team quality improvement (QI) skills, and clinician involvement on the QI team are associated with success. The need for clinician involvement in QI has been recognized, and there is emerging evidence that high-performing organizations benefit from clinician leadership in improving care.14-16 The CS dashboard was designed and implemented by 2 of our local clinician leaders who realized there was a demand for relevant, reliable, timely COVID data amongst hospital leadership in order to make daily decisions. It was essential to have clinicians involved in the creation and implementation of the dashboard because they understood which information would be clinically relevant and important to disseminate to other stakeholders.

Prior to the creation of the dashboard, leadership did not have an easily decipherable tool to quickly determine trends in patient volume, availability of respiratory equipment, and ICU capacity. Subsequently, real-time feedback regarding CS was incorporated from clinical and administrative colleagues to define and refine the 14 variables for graphical representation.

Quality dashboards provide information on standardized performance metrics at a unit or organizational level to leaders in order to assist with operational decision-making.1 The CS dashboard was designed to be easily decipherable for hospital leadership, contained essential and relevant information trending over time, and provided surge thresholds in order to convey the predictive urgency of possible impending risk of overwhelmed hospital resources. In addition, CS was updated daily and provided prompt up-to-date information that was easily accessible. Dashboards were used by our institution in the past for throughput, capacity, and operations management; yet, CS provided a customized dashboard during the COVID clinical crisis that provided a real-time snapshot of the most important factors to moderate operations for the system as a whole.

These distinctive features of the CS dashboard were essential in contributing to the effectiveness and success of the platform. This is evident from the gathered survey responses of leadership, which convey significant satisfaction with CS. In summary of the survey free text, leadership members stated that CS effectively provided a concise summary of relevant and timely data on the state of our hospital that easily enabled them to see trends in order to plan and anticipate necessary clinical and operational modifications during the COVID-19 pandemic.

Another advantage of CS was the relative simplicity and feasibility of its creation. Microsoft Excel—a basic and easily accessible software available in most hospitals—was utilized for the CS graph creation. This was a low-cost, efficient system that did not require additional complex software, hiring of technologic support, or significant training. The creation of the daily graphs included in the dashboard was produced by an active clinician leader using built-in Microsoft Excel functions with a reasonable time commitment (~30 minutes daily).

Given the unique nature of the pandemic and the need for accurate, succinct, and timely information, this specific platform and content may not be generalizable to all populations, but the concept and practicality of implementing a low-cost visual dashboard can be utilized for many different clinical and operational circumstances. In addition, though our dashboard lacks some of the interactive functionality of commercially developed dashboards, it provided an effective, budget-neutral, informative platform for hospital leadership to make crucial decisions during an unprecedented time. Finally, to create such a dashboard, one must have access to and some familiarity with Microsoft Excel; this software, however, is commonly available, and the functions are relatively straightforward to learn. No additional advanced training in coding or design is required.

CONCLUSIONS

Our project describes the creation and implementation of a low-cost clinical and quality dashboard created for leadership during the COVID-19 pandemic that was utilized as a tool for clinical and operational challenges. This concept can be practically extrapolated and used for other operational and clinical predicaments in which concise, timely, and accurate information is required. Our institution continues to use this template for operational management of daily activities and an updated daily e-mail has continued to be sent out to hospital leadership to assist in day-to-day decisions.

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