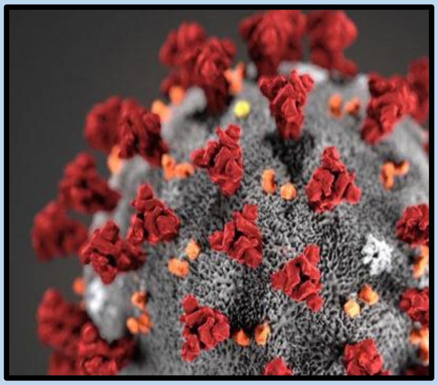
# MEMA COVID-19 BURN RATE PROJECTION PLANNING TOOL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# COVID-19 BURN RATE PROJECTION PLANNING TOOL

## Maryland Emergency Management Agency

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**Special thanks to all of the agencies and team members who made this report possible, all the agencies and facilities that provided daily reports, and all of the healthcare workers, responders, volunteers, and staff across the state who worked tirelessly during the COVID-19 Pandemic response.**

This report is not a replacement to previous burn rate methodology reports, but is in fact intended as the summation of the development of the Tool. To better understand the data collection and initial burn rate process driving the core of this tool, please reference the *MEMA COVID-19 Burn Rate Methodology Summary Report*. (Available upon request to MEMA)

# I. Executive Summary

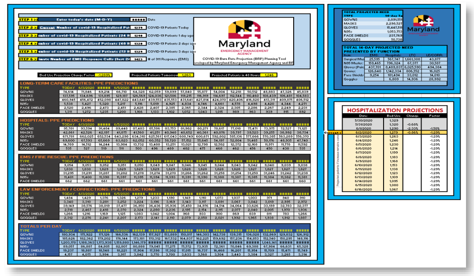


Figure 1: Screenshot of the Maryland Future Planning Burn Rate Projection (BRP) Tool.

This report summarizes three specific items: The Maryland Burn Rate Projection (BRP) Planning Tool, use of the BRP Tool, and the background methodology and data used to develop the BRP Tool.

The Maryland BRP Planning Tool development was driven by need to support several critical planning factors:

- A single tool for projecting personal protective Equipment (PPE) burn rate across the state.
- An intuitive tool requiring no special training.
- Accurate data-driven projections.

Figure 2: Members of the Maryland Air National Guard 175th Logistics Readiness Squadron load medical supplies and equipment at the Maryland Strategic National Stockpile. (Photo by Master Sgt. Christopher Schepers)

During the COVID-19 Pandemic response the State of Maryland designed and implemented a robust burn rate tracking process. This process involved the collection of local level burn rate reports from facilities around the state combined with powerful modeling tools. The process allowed the Maryland Emergency Management Agency (MEMA) to accurately capture and project statewide burn rates, a process crucial to meet Federal Emergency Management Agency (FEMA) requirements. As a result of this in depth process, Maryland qualified for and received numerous shipments of critical Personal Protective Equipment (PPE) from the federal government.

Additionally, the process provided a unique opportunity to MEMA. The process resulted in the cataloging of thousands of daily burn rate reports from around the state. From this robust dataset the MEMA Burn Rate Team was able to construct a powerful projection tool that utilized formulas built on real-world data collected over two months during the peak of the initial COVID-19 response.

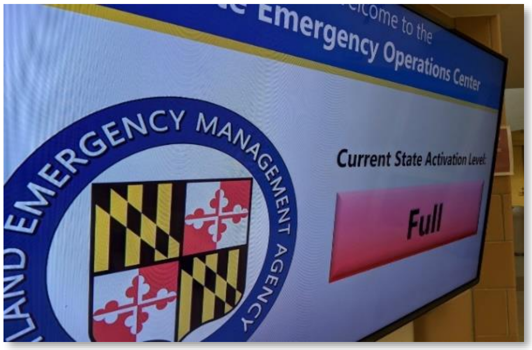
The new tool greatly enhances state planning abilities and contains instrumental features including:

- Projected changes in hospitalizations.
- Statewide burn rate across critical infrastructure functions such as hospitals and long-term care facilities.
- Burn rate projections per county for use by county level emergency planners.


Sound planning will bolster Maryland's preparedness should subsequent waves of the COVID-19 or similar viruses emerge in the future. Embracing a forward thinking posture as response transitioned into recovery, MEMA began evaluating lessons learned and crucial data collected from the March-May, 2020 COVID-19 Pandemic Response. The new BRP tool is just one of many valuable planning tools resulting from MEMA's proactive posture. This report includes detailed analytics on the data and processes that led to the development of this powerful planning tool.

This report is not a replacement to previous burn rate methodology reports, but is in fact intended as the summation of the development of the Tool. To better understand the data collection and initial burn rate process driving the core of this tool, please reference the *MEMA COVID-19 Burn Rate Methodology Summary Report*. (Available upon request to MEMA)

# II. Background




Effective response and mitigation during the COVID-19 Pandemic Response relied heavily on innovative solutions to track and report accurate and verifiable burn rates of PPE. The Maryland Emergency Management Agency (MEMA) implemented a resourceful solution activating a dedicated Burn Rate Team within the Resources Section to focus on resource and Logistic Future Planning at the State Emergency Operations Center (SEOC).

To capture the granular level data needed for accurate burn rate projections and planning during the initial COVID-19 Pandemic Response, the MEMA Burn Rate Team relied on daily Burn Rate Calculators (BRCs) submitted from around the state. This process was conducted in collaboration between hospital coalitions, universities, private sector business, and emergency management. The team collected and compiled thousands of local-level burn rate reports from agencies and facilities around the state over a two-month period.

Local-level sampling from end users on the frontlines around the state provided daily snapshots of actual usage at the "boots on ground" level, which could then be extrapolated across the state to produce burn rate projections. Additionally, this initial MEMA process combined the reported data with composite modeling to produce a mean burn rate. The mean burn rate resulting from the process, granted MEMA a unique opportunity to balance PPE conservation with "ideal use" standards to improve protection for frontline workers throughout the state, while still managing supply chain concerns. In May of 2020, MEMA produced an in-depth document, *MEMA COVID-19 Burn Rate Methodology Summary Report* to detail the extensive process. (Available upon request to MEMA)

As the transition to recovery began, two conclusions became apparent: First, the ad hoc system to collect granular detailed data required significant staff hours at both the local and state level and would not be sustainable. From this first conclusion, the second became apparent: a simplified process or tool for burn rate projections was needed to support recovery and planning efforts.

The MEMA Burn Rate Team started analyzing the collected data and launched an additional process to construct a new tool that would support long-term planning.

This process included:

- Graphing individual PPE burn rate data into scatter-plots to identify trend lines.
- Creating formulas to project the identified trend lines against known values.
- Retroactively modeling the trend lines to establish baselines for each item of PPE.
- Creating polynomial formulas from the established baseline to project PPE need against bed usage input as known X values to then map out Y values as burn rate.
- Validating tool outputs against the historic data collected during the response phase.
- Expanding the tool to include county datasets based on hospital bed census and other key data.
- Beta testing the tool through collaboration with the surge task force and various partners working on future planning, including a local emergency management agency.

# III. New BRP Tool Development

The MEMA BRP Tool was developed by combining historic data, sampled burn rate data and projection tools. The first step was to establish baseline data for the BRP Tool. This baseline data is amplified by various factors and processes when the tool is utilized by end users. While the baseline process is described here, for ease of use the process to establish the baseline data is not a part of the final MEMA BRP Tool.

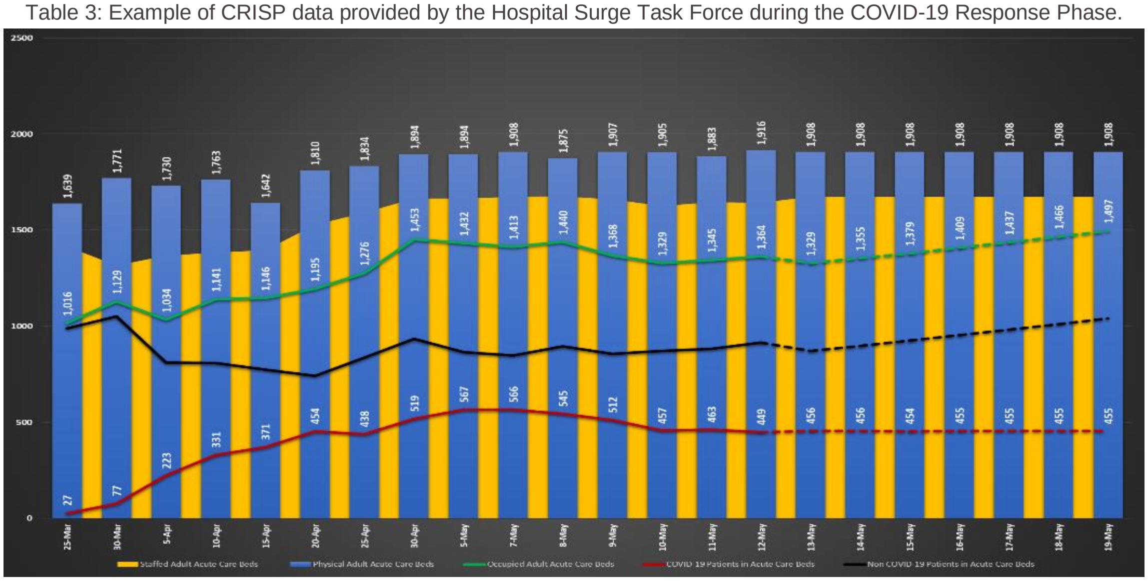
## BRP TOOL DATA BASELINES

To create the MEMA BRP Tool two sets of baseline data were required. First, the Burn Rate Team needed a baseline of PPE Burn Rate. Second, a baseline of COVID-19 hospital bed usage had to be established. The first step in creating the baselines was to normalize data sets and then identify trend lines.

### COVID-19 Bed Usage Trend Lines

The MEMA Hospital Surge Task Force proved vital in this process. This team had been tracking bed usage across the state, organized by date, facility, and patient type; COVID-19 Acute Care, COVID-19 Intensive Care, and Non-COVID-19. The data compiled by this team was assembled from reports with Maryland's Regional Health Information Exchange (HIE) Portal, known as the Chesapeake Regional Information System for our Patients (CRISP).

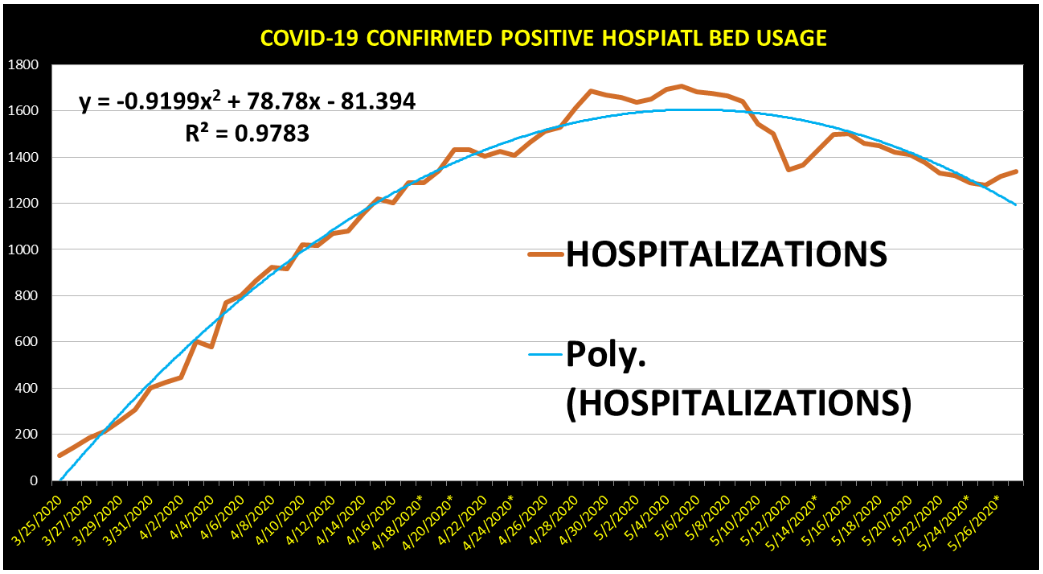
Table 3: Example of CRISP data provided by the Hospital Surge Task Force during the COVID-19 Response Phase.



The CRISP data provided the Burn Rate Team with a total number of hospital beds used for COVID-19 Patients per day. To normalize this data for the next step in the BRP development process, the Burn Rate Team graphed the data into a scatterplot and applied a trend line. Initially, the Burn rate Team considered exponential and linear trend lines. However, it was determined that a polynomial trend line would work more effectively for the following reasons:

- The same type of trend line would need to be utilized for each PPE item modeled in the next phase of tool development.
- A polynomial trend presented the best fit between the various datasets, particularly when graphing the usage of PPE items against bed use changes.
- The polynomial trend line applied to each PPE dataset returned stronger $R^2$ values as opposed to linear or exponential trend lines.
- Polynomial trend lines also provided the most effective method to predict Y values for retroactive modeling, and future projections.
- Initial efforts using an exponential approach showed strong correlation between data and produced strong $R^2$ values. However, this approach created upper limits of tool effectiveness and reflected extraordinarily high burn rates when bed use significantly increased. Exponential modeling would be extremely inaccurate for long-term surge planning or high-case volumes.

Figure 4: Data normalization of COVID-19 bed usage per day. Example of bed usage from March 25th – May 26th, 2020 with trend line applied.




## Burn Rate Trend Lines

To create the baseline for PPE Burn Rate, the team captured sample data collected during the COVID-19 Pandemic. The sample burn rate for each PPE item was also graphed into a scatter-plot with trend lines applied to the graphed data. Most data presented with strong correlation along the trend line and favorable $R^2$ values, although some graphs did have lower $R^2$ values based on outliers. However, visual inspection of the data revealed acceptable correlation to the mean, and the outliers (though significant in deviation) were infrequent, explainable, and easily normalized for projection purposes (See *Limitations Sections* for further explanation regarding outliers).

After applying the trend line, the Burn Rate Team used the polynomial formula to determine the values on the trend line. Bed use data supplied a known X value allowing the team to identify Y values for each date.

As discussed above, some PPE graphing required normalizing of outliers. To accomplish this, the Burn Rate Team graphed the data into a scatterplot to identify significant outliers. These outliers were normalized by averaging the data for the previous day Y value, and next day Y value. To ensure outliers were appropriately normalized, the Burn rate Team investigated causes for outliers by contacting reporting facilities. In most cases, it was determined that the cause of the outlier data was a result of two factors:

- Some reporting facilities relied on burn rate counts taken at a central distribution point. Upon receiving large shipments of supplies, resources were “pushed” to numerous locations throughout facilities or networks to build stock at point-of-use storage.
- PPE items in high-demand were conserved and reused extensively. Upon receiving a shipment of critical PPE, system wide replacement of these items would occur on a single day resulting in unnatural inflation of daily burn rates.

The process described above was completed for each item of PPE and each critical function being tracked by the MEMA Burn Rate Team. Items and functions graphed during the process included the following:

| PPE ITEMS AND USAGE AREAS CALCULATED | | | |
|---|---|---|---|
| **Long-Term Care Facilities (LTC)** | **Hospitals** | **EMS & Fire Rescue** | **Law Enforcement & Corrections** |
| • Gowns<br>• Masks<br>• Gloves<br>• N95s<br>• Face shields<br>• Goggles | • Gowns<br>• Masks<br>• Gloves<br>• N95s<br>• Face shields<br>• Goggles | • Gowns<br>• Masks<br>• Gloves<br>• N95s<br>• Face Shields | • Gowns<br>• Masks<br>• Gloves<br>• N95s<br>• Face shields<br>• Goggles |

**Table 1: MEMA Burn Rate Team PPE items tracked across functions.**

After graphing data, assessing trend lines, normalizing datasets, and determining projection equations, the Burn Rate Team was able to input the resulting formulas and values into a Beta Version of the new BRP Tool.

## EMS / Fire Rescue Projections

A similar method was applied to create projection formulas for Emergency Medical Services (EMS) and Fire Rescue across the state. However, the EMS burn rate data had been compiled from a different process during the initial COVID-19 Response Phase of the Pandemic.

Ruth Vogel, BSN, MPH, was deployed to the Maryland State EOC under the Maryland Medical Reserve Corps (MRC) as a volunteer. Ms. Vogel is also the Emergency Response and

Communications Systems Program Manager for the Johns Hopkins University Applied Physics Laboratory, so in leading this effort, she reached back to subject matter experts and colleagues at APL. In partnership with the Maryland Institute of Emergency Medical Services System (MIEMSS), they developed a PPE Burn Rate Model for Hospitals, Fire/EMS, and Long-term Care Facilities. This became referenced internally as the "MD APL Model."

Integrating the MD APL Model into the New BRP Planning tool was also completed by graphing the data to identify the trend line. However, the data from the MD APL model presented in a far more linear fashion with few outliers since it was based on a modeling tool. Even though the projections were built on a model, the same process was completed for each EMS dataset to develop the BRP Tool. There were two primary reasons to convert the MD APL Model into the new BRP Tool:

- It created a unified platform for projections, without requiring planners to use multiple tools.
- It transitioned the data from using a growth/decrease factor based on positive COVID-19 case increases to a Positive COVID-19 Hospital Bed usage, thus aligning all tools with a single projection factor.

## Estimated PPE Need per Patient

In addition to the 14-day projections within the BRP Tool, there is a separate window which provides a baseline of PPE needed to support a single patient for one day in a hospital, as well as, a single patient in a long-term care (LTC) facility. This information was specifically included to support planning efforts for the Maryland Hospital Surge Task Force, and Maryland Nursing Home Task Force.

Estimates for the "per patient per day" need were established by comparing data projections from initial models to reported usage. From April 7$^{th}$ – June 7$^{th}$ the MEMA Burn Rate Team compiled data reported from around the state to determine statewide burn rate per day. To project estimated statewide need, this data was averaged against two models: the Maryland Applied Physics Lab (MD APL) Model and the Health and Human Services (HHS) Pandemic Toolkit Model. The use of these models (representing ideal PPE usage) and the actual reported burn rate (representing COVID-19 PPE conservation usage) provided MEMA with a projected need that balanced PPE usage. This process is explained in greater detail in the *MEMA COVID-19 Burn Rate Methodology* Report, May 2020.

To determine the estimated "per patient per day" PPE need, the MEMA Burn Rate Team compared the output of the models against the average burn rate over the 60-day period of data compiling. The average variation from each day over the sixty day period was then applied to the models baseline to adjust the initial assumptions. From this process, the MEMA Burn Rate Team was able to create a more accurate baseline.

| PPE Item | Initial Baselines (Per Pt / Per Day) | Projection Process (Usage against model) | Adjusted Baseline (Per Pt / Per Day) |
|---|---|---|---|
| GOWNS | 48 | 46% | 22 |
| MASKS | 9 | 89% | 8 |
| GLOVES | 48 | 32% | 16 |
| N95s | 10 | 54% | 6 |
| FACESHIELDS | 12 | 63% | 8 |

**Table 2: Per Pt. / Per Day PPE Adjusted need against model baselines.**

## County Projection Factors:

The output presented in the county tab is achieved by three factors, each described below:

**Long-Term Care Facility Bed Census:**

LTC bed census data is utilized to determine the PPE need for LTCs within each county. The percentage of total state LTC beds for each county is applied to statewide projections.

**Hospital Bed Census:**

Hospital bed census data is utilized to determine the PPE need for Hospitals within each county. The percentage of total hospital beds for each county is applied to statewide projections. Note, that hospital bed census is a dynamic number. Baselines for this factor were captured on May 15th, 2020 and do not include Advanced Medical Tents, or temporary surge Alternate Care Facilities built outside of medical centers. For more information see the *Limitations Section* of this report.

**Population Percentage:**

To determine the PPE need for EMS and Law Enforcement functions within each county, the data attained is based on county population. The percentage of total state population for each county is applied to statewide projections.

Since the county level projections are based on percentages of population and bed use data, the projections may vary from actual circumstances within each county. For example, the factoring based on county population percentage assumes that case volume will be close to the same percentage. Essentially, a county that represents approximately 5% of the state population is assumed to have 5% of the total state cases. It is understood by the development team that due to a number of variables that may not be the case. A county with 5% of the state's population may have 10% of total cases. In this case, the projected burn rate from the BRP tool would like present lower values than actual need.  County level planners should take time to understand how the projections in this tool are developed, and then adjust those projections based on specific circumstances within their jurisdiction. This is discussed further in the *Limitations* section of this document.

The Burn Rate Team evaluated various methods for calculating county level data based on overall state projections. Ultimately, it was determined that adding additional factors, tool inputs, and data points would undermine the initial premise of the tool – an easy to use projection tool to support planning efforts.

Additionally, by understanding the limitations of this tool, as well as, the underlying formulas and logic, planners can utilize this to establish a data-driven baseline that can be adjusted across multiple counties to reflect the nuances of individual districts circumstances.

# IV. BRP Application

This section summarizes the use of the Maryland BRP Tool, as well as, considerations for how the tool output can be utilized for planning.

The BRP tool was designed with specific criteria driving development:

- The tool needed to provide key information for state planners, as well as, Local EMs.
- The tool needed to be easy to use, intuitive, and require minimal input data.
- The tool needed to provide accurate output projections.
- The tool needed to be supported by a data driven development process limiting assumptions.

MEMA was able to achieve all of these directives and develop a tool to be utilized during the recovery process, as well as, to support future planning needs in the event subsequent waves of infections were to emerge.

The following sections of this report summarize the various components of the BRP Tool and outline how to use the tool for planning purposes.

## BRP Tool Input – Section 1:

Using the BRP Tool is a simple process that requires 6 data points to create projections. This input data includes:

- The total number of MD hospital beds occupied by positive COVID-19 patients for the current date (at time of use).
- The total bed use for COVID-19 patients over the previous 24, 48, and 72 hours.
- The total number of EMS response calls for the past 24 hours.
  (NOTE: In the event users do not know the number of statewide EMS responses, the tool is pre-populated with a default value until more accurate information can be obtained)

### GETTING STARTED:

There are a total of six steps to use the BRP Tool. Each of these input points is described below, along with a brief summary of how the data applies within the BRP Tool.

The BRP Tool includes multiple tabs, or sheets displayed across the bottom of the tool. Each of these tabs are described in greater detail in the BRP Projection Outputs Section below. The first tab across the bottom is labeled as “Start Here.” This tab provides concise directions for end-users, as well as, a summary of limitations and reference locations to gather the data needed for initial input. Users are encouraged to read the referenced methodology report for more information on the underlying data used to build MD BRP Tool. (To learn more, contact the Maryland Emergency Management Agency for a copy of the *MEMA COVID-19 Burn Rate Methodology* Report, May 2020)

## DATA INPUT:

After reviewing the BRP Tool instructions and limitations, end-users can click on the second tab across the bottom to begin data input. As long as the necessary data points have been acquired, completing the input steps can be done in only a few seconds. Data input is a simple, six-step process.

Figure 6: Detailed view of the data input section for the Maryland BRP Planning Tool.

| | | | |
|---|---|---|---|
| STEP 1 >> | Enter today's date (M-D-Y) | 6/2/2020 | Date |
| STEP 2 >> | Enter Current Number of covid-19 Hospitalized Patients: | 1279 | COVID-19 Patients Today |
| STEP 3 >> | Enter Number of covid-19 Hospitalized Patients (24 Hrs ago): | 1290 | COVID-19 Patients 1 day ago |
| STEP 4 >> | Enter Number of covid-19 Hospitalized Patients (48 Hrs ago): | 1320 | COVID-19 Patients 2 days ago |
| STEP 5 >> | Enter Number of covid-19 Hospitalized Patients (72 Hrs ago): | 1329 | COVID-19 Patients 3 days ago |
| STEP 6 >> | Approximate Number of EMS Response Calls (last 24 hours) | 1423 | # of 911 Response (EMS) |

### STEP ONE >>

End-users enter the current date (at time of use). This step will auto-populate the current date and a 14-day range for all sections and tabs throughout the BRP Tool.

### STEP TWO >>

Enter the current number of COVID-19 positive patients occupying beds throughout Maryland. This count should be the total number of occupied beds including acute care and Intensive Care Unit (ICU) beds.

### STEP THREE >>

Enter the number of COVID-19 positive patients occupying beds throughout Maryland for the previous day.

### STEP FOUR >>

Enter the number of COVID-19 positive patients occupying beds throughout Maryland for the day 48 hours prior to the current date.

### STEP FIVE >>

Enter the number of COVID-19 positive patients occupying beds throughout Maryland for the day 72 hours prior to the current date.

**STEP SIX >>**

Enter the total number of EMS runs for the previous 24 hours. (This should include *all* EMS runs, not just transports or COVID-19 related responses).

### GATHERING DATA FOR BRP USAGE

Data for the BRP Tool may not be readily available to all users. There are several sources that may provide consolidated data, as well as, key agencies that can provide the data. These sources include:

- Maryland Emergency Management Agency at the State Emergency Operations Center.
- Maryland Department of Health (https://mema.maryland.gov).
- Maryland Institute for Emergency Medical Services Systems (MIEMSS) (https://www.miemss.org).
- Maryland Coronavirus Dashboard maintained by The Maryland Department of Health: (https://coronavirus.maryland.gov).
- The Maryland Department of Health (MDOH): (https://health.maryland.gov).

## BRP Tool Output – Section 2:

The Maryland BRP Planning Tool provides valuable data output that can be used at the state level, as well as, the local level for County Emergency Managers. With the simple input steps followed above, end-users are ready to start using the final values provided by the BRP tool. Data is divided into 25 output tabs. This includes a comprehensive tab summarizing statewide data, as well as, 24 county level tabs.

The main tab for statewide data (MEMA – BRP) provides additional information not found on each county tab. That unique data on this tab is summarized below, followed by an overall description of the data elements on each county tab.

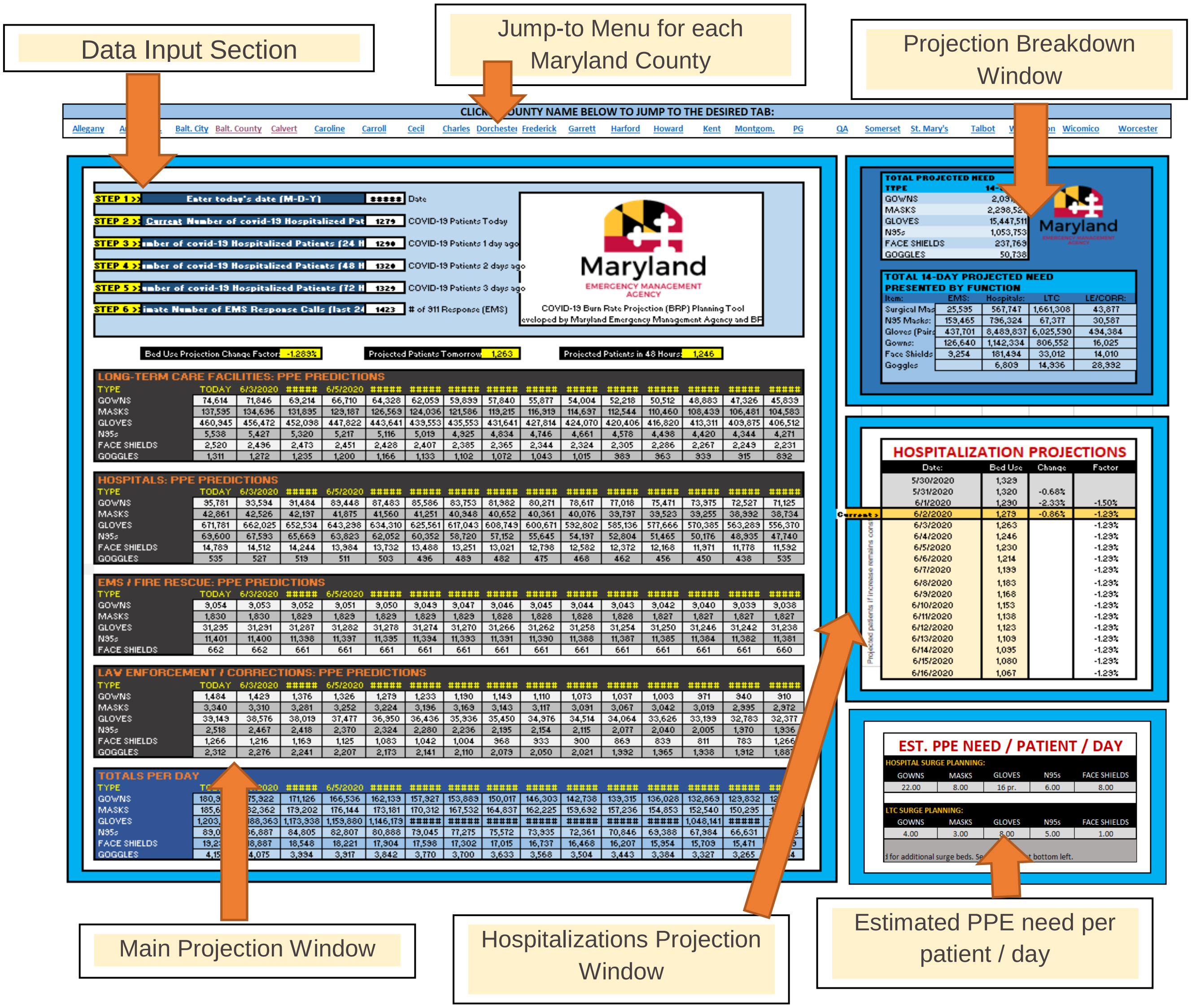
## "MEMA – BRP" Main tab:

The main tab for the BRP Tool is tab two, titled: MEMA –BRP. This tab features 6 key areas:

- Data Input Section.
- Jump-to Menu for each Maryland County.
- Main Projection Window.
- Projection Breakdown Window.
- Hospitalizations Projection Window.
- Estimated PPE need per patient / day.

Areas of the primary tab are briefly explained in the following pages.

**Figure 7: New BRP Tool primary tab with callout indicators of key items.**



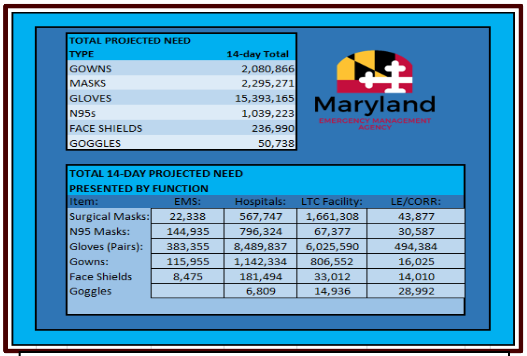

The key areas of the primary tab for the Maryland BRP Planning Tool are summarized below:

- **Data Input Section:**
  Using the BRP Tool provides planners a streamlined process for burn rate projection based on real-world data. With this streamlined process, end-users input the required data points and the current date. From this data, the tool will calculate statewide, and county level burn rates for the current date and following 14 days.

- **Jump-to Menu:**
  The BRP Tool features a jump-to menu at the top of the main tab. From this point, end-users can enter the required data, and then immediately select any Maryland County to view local-level projections. Additionally, each county page includes links at the top to return to the main tab.

- **Main Projection Window:**
  The main projection window displays burn rate projections. This includes a breakdown for each critical infrastructure function listed per PPE item. This same data is presented on each county page, specific to the given jurisdiction.

- **Projection Breakdown:**
  A separate projection summary window is found to the right side of the screen. This window totals the 14 days in the projection window and provides users a total number of items for the next 14-day period. Also included in this window is a total 14-day need per item, listed by critical function. This same data is presented on each county page, specific to the given jurisdiction.



| TOTAL PROJECTED NEED | |
|---|---|
| TYPE | 14-day Total |
| GOWNS | 2,080,866 |
| MASKS | 2,295,271 |
| GLOVES | 15,393,165 |
| N95s | 1,039,223 |
| FACE SHIELDS | 236,990 |
| GOGGLES | 50,738 |



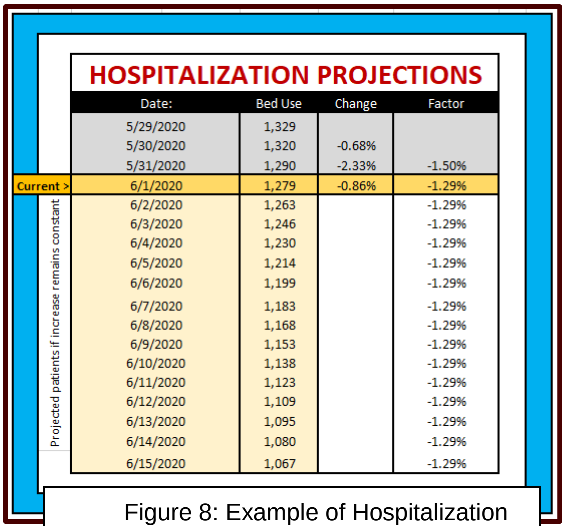
TOTAL 14-DAY PROJECTED NEED PRESENTED BY FUNCTION

| Item: | EMS: | Hospitals: | LTC Facility: | LE/CORR: |
|---|---|---|---|---|
| Surgical Masks: | 22,338 | 567,747 | 1,661,308 | 43,877 |
| N95 Masks: | 144,935 | 796,324 | 67,377 | 30,587 |
| Gloves (Pairs): | 383,355 | 8,489,837 | 6,025,590 | 494,384 |
| Gowns: | 115,955 | 1,142,334 | 806,552 | 16,025 |
| Face Shields | 8,475 | 181,494 | 33,012 | 14,010 |
| Goggles | | 6,809 | 14,936 | 28,992 |

Figure 7: Example of Projection Breakdown Window and Data Summary

- **Hospitalizations Projections:**
  Also on the right side of the main tab is the Hospitalization Projection Window. This section lists the data entered by the end-user and creates a percentage factor to represent the rate of change in hospital bed use (average change over the past 72 hours). From these calculations, this window also provides a 14-day outlook of possible hospital bed usage.

  Note: The projected hospital bed use per day is used in conjunction with the underlying formulas to create the 14-day burn rate outlook.



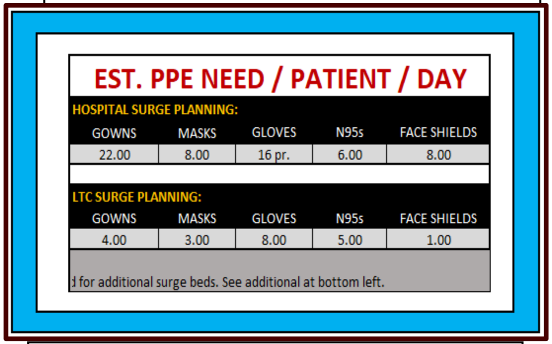
HOSPITALIZATION PROJECTIONS

| | Date: | Bed Use | Change | Factor |
|---|---|---|---|---|
| | 5/29/2020 | 1,329 | | |
| | 5/30/2020 | 1,320 | -0.68% | |
| | 5/31/2020 | 1,290 | -2.33% | -1.50% |
| Current > | 6/1/2020 | 1,279 | -0.86% | -1.29% |
| | 6/2/2020 | 1,263 | | -1.29% |
| | 6/3/2020 | 1,246 | | -1.29% |
| | 6/4/2020 | 1,230 | | -1.29% |
| | 6/5/2020 | 1,214 | | -1.29% |
| | 6/6/2020 | 1,199 | | -1.29% |
| | 6/7/2020 | 1,183 | | -1.29% |
| | 6/8/2020 | 1,168 | | -1.29% |
| | 6/9/2020 | 1,153 | | -1.29% |
| | 6/10/2020 | 1,138 | | -1.29% |
| | 6/11/2020 | 1,123 | | -1.29% |
| | 6/12/2020 | 1,109 | | -1.29% |
| | 6/13/2020 | 1,095 | | -1.29% |
| | 6/14/2020 | 1,080 | | -1.29% |
| | 6/15/2020 | 1,067 | | -1.29% |



Figure 8: Example of Hospitalization Projection Window

- **PPE per Patient per Day:**
  Also on the main projection tab is a window to display a baseline of PPE need per patient per day. This window includes baseline PPE need for both hospitals and Long Term Care (LTC's) facilities. Development of these calculations is explained above in *Section III*. It should be noted that the PPE Need per patient per day is intended for planning surge support and should only be utilized as a basis for calculating initial need for additional surge beds.



EST. PPE NEED / PATIENT / DAY

HOSPITAL SURGE PLANNING:

| GOWNS | MASKS | GLOVES | N95s | FACE SHIELDS |
|---|---|---|---|---|
| 22.00 | 8.00 | 16 pr. | 6.00 | 8.00 |

LTC SURGE PLANNING:

| GOWNS | MASKS | GLOVES | N95s | FACE SHIELDS |
|---|---|---|---|---|
| 4.00 | 3.00 | 8.00 | 5.00 | 1.00 |

d for additional surge beds. See additional at bottom left.

Figure 9: Example of estimated PPE per patient, per day window.

## Maryland County Tabs:

The BRP Planning Tool also provides a breakdown of PPE need per county for the State of Maryland. The tabs can be accessed across the bottom of the tool workbook, or through the "jump-to" menu located at the top of the main tab, "MEMA – BRP."

**Figure 10: BRP Tool "jump-to" menu for individual county data.**

| CLICK A COUNTY NAME BELOW TO JUMP TO THE DESIRED TAB: | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Allegany | Anne Arun. | Balt. City | Balt. County | Calvert | Caroline | Carroll | Cecil | Charles | Dorchester | Frederick | Garrett | Harford | Howard | Kent | Montgom. | PG | QA | Somerset | St. Mary's | Talbot | Washington | Wicomico | Worcester |

Each individual county page includes a similar presentation to that found on the main tab, with the exception that the data represents projected need for only that specific county.

**Figure 11: Example of BRP Planning Tool county data tab for Baltimore County.**

Return to State Projections Return to Start Tab

**BALTIMORE COUNTY**

based on % of total state beds. LEO and EMS based on % of State Population.

COUNTY DATA: ##### of State Population ##### of Total State Hosp. Bed: ##### of State LTC Beds

**LONG-TERM CARE FACILITIES: PPE PREDICTIONS**

| TYPE | TODAY | 5/30/2020 | 5/31/2020 | 6/1/2020 | 6/2/2020 | 6/3/2020 | 6/4/2020 | 6/5/2020 | 6/6/2020 | 6/7/2020 | 6/8/2020 | 6/9/2020 | 6/10/2020 | 6/11/2020 | 6/12/2020 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GOWNS | 25,064 | 23,953 | 22,903 | 21,911 | 20,974 | 20,088 | 19,250 | 18,458 | 17,708 | 16,999 | 16,329 | 15,694 | 15,093 | 14,524 | 13,985 |
| MASKS | 43,382 | 41,594 | 39,896 | 38,283 | 36,750 | 35,293 | 33,908 | 32,592 | 31,339 | 30,148 | 29,014 | 27,934 | 26,907 | 25,928 | 24,996 |
| GLOVES | 100,379 | 98,710 | 97,101 | 95,547 | 94,047 | 92,599 | 91,201 | 89,852 | 88,548 | 87,290 | 86,075 | 84,901 | 83,767 | 82,672 | 81,614 |
| N95s | 1,403 | 1,368 | 1,335 | 1,302 | 1,271 | 1,241 | 1,212 | 1,184 | 1,156 | 1,130 | 1,104 | 1,080 | 1,056 | 1,033 | 1,011 |
| FACE SHIELDS | 854 | 827 | 801 | 777 | 754 | 732 | 712 | 692 | 674 | 657 | 640 | 625 | 610 | 596 | 583 |
| GOGGLES | 267 | 256 | 246 | 236 | 227 | 218 | 210 | 202 | 195 | 188 | 181 | 175 | 169 | 163 | 158 |

**HOSPITALS: PPE PREDICTIONS**

| TYPE | TODAY | 5/30/2020 | 5/31/2020 | 6/1/2020 | 6/2/2020 | 6/3/2020 | 6/4/2020 | 6/5/2020 | 6/6/2020 | 6/7/2020 | 6/8/2020 | 6/9/2020 | 6/10/2020 | 6/11/2020 | 6/12/2020 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GOWNS | 9,259 | 8,893 | 8,547 | 8,220 | 7,910 | 4,552 | 7,338 | 7,075 | 6,826 | 6,590 | 6,366 | 6,154 | 5,953 | 5,762 | 5,581 |
| MASKS | 4,373 | 4,280 | 4,190 | 4,103 | 4,019 | 3,938 | 3,860 | 3,785 | 3,713 | 3,643 | 3,576 | 3,511 | 3,448 | 3,387 | 3,329 |
| GLOVES | 59,442 | 57,889 | 56,406 | 54,987 | 53,630 | 52,331 | 51,089 | 49,900 | 48,761 | 47,671 | 46,627 | 45,626 | 44,668 | 43,749 | 42,868 |
| N95s | 6,773 | 6,428 | 6,103 | 5,797 | 5,509 | 5,238 | 4,983 | 4,743 | 4,516 | 4,303 | 4,103 | 3,914 | 3,736 | 3,568 | 3,410 |
| FACE SHIELDS | 1,611 | 1,556 | 1,503 | 1,453 | 1,405 | 1,360 | 1,316 | 1,275 | 1,235 | 1,197 | 1,161 | 1,127 | 1,094 | 1,062 | 1,032 |
| GOGGLES | 37 | 36 | 35 | 34 | 33 | 32 | 32 | 31 | 30 | 30 | 29 | 29 | 28 | 28 | 27 |

**EMS / FIRE RESCUE: PPE PREDICTIONS**

| TYPE | TODAY | 5/30/2020 | 5/31/2020 | 6/1/2020 | 6/2/2020 | 6/3/2020 | 6/4/2020 | 6/5/2020 | 6/6/2020 | 6/7/2020 | 6/8/2020 | 6/9/2020 | 6/10/2020 | 6/11/2020 | 6/12/2020 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GOWNS | 2,470 | 2,267 | 2,182 | 2,101 | 2,026 | 1,954 | 1,887 | 1,823 | 1,764 | 1,707 | 1,654 | 1,604 | 1,556 | 1,512 | 1,470 |
| MASKS | 396 | 386 | 377 | 368 | 359 | 351 | 343 | 336 | 329 | 322 | 316 | 310 | 304 | 299 | 396 |
| GLOVES | 9,915 | 9,507 | 9,124 | 8,766 | 8,429 | 8,114 | 7,818 | 7,540 | 7,280 | 7,035 | 6,806 | 6,591 | 6,389 | 6,200 | 6,023 |
| N95s | 2,322 | 2,188 | 2,061 | 1,942 | 1,831 | 1,727 | 1,629 | 1,537 | 1,451 | 1,370 | 1,294 | 1,223 | 1,156 | 1,093 | 1,034 |
| FACE SHIELDS | 152 | 146 | 140 | 134 | 129 | 124 | 119 | 115 | 111 | 107 | 103 | 100 | 97 | 94 | 91 |

**LAW ENFORCEMENT / CORRECTIONS: PPE PREDICTIONS**

| TYPE | TODAY | 5/30/2020 | 5/31/2020 | 6/1/2020 | 6/2/2020 | 6/3/2020 | 6/4/2020 | 6/5/2020 | 6/6/2020 | 6/7/2020 | 6/8/2020 | 6/9/2020 | 6/10/2020 | 6/11/2020 | 6/12/2020 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GOWNS | 152 | 146 | 141 | 135 | 131 | 126 | 121 | 117 | 113 | 109 | 105 | 101 | 98 | 95 | 92 |
| MASKS | 447 | 438 | 430 | 421 | 414 | 406 | 399 | 392 | 386 | 379 | 373 | 368 | 362 | 357 | 352 |
| GLOVES | 4,153 | 4,079 | 4,008 | 3,939 | 3,873 | 3,809 | 3,748 | 3,688 | 3,631 | 3,575 | 3,522 | 3,470 | 3,421 | 3,373 | 3,326 |
| N95s | 836 | 807 | 780 | 753 | 727 | 703 | 679 | 657 | 635 | 614 | 594 | 575 | 557 | 539 | 522 |
| FACE SHIELDS | 285 | 276 | 269 | 261 | 254 | 247 | 240 | 233 | 227 | 221 | 215 | 200 | 204 | 198 | 193 |
| GOGGLES | 290 | 279 | 268 | 259 | 249 | 240 | 232 | 223 | 216 | 208 | 201 | 195 | 188 | 182 | 176 |

**TOTALS PER DAY**

| TYPE | TODAY | 5/30/2020 | 5/31/2020 | 6/1/2020 | 6/2/2020 | 6/3/2020 | 6/4/2020 | 6/5/2020 | 6/6/2020 | 6/7/2020 | 6/8/2020 | 6/9/2020 | 6/10/2020 | 6/11/2020 | 6/12/2020 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GOWNS | 36,945 | 35,259 | 33,773 | 32,368 | 31,040 | 26,720 | 28,597 | 27,473 | 26,411 | 25,405 | 24,454 | 23,553 | 22,700 | 21,892 | 21,127 |
| MASKS | 48,599 | 46,698 | 44,892 | 43,174 | 41,542 | 39,988 | 38,511 | 37,105 | 35,766 | 34,492 | 33,278 | 32,122 | 31,021 | 29,971 | 29,073 |
| GLOVES | 173,887 | 170,186 | 166,638 | 163,238 | 159,979 | 156,853 | 153,855 | 150,979 | 148,220 | 145,572 | 143,030 | 140,589 | 138,245 | 135,994 | 133,831 |
| N95s | 11,335 | 10,791 | 10,278 | 9,794 | 9,338 | 8,908 | 8,502 | 8,120 | 7,758 | 7,417 | 7,095 | 6,792 | 6,505 | 6,234 | 5,977 |
| FACE SHIELDS | 2,902 | 2,805 | 2,713 | 2,625 | 2,542 | 2,462 | 2,387 | 2,315 | 2,247 | 2,181 | 2,119 | 2,051 | 2,004 | 1,950 | 1,899 |
| GOGGLES | 593 | 570 | 549 | 529 | 509 | 491 | 474 | 457 | 441 | 426 | 412 | 398 | 385 | 373 | 361 |

| TOTAL PROJECTED NEED | |
|---|---|
| TYPE | 14-day Total |
| GOWNS | 380,771 |
| MASKS | 517,633 |
| GLOVES | 2,107,208 |
| N95s | 113,510 |
| FACE SHIELDS | 32,301 |
| GOGGLES | 6,375 |

Maryland EMERGENCY MANAGEMENT AGENCY

| TOTAL 14-DAY PROJECTED NEED PRESENTED BY FUNCTION | | | | |
|---|---|---|---|---|
| Item: | EMS: | Hospitals: | LTC Facility: | LE/CORR: |
| Gowns: | 25,507 | 95,767 | 282,933 | 1,781 |
| Masks | 4,793 | 52,781 | 497,963 | 5,925 |
| Gloves | 105,621 | 696,201 | 1,354,302 | 55,614 |
| N95s | 21,534 | 66,349 | 17,886 | 9,980 |
| Face Shields | 1,609 | 17,776 | 10,534 | 3,521 |
| Goggles | | 435 | 3,091 | 3,406 |

## County Tab Data:

The output presented in the county tab is achieved by three factors, each described below:

### Long-Term Care Facility Bed Census:

To determine the PPE need for LTCs within each county, the data is based on LTC bed census data. The percentage of total state LTC beds for each county is applied to statewide projections.

### Hospital Bed Census:

To determine the PPE need for hospitals within each county, the data is based on hospital bed census data. The percentage of total state hospital beds for each county is applied to statewide projections.

**Population Percentage:**

To determine the PPE need for EMS and Law Enforcement functions within each county, the data attained is based on county population. The percentage of total state population for each county is applied to statewide projections.

## BRP Planning Usage

The BRP Tool provides the State of Maryland with a powerful planning tool built on a platform of real-world date collection over a two month period during the initial COVID-19 Pandemic Response. The initial process to project burn rate for the state, required a dedicated burn rate team at the State Emergency Operations Center (SEOC). This team tracked and compiled thousands of daily burn rate reports submitted during the initial response phase. Each day, this team compiled the data into a series of tools as part of a complex projection process. Form this effort and collected data, the BRP was developed allowing planners to project PPE Burn Rate in a few seconds, inputting only 5 pieces of data. The BRP tool supports the following planning functions:

- Federal Medical Station (FMS) planning
- Hospital surge planning
- LTC surge planning
- County level emergency management planning

# V. Limitations

This section summarizes BRP Tool limitations, challenges, and efforts by the MEMA BRC Team to overcome those challenges.

## Effective Model Range

The Maryland BRP Planning Tool has an upper threshold of confident accurate projection capabilities. The tool is built on polynomial trend line factoring of real-world burn rate data with modeling projections developed up to a hospital bed usage of 6,500 patients. However, during the initial COVID-19 Pandemic Response, hospital bed usage peaked at 1,707 patients on May 5$^{th}$, 2020. Thus benchmarking tool projections against real-world bed usage statistics above that threshold is not possible.

Since the model is constructed through the use of polynomial trend lines (which demonstrated the closest fit to sample data) extending projections indefinitely with this method may produce artificially high burn rates once an input above the 6,500 bed usage threshold is exceeded. While the output above that point can still be used, the output at extreme high levels of patients has not been tested/validated. This limitation is discussed to provide an understanding that no real-world validation data, or confidence predictions are offered beyond that upper threshold. Therefore, the MEMA BRP Tool should be used as part of a holistic approach with data and input from a multitude of sources and partners to strengthen decision frameworks.

## Low $R^2$ Values

During the development process for this tool, some PPE items when graphed into scatterplots, presented $R^2$ values below what the Burn Rate Team would have preferred. The lower $R^2$ values were a result of outliers. Most of the outliers were infrequent in occurrence, but presented with high enough quantity to considerably reduce the overall $R^2$ value. Every reasonable effort was made by the Burn Rate Team to normalize this data through generally acceptable processes, and direct contact was made with facilities to understand the root cause of the outliers. Outliers were averaged with the previous, and next day's values to normalize the data set.

## PPE Need per Patient per Day:

PPE Need per patient / day is intended for planning surge support only. These figures are not designed to be extrapolated system wide or used to build long-term projections. This data should only be used as a basis for calculating initial need for additional surge beds. Data is based on initial modeling assumptions benchmarked against 60 day historic average usage. For more details on data basis, contact MEMA to request the *Burn Rate Process Methodology Summary* report Published in May 2020.

## County Projection Factoring:

The BRP is designed to provide planners with a tool to assist in developing projections. The county data is provided based on population percentages and bed census data. It is understood that this is not guaranteed to provide accurate results. There are a number of factors that can significantly influence projections including COVID-19 outbreaks, population density, population demographics and more. As a result of the myriad of variables, it must be understood this tool is not an ultimate solution but rather a starting point for planners. County level planners should take time to understand how the projections in this tool are developed, and then adjust those projections based on specific circumstances within their jurisdiction.

During the development of this tool (described in *Section III* above) Burn Rate Team members evaluated county population against confirmed COVID-19 cases per county to determine viable projection factors. It was discovered that counties with very small population percentages presented with proportionally smaller numbers of cases. For example, Kent County represents .33% of the states total population. During the 30-day assessment period BRP developers found that Kent County accounted for .25% of state COVID-19 cases. In fact, all counties with less than 2% of total state population presented with proportionally smaller case volumes. With this in mind, it should be understood that projections for these counties using the BRP Tool presented higher burn rates since the calculation is based on population percentages as opposed to case percentages. The result would be slightly higher burn rate projections than what may actually be needed.

Assessment of county factoring also revealed that confirmed case percentages vs. county population percentages for the assessment period did not result in more than a ten percent negative variation except for two counties: Montgomery and Prince George's. For the assessment period, Montgomery County presented an average of 19.77% of total state COVID-19 cases with 17.38% of total state population. This presented as 13.74% higher case volume than estimated solely by population data. Additionally, Prince George's County presented an average of 26.25% of total state COVID-19 cases with only 15.14% of total state population. This presented as 42.33% higher case volume than estimated solely by population data. As a result of these two counties case volume representing a higher percentage than population data, the projected burn rate may be lower than actual need. This is noted to illustrate how the impacting variables influence the results. This limitation needs to be understood by county planners so that appropriate projection adjustments can be made based on real-time data that may present differently than baseline assumptions.

## Bed Usage for County Projections

Projections for each county tab include hospital PPE burn rate. These calculations are derived by determining the counties percent of total hospital beds. It should be understood by planners that hospital bed census data is a fluid number that fluctuates over time. For this tool, the numbers were obtained on May 15th, 2020 and do not include Advanced Medical Tents, or temporary surge Alternate Care Facilities built outside of medical centers.

At the time of development for the BRP Tool, the total number of hospital beds, including acute care/surge beds, and ICU beds were calculated to be 10,002 in the State of Maryland. For each county, the available beds are divided by the total state beds to determine the counties percentage of state beds. For example, at the time of this report Baltimore County had a total of 933 hospital beds. This represented 9.328% of the state total. Thus, the Baltimore County tab presents hospital PPE burn rate as 9.328% of the states total burn rate.

The development team recognized that two factors can influence the accuracy of this projection method: First, the actual number of hospital beds available in a given county at the time of tool usage, and the number of COVID-19 positive patients occupying those beds at the time of tool usage. Significant deviations from the underlying assumptions in either of those numbers will impact accuracy of the projections. County planners utilizing this tool should understand this limitation and adjust projections as needed based on specific circumstances within their county.

# VI. Outcomes

## NEW BRP TOOL VALIDATION

Validation of the BRP Planning tool began with tool development. The MEMA Burn Rate Team carefully reviewed data for outliers and then normalized that data through direct investigation of the root cause. In addition, as the underlying formulas were constructed, graphed, and tested the team tracked the $R^2$ value for each item, as well as, the data correlation between the BRP Projections and the real-world burn rate reports generated during the initial process. Also during development, the team used the BRP Tool to retroactively project Burn Rate for a period in which real-world burn rate reports existed. This direct comparison of the BRP Tool vs. the detailed process produced a variation level for the BRP Tool from which a confidence level could be determined. Results of this data is summarized in the tables below:

LTC: PPE PREDICTION ANALYTICS FOR BRP DEVELOPMENT

| PPE TYPE | TREND LINE $R^2$ VALUE | TRENDLINES: Polynomial (Order 2) BRP Tool Formula | Avg. Difference: Sample Proj. vs. New BRP Tool | Correlation: Sample Proj. vs. New BRP Tool |
|---|---|---|---|---|
| GOWNS | $R^2 = 0.8071$ | $y = 0.0379x^2 + 26.637x + 12455$ | 2% | 0.891542197 |
| MASKS | $R^2 = 0.6249$ | $y = 0.0481x^2 + 72.683x + 14525$ | 8% | 0.790562123 |
| GLOVES | $R^2 = 0.5734$ | $y = -0.0077x^2 + 153.66x + 193310$ | 9% | 0.642797099 |
| N95s | $R^2 = 0.6554$ | y = 0.0001x2 + 3.3292x + 1325 | 5% | 0.710684554 |
| FACE SHIELDS | $R^2 = 0.6389$ | y = 0.0009x2 + 0.7061x + 1200 | 6% | 0.799881699 |
| GOGGLES | $R^2 = 0.5533$ | $y = 0.0003x^2 + 0.4042x + 135$ | 8% | 0.673558973 |

**Table 3: BRP development data validation process outcomes for LTC BRP formulas**

HOSPITALS: PPE PREDICTION ANALYTICS FOR BRP DEVELOPMENT

| PPE TYPE | TREND LINE $R^2$ VALUE | TRENDLINES: Polynomial (Order 2) BRP Tool Formula | Avg. Difference: Sample Proj. vs. New BRP Tool | Correlation: Sample Proj. vs. New BRP Tool |
|---|---|---|---|---|
| GOWNS | $R^2 = 0.7831$ | $y = 0.0329x^2 + 29.238x + 19587$ | 1% | 0.863521192 |
| MASKS | $R^2 = 0.7516$ | y = -0.0017x2 + 22.98x + 17560 | 2% | 0.867155776 |
| GLOVES | $R^2 = 0.8061$ | y = 0.0773x2 + 268.07x + 215974 | 2% | 0.899187843 |
| N95s | $R^2 = 0.771$ | y = 0.0382x2 + 11.127x + 6894 | 3% | 0.878718725 |
| FACE SHIELDS | $R^2 = 0.6543$ | $y = 0.0035x^2 + 7.8355x + 3252$ | 2% | 0.811654483 |
| GOGGLES | $R^2 = 0.6757$ | y = 0.0001x2 + 0.0463x + 202 | 2% | 0.827584599 |

**Table 4: BRP development data validation process outcomes for Hospital BRP formulas**

LEO / CORR: PPE PREDICTION ANALYTICS FOR BRP DEVELOPMENT

| PPE TYPE | TREND LINE $R^2$ VALUE | TRENDLINES: Polynomial (Order 2) BRP Tool Formula | Avg. Difference: Sample Proj. vs. New BRP Tool | Correlation: Sample Proj. vs. New BRP Tool |
|---|---|---|---|---|
| GOWNS | $R^2 = 0.6559$ | y = 0.0002x2 + 0.6334x + 75 | 9% | 0.800919057 |
| MASKS | $R^2 = 0.5827$ | y = 0.0003x2 + 1.0334x + 1598.9 | 3% | 0.763283638 |
| GLOVES | $R^2 = 0.5717$ | y = 0.0008x2 + 12.444x + 14250 | 2% | 0.764632889 |
| N95s | $R^2 = 0.5590$ | y = 0.0008x2 + 0.7749x + 500 | 10% | 0.739184575 |
| FACE SHIELDS | $R^2 = 0.5214$ | y = 0.0001x2 + 1.3552x + 325 | 10% | 0.723401225 |
| GOGGLES | $R^2 = 0.6029$ | y = 0.0005x2 + 0.9593x + 275 | 10% | 0.778784842 |

**Table 3: BRP development data validation process outcomes for LEO / CORR BRP formulas**

# BETA TESTING

Upon completion of the BRP Tool, the development team identified qualified beta testers to review the tool, look for errors, and attempt to identify errors or deficiencies. From this process several additions were added to the first version of the BRP Tool. These additions included the individual county data sets, and the “per patient per day” window for surge support planning. Beta testers for this tool included:

- MEMA Executive SEOC Staff
- A Maryland County Emergency Manager
- COVID-19 Pandemic Response Surge Task Force Members

# FINAL VALIDATION

During the initial process the Burn Rate Team noted that reported burn rates from facilities would often lag several days behind real-world spikes or reductions in COVID-19 hospitalizations. For example, during April, 2020 confirmed cases of COVID-19 rose significantly. However, within that overall trend, there were brief periods in which hospitalizations would rise for several straight days, decrease for one day, and then continue rising. Burn rate averages across the state would follow the same pattern, but usually 3-5 days after the event change.

The primary reason for this phenomenon is a result of the burn rate reporting process. Burn rate at the local level was determined by counting inventory and submitting a report to MEMA daily. The MEMA Burn Rate Team would compile the daily reports and record changes to determine burn rates. Often, the inventory count was conducted at the local level from a point of central distribution within larger facilities. A sudden spike in cases resulted in a sudden increase in burn rate, however that would not be reflected in the reported data until the central distribution point pushed supplies throughout the facility. These supply “pushes” within facilities generally occurred every 3-5 days. Visualizations of this phenomenon can be found in the *Appendix* of this document. Additionally, more detail about the reporting process, including the logic and theory behind the approach can be found in the *Burn Rate Process Methodology Summary* report published by MEMA in May 2020.

Whereas the initial burn rate process presented a delayed response in data visualizations, the BRP Tool presents real-time values immediately during use. With these differences in mind, the MEMA Burn Rate Team spent ten days comparing projections from both the BRP Planning Tool, and the existing process. As hospitalizations began steadily decreasing in a more stable manner, the output of the BRP Tool and existing process began to align. When output between the two were within approximately 5% of each other, the MEMA Burn Rate Team transitioned to reporting daily projections from the BRP Tool output. After transitioning to the BRP Tool, the MEMA Burn rate Team continued to compare results of both tools for an additional five days observing close convergence between the two methods over the five day period.

# VII. Recommendations

## THE WAY FORWARD

Future pandemic planning should include development of a streamlined automated burn rate reporting process/system. If the system cannot be fully automated, it is recommended that this system provide an online burn rate calculator that is intuitive in design without requiring end-user training. Ideally, the system would be accessible via mobile devices allowing end users to input burn rate data directly from their inventory location or point of distribution. The system should include outputs that provide MDH/MEMA with a count of units utilized per day, and simultaneously output days of supply remaining for end users.

Additionally, consideration should be given to the following:

- The development of a system that populates data directly to a dashboard supporting a common operating picture.

- The development of a system that integrates multiple reporting requirements into a single portal

- Long-term PPE planning to include strategies for stockpiles, conservation, and integrated solutions for supply chain shortages.

For detailed information related to recommendations, please review the *MEMA COVID-19 Burn Rate Methodology Summary Report* published by MEMA in May of 2020 (Available upon request to MEMA).

# VIII. Conclusion


The COVID-19 Pandemic Response demanded quick response and creative thinking from responders, healthcare workers, leaders, and decision-makers. The burn rate process implemented by MEMA represented just one of the many creative processes developed to meet the unprecedented demand of the COVID-19 Pandemic. Additionally, the data collected during this process, presented MEMA the opportunity to build a tool designed for future use to strengthen preparedness and bolster resiliency.

The development of the Burn Rate Projection Tool was dependent on the data collected over a two-month period during the initial COVID-19 Pandemic response. Data, that was only possible to compile thanks to hundreds of frontline and essential workers submitting local-level burn rate reports to the state every day. In addition to this effort, the BRP development Team worked closely with other state partners while building this tool. This includes members of the Hospital and Nursing Home Surge Task Forces, CRISP partners, and county emergency managers. As a result of this incredible collaborative drive, the State of Maryland was able to engineer a powerful new tool that gives our county emergency managers, state leaders, and leadership additional information to make informed decisions streamlining future responses.

Collectively the residents of Maryland, our first responders, healthcare workers, and leaders pulled together with safety at the forefront of every action, united by our tremendous resilience. Maryland Strong became our mantra as we began taking first steps along the *Roadmap to Recovery*. As we honor those we lost, and study the lessons learned, we turn from recovery and look to the future.

Together, we are: Maryland Strong

# Appendix

## A. ACRONYMS

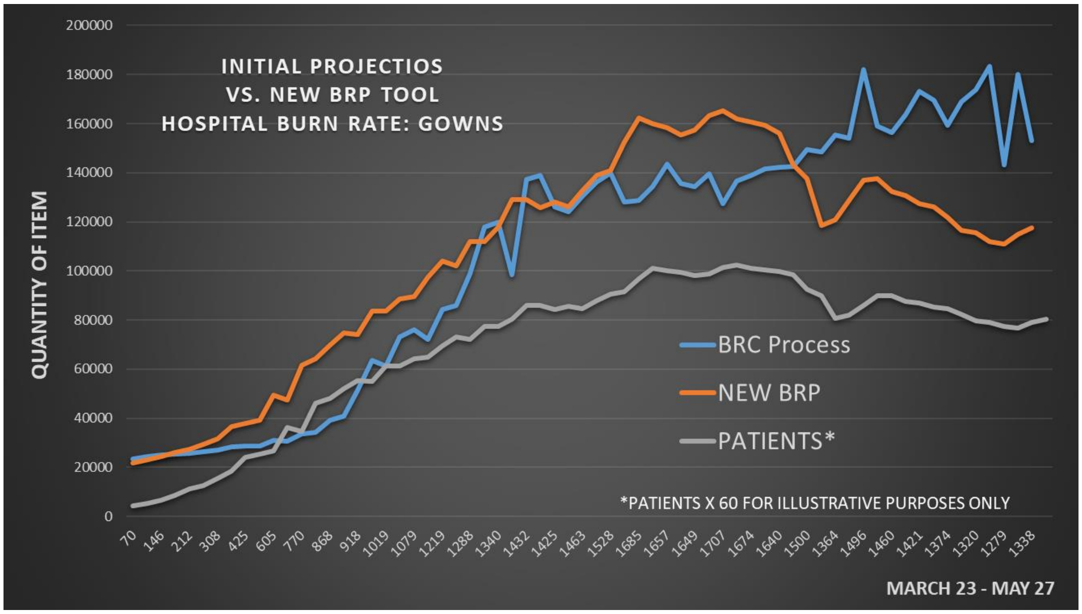
| | |
|---|---|
| **ASPR** | Assistant Secretary of Preparedness and Response |
| **BiPAP** | Bi-level Positive Airway Pressure |
| **BR** | Burn Rate |
| **BRC** | Burn Rate Calculator |
| **BVM** | Bag Valve Mask |
| **CDC** | Centers for Disease Control |
| **COU** | Cone of Uncertainty |
| **CPAP** | Continuous Positive Airway Pressure |
| **CPR** | Cardiopulmonary Resuscitation |
| **CRISP** | Chesapeake Regional Information System for our Patients |
| **EM** | Emergency Management |
| **EMS** | Emergency Medical Services |
| **EMT** | Emergency Medical Technician |
| **EOC** | Emergency Operations Center |
| **ESF** | Emergency Support Function |
| **FEMA** | Federal Emergency Management Agency |
| **FMS** | Field Medical Station |
| **HCC** | Healthcare Coalition |
| **HIE** | Health Information Exchange |
| **ICU** | Intensive Care Unit |
| **JHAPL** | Johns Hopkins Applied Physics Lab |
| **LTC** | Long-term Care |
| **MDH** | Maryland Department of Health |
| **MEMA** | Maryland Emergency Management Agency |
| **MHA** | Maryland Hospital Administration |
| **MIEMSS** | Maryland Institute of Emergency Medical Services System |
| **NCR** | National Capital Region |
| **NFPA** | National Fire Protection Association |
| **NHSA** | National Hospital Safety Agency |
| **PPE** | Personal Protective Equipment |
| **PUI** | Patient Under Investigation |
| **SEOC** | State Emergency Operations Center |
| **SNS** | Strategic National Stockpile |

# E. NEW BRP TOOL VALIDATION GRAPHS

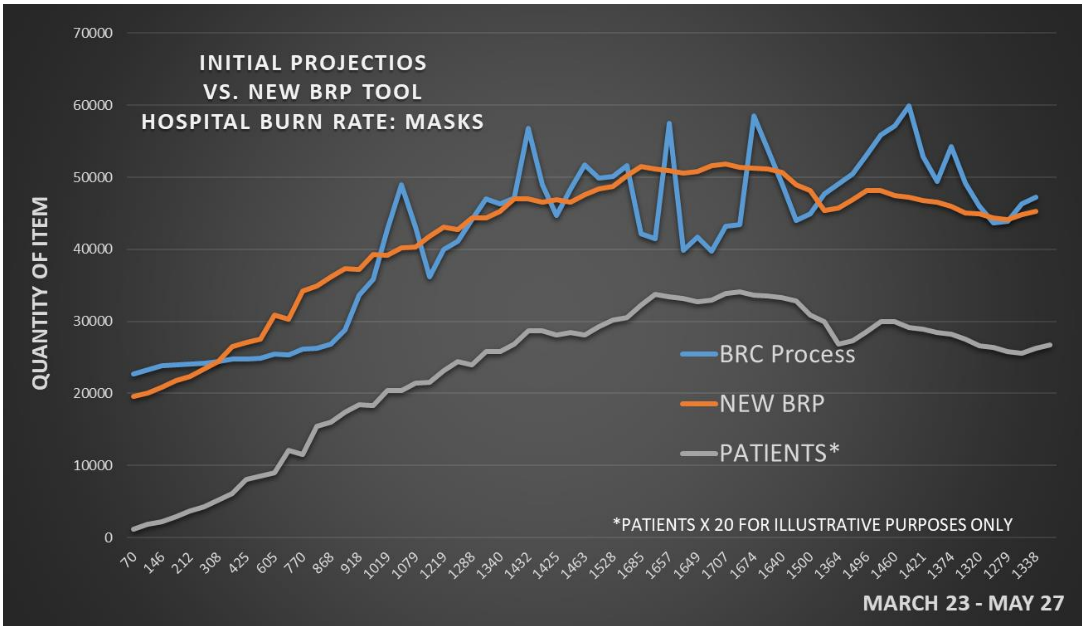
## HOSPITALS

The following graphs compare the data collected during the initial burn rate process against the projections from the new BRP tool:

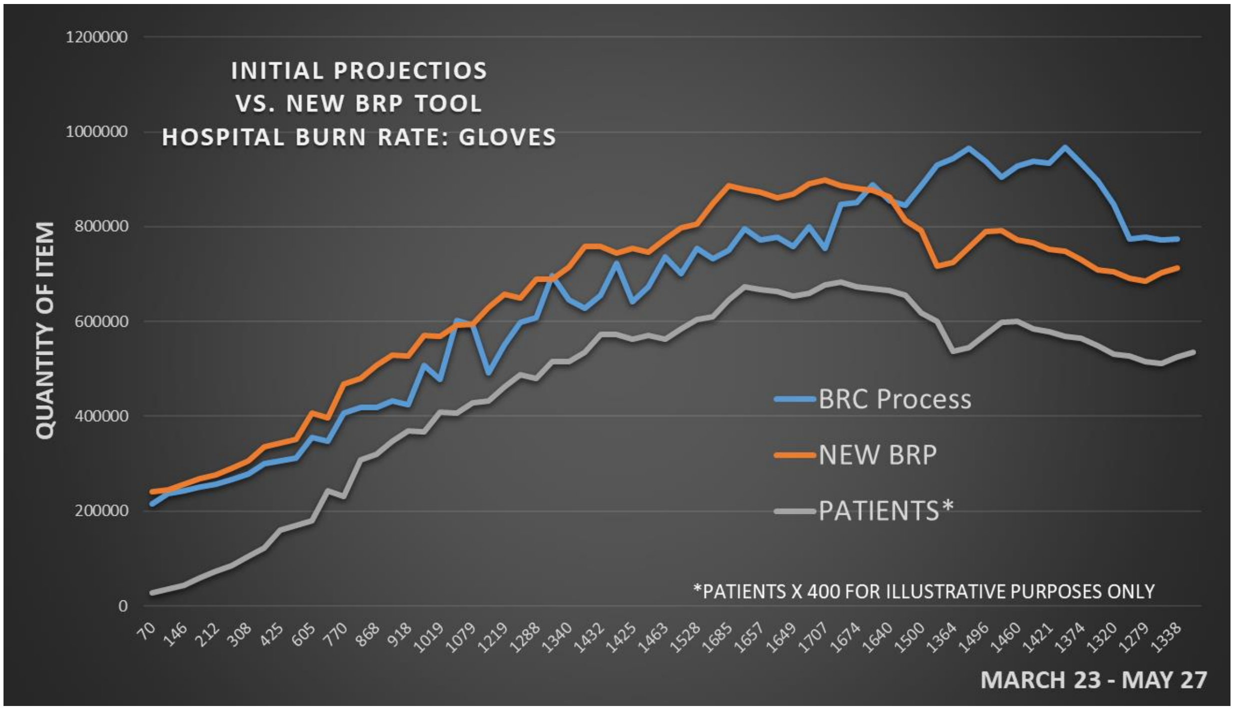
***BR Process vs. New BRP Tool for Hospitals – PPE Item: Gowns***



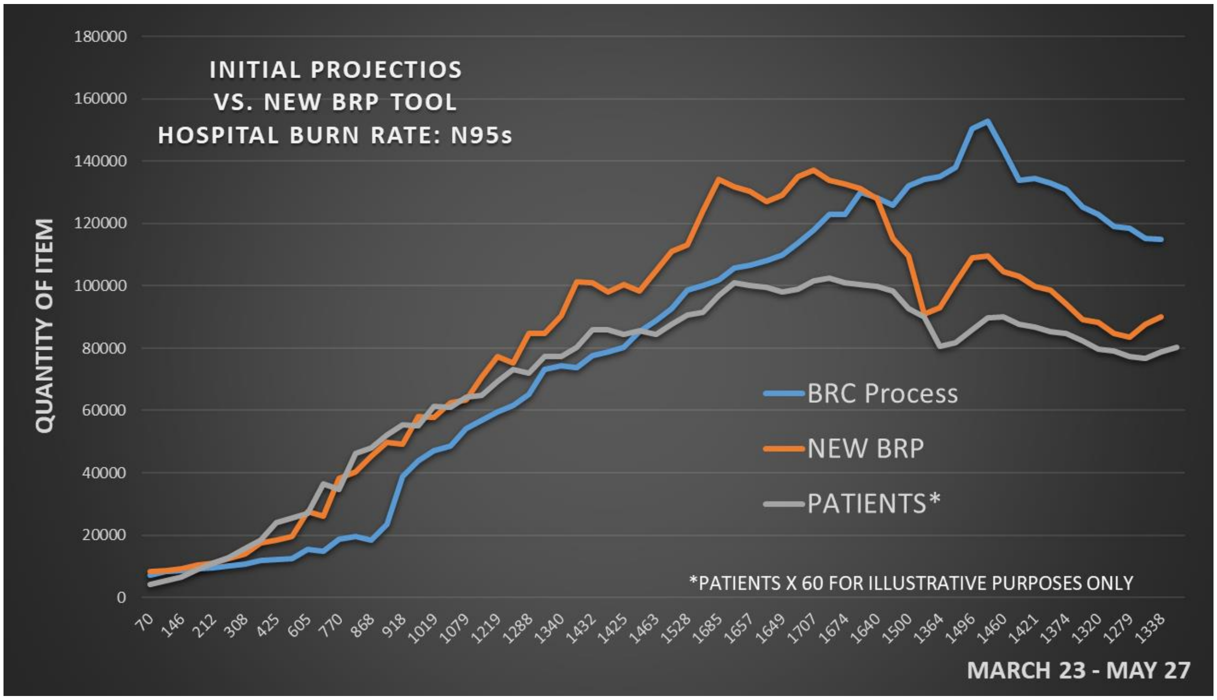

***BR Process vs. New BRP Tool for Hospitals – PPE Item: Masks***



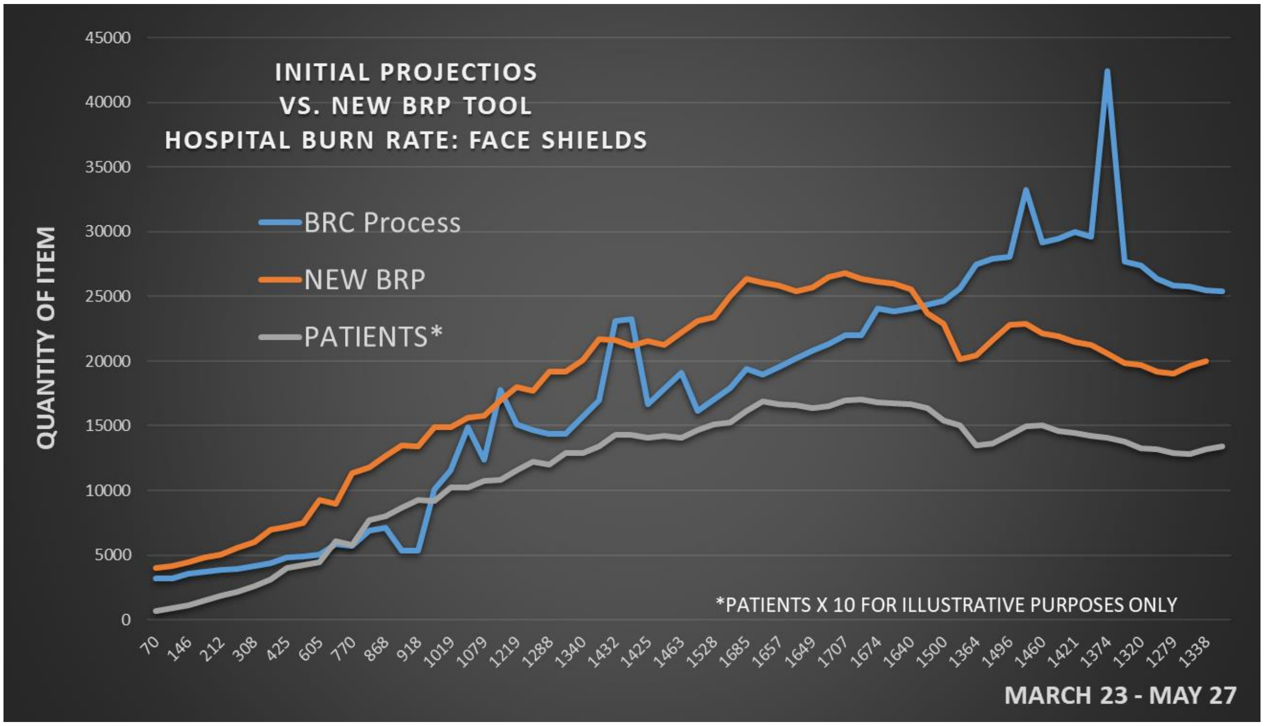
***BR Process vs. New BRP Tool for Hospitals – PPE Item: Gloves***



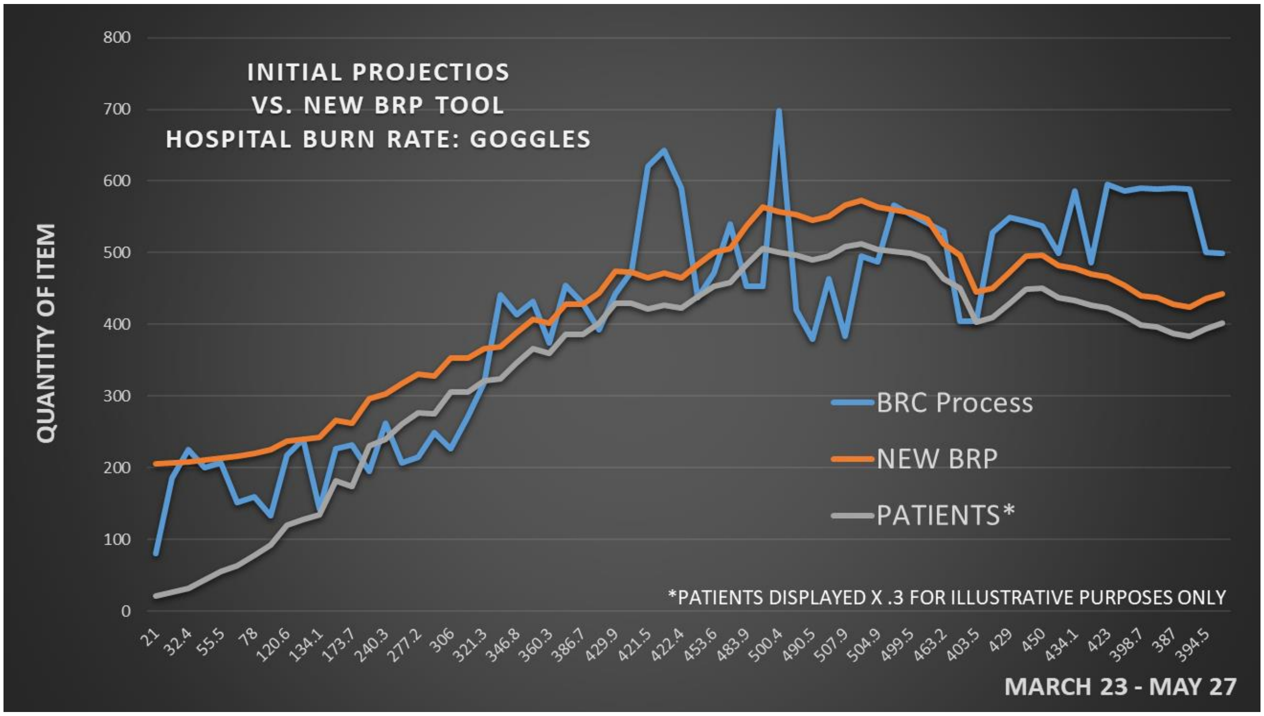

***BR Process vs. New BRP Tool for Hospitals – PPE Item: N95s Respirators***



***BR Process vs. New BRP Tool for Hospitals – PPE Item: Face Shields***



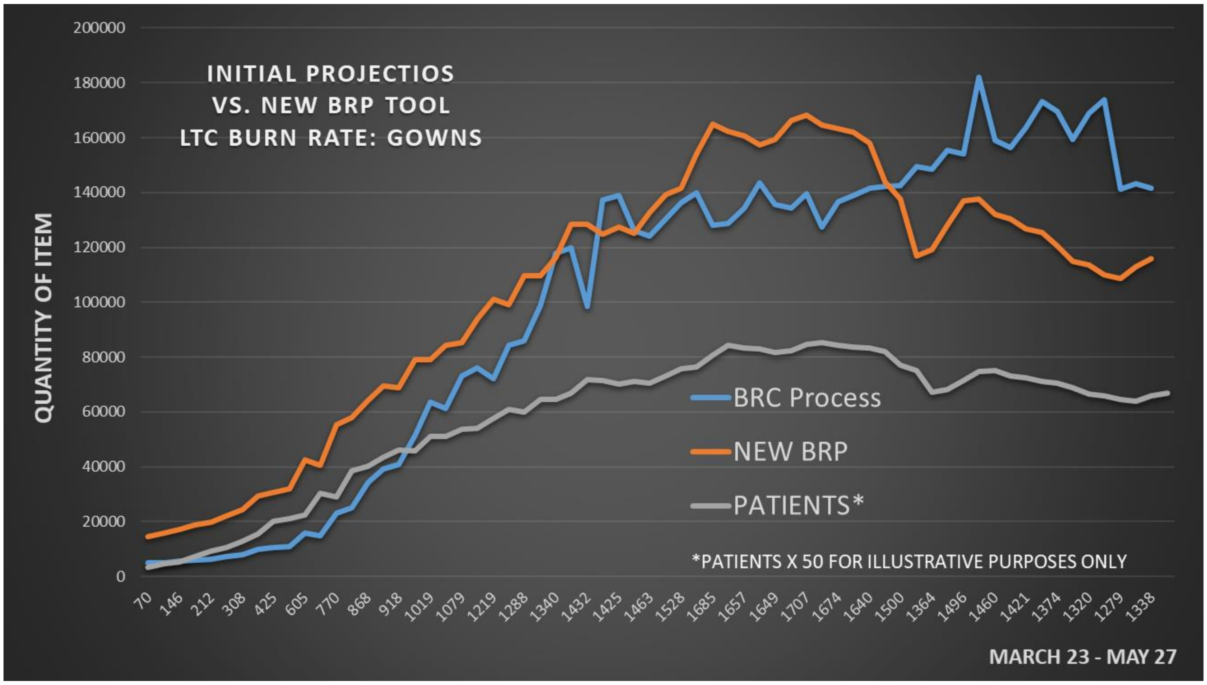

***BR Process vs. New BRP Tool for Hospitals – PPE Item: Goggles***



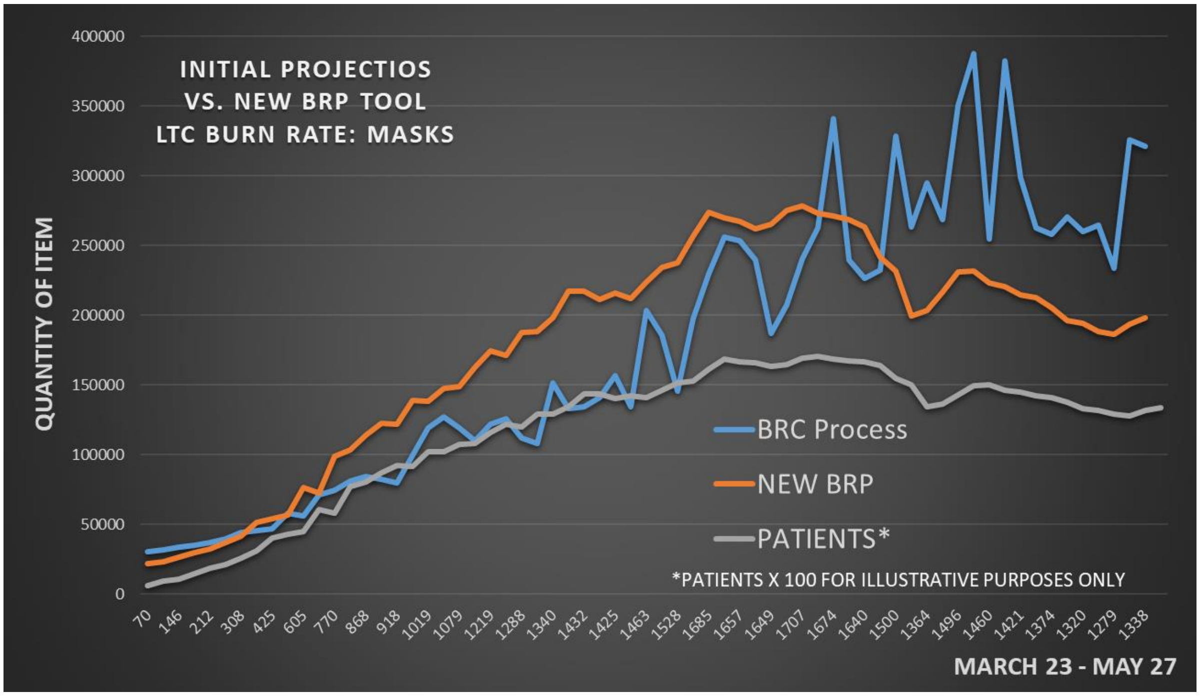
## LONG-TERM CARE CENTERS

The following graphs compare the data collected during the initial burn rate process against the projections from the new BRP tool:

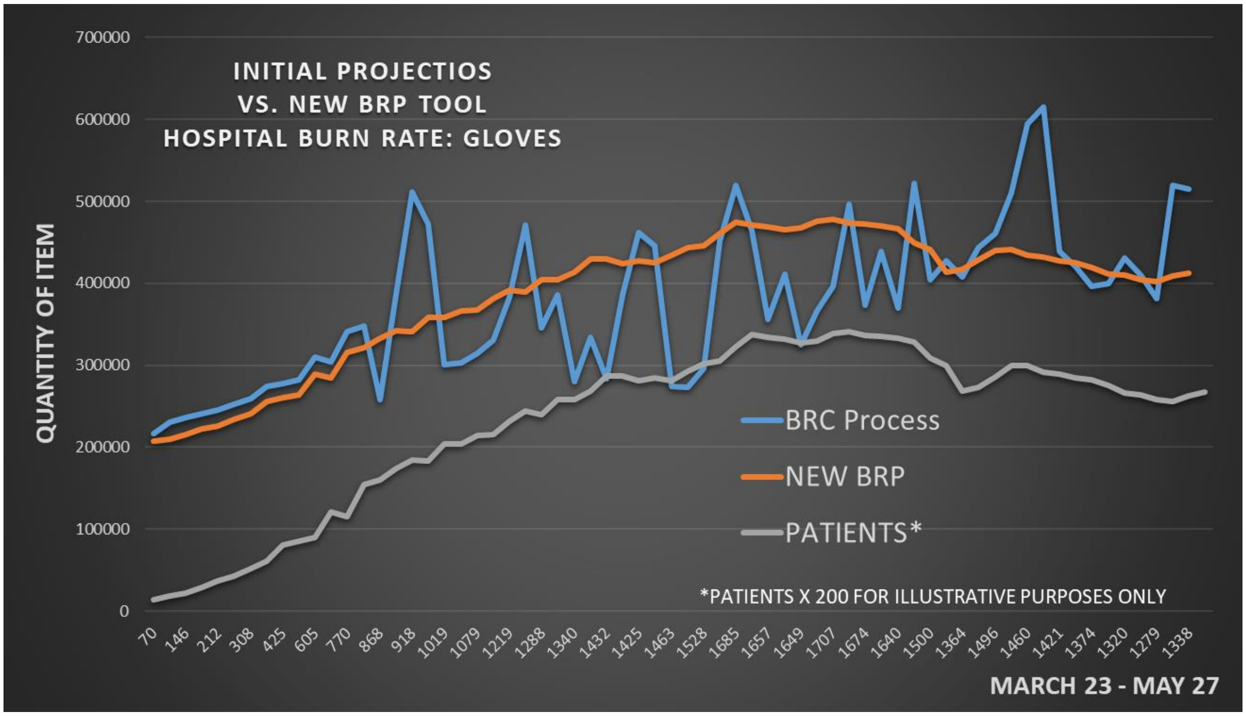
***BR Process vs. New BRP Tool for LTCs – PPE Item: Gowns***



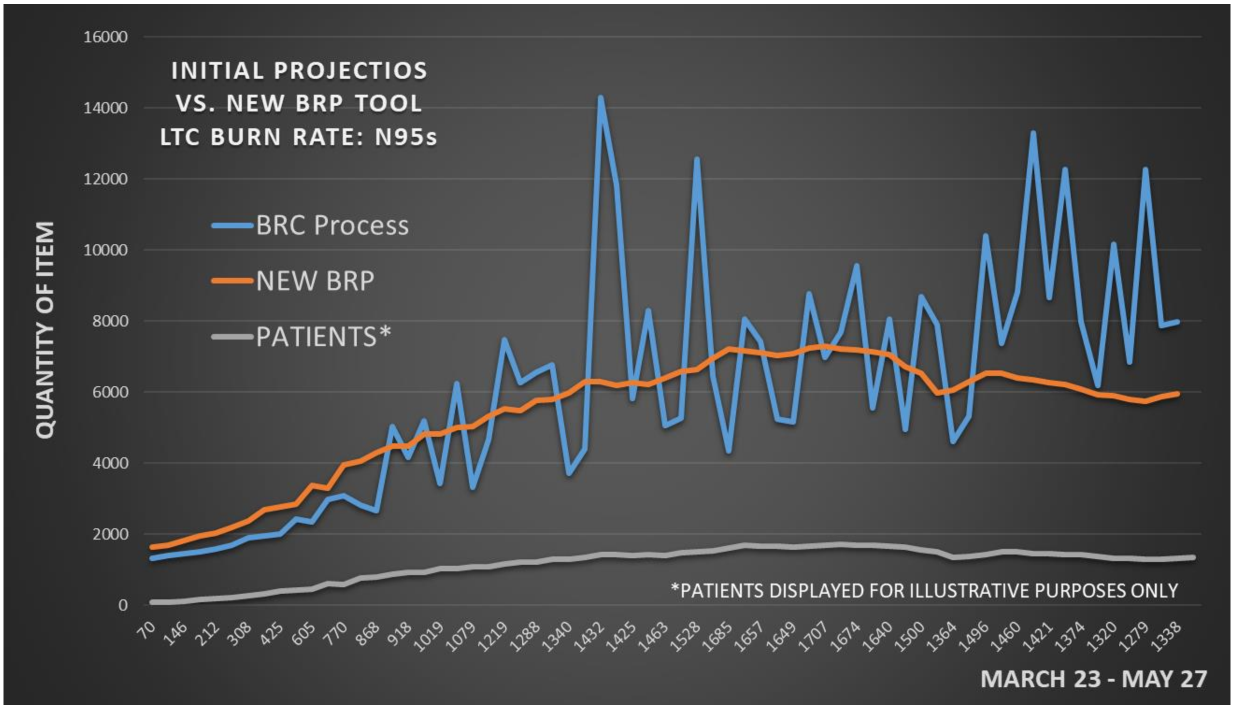

***BR Process vs. New BRP Tool for LTCs – PPE Item: Masks***



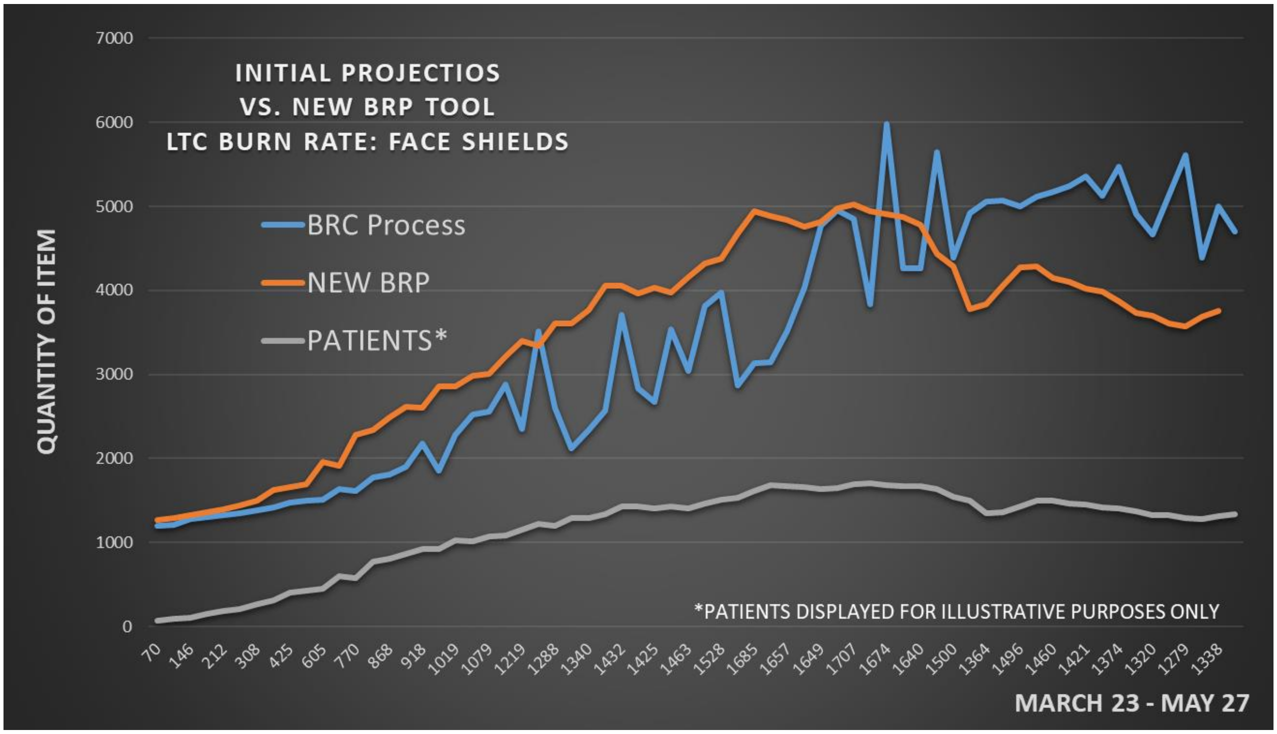
***BR Process vs. New BRP Tool for LTCs – PPE Item: Gloves***



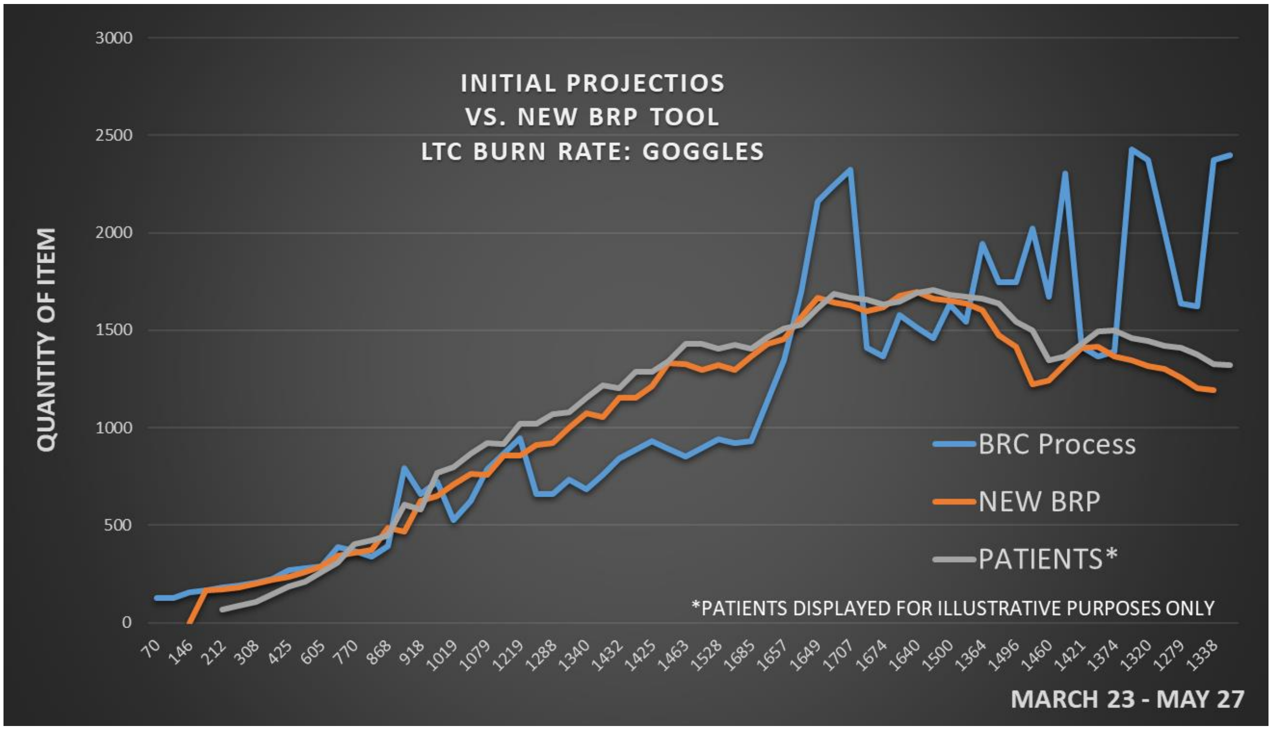

***BR Process vs. New BRP Tool for LTCs – PPE Item: N95s Respirators***



***BR Process vs. New BRP Tool for LTCs – PPE Item: Face Shields***



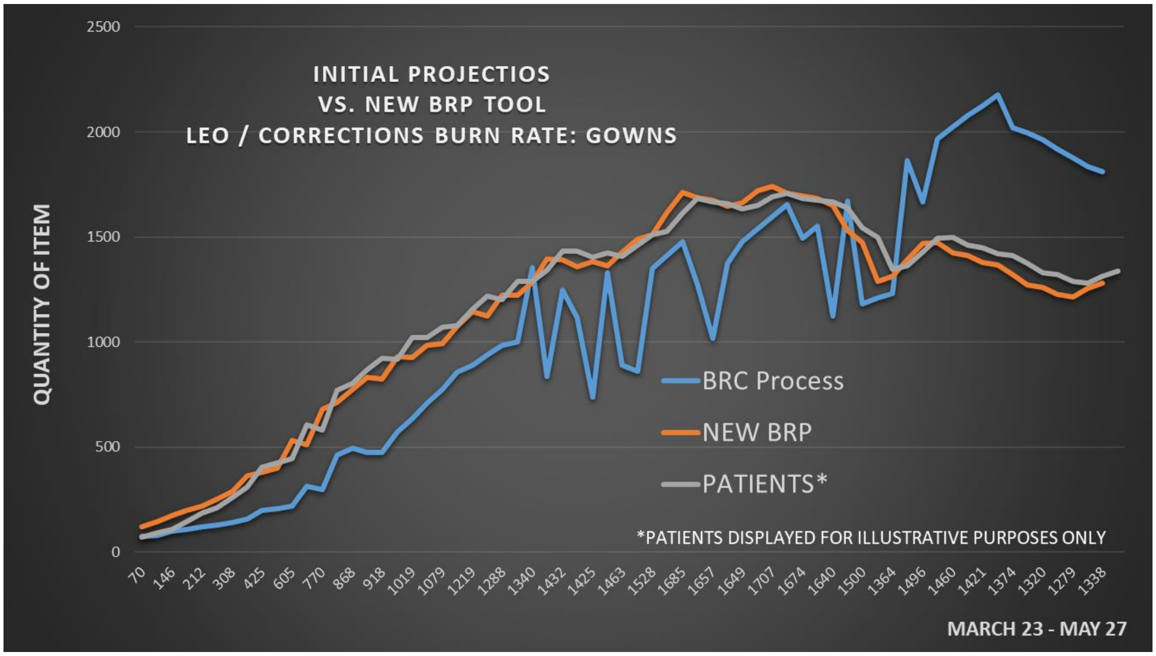

***BR Process vs. New BRP Tool for LTCs – PPE Item: Goggles***



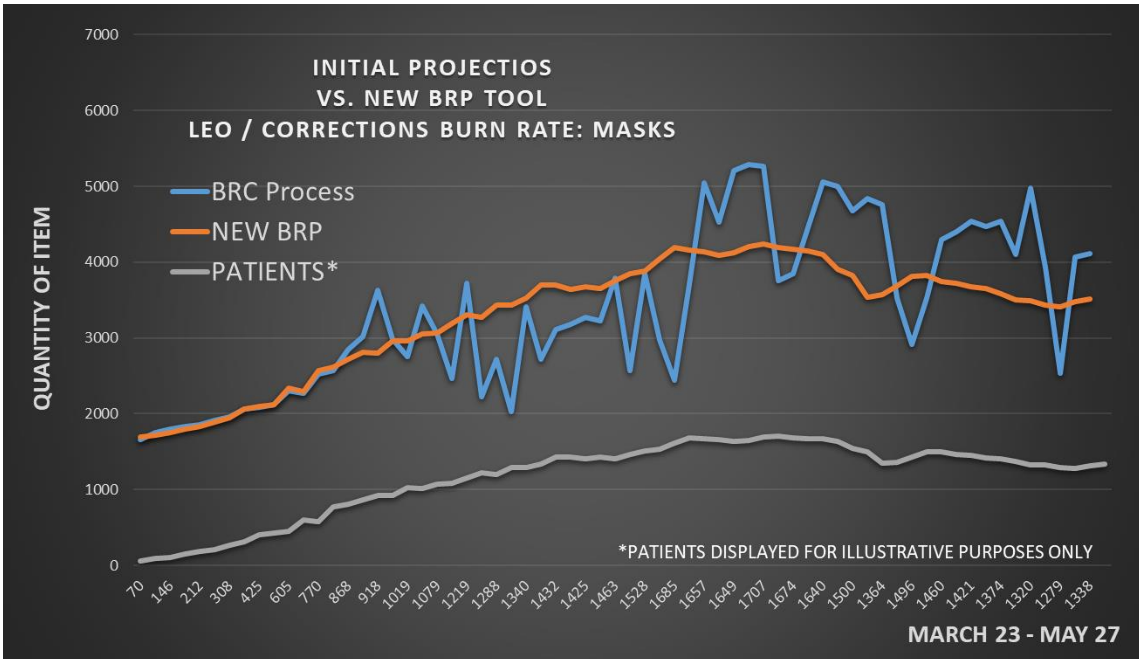
## LAW ENFORCEMENT / CORRECTIONS

The following graphs compare the data collected during the initial burn rate process against the projections from the new BRP tool:

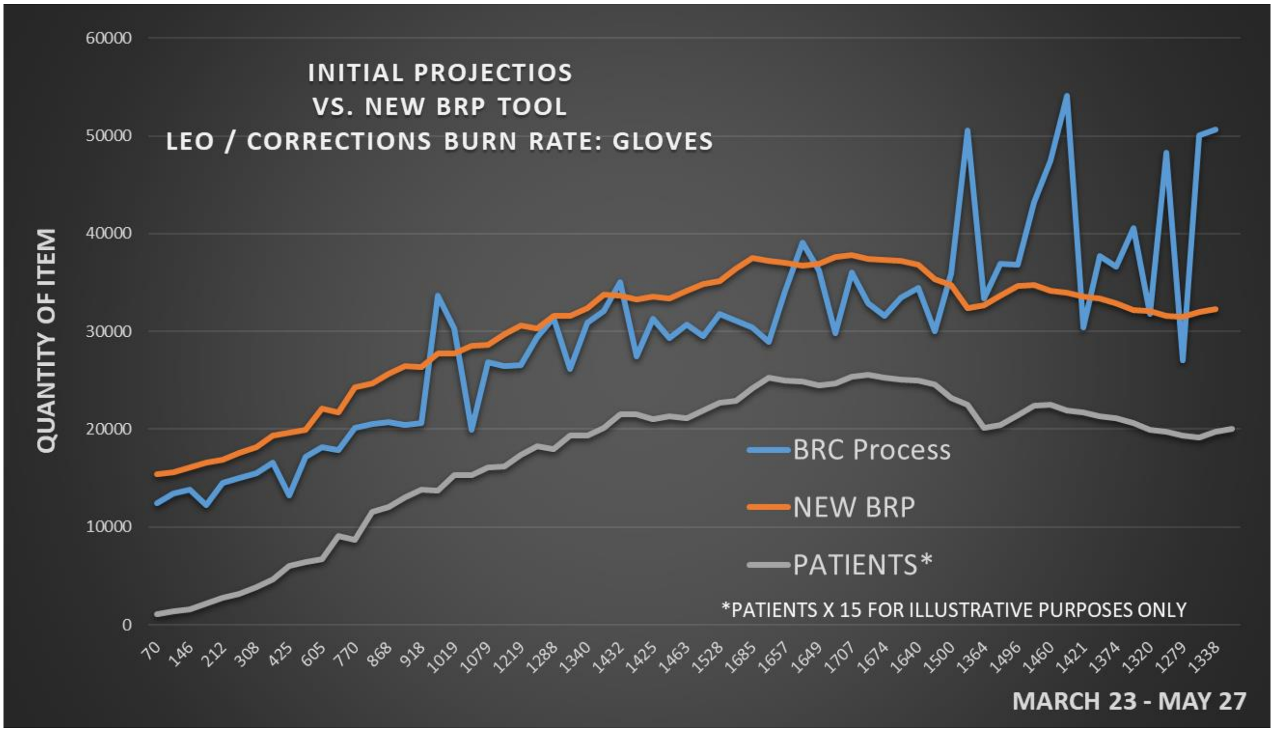
***BR Process vs. New BRP Tool for LEO / CORR – PPE Item: Gowns***



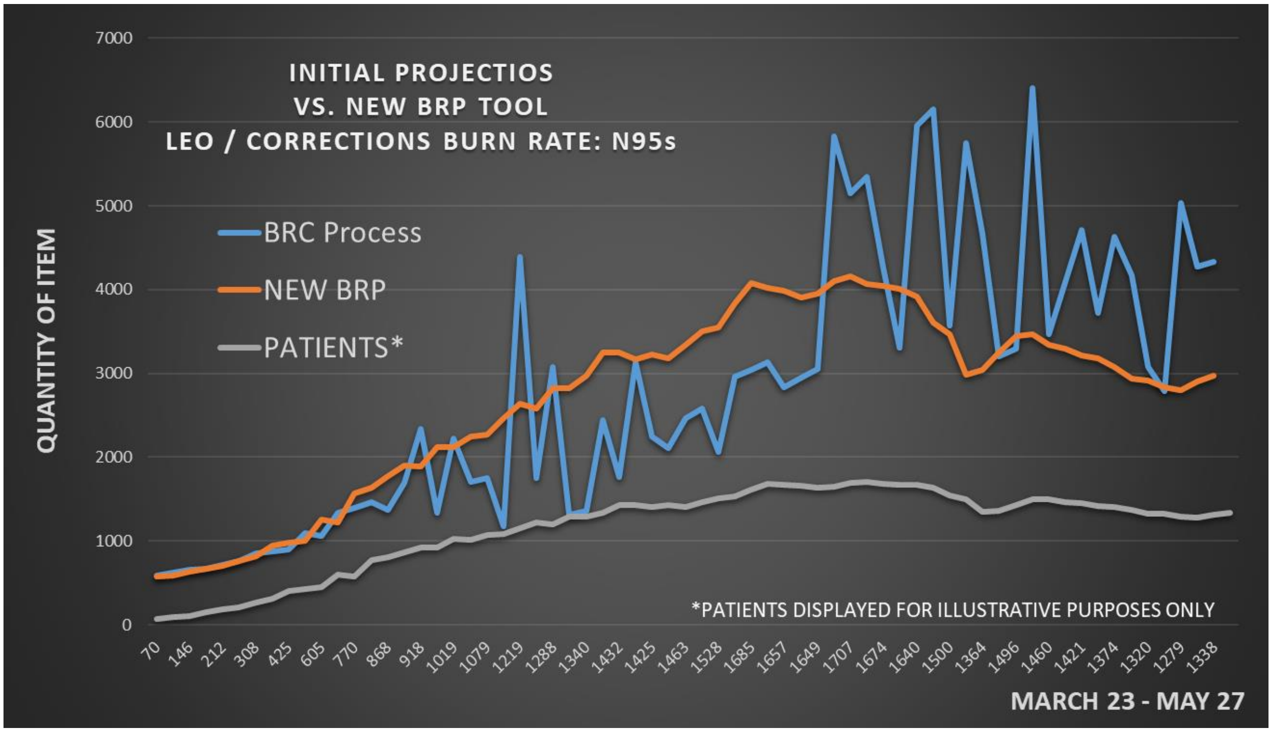

***BR Process vs. New BRP Tool for LEO / CORR – PPE Item: Masks***



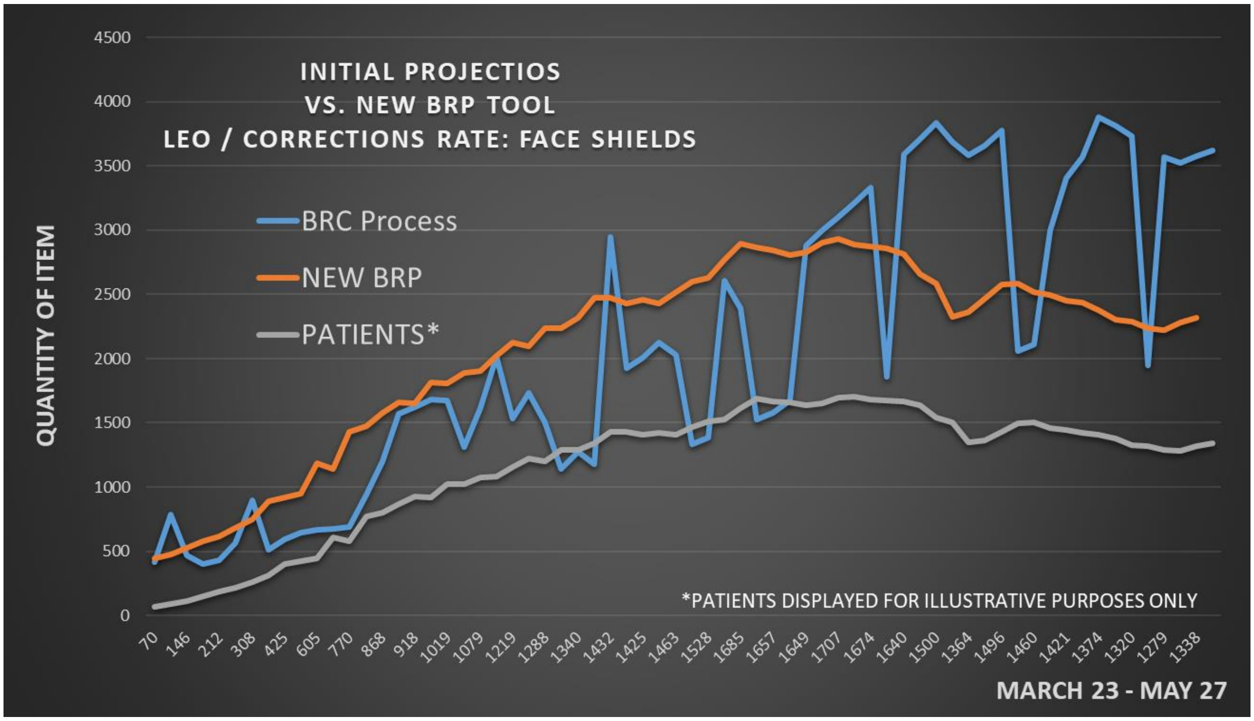
*BR Process vs. New BRP Tool for LEO / CORR – **PPE Item: Gloves***



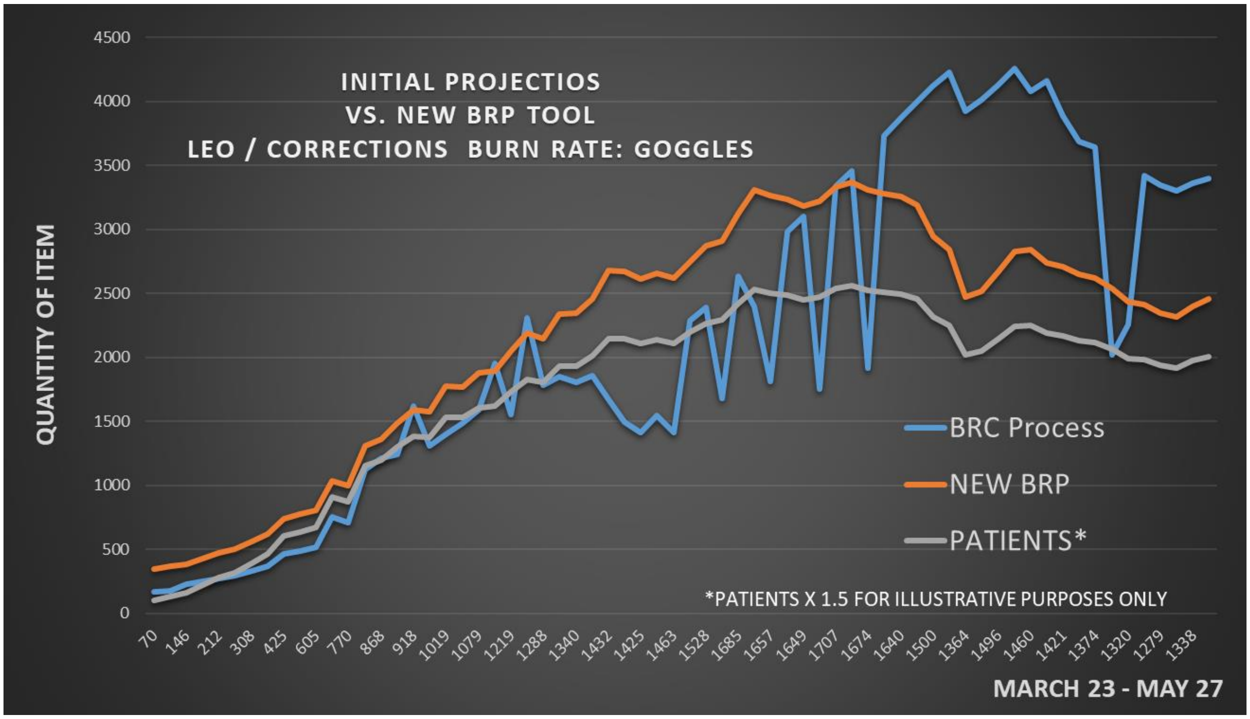

*BR Process vs. New BRP Tool for LEO / CORR – **PPE Item: N95s Respirators***



***BR Process vs. New BRP Tool for LEO / CORR – PPE Item: Face Shields***




***BR Process vs. New BRP Tool for LEO / CORR – PPE Item: Goggles***



# G. REFERENCES

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https://www.cdc.gov/coronavirus/2019-ncov/hcp/ppe-strategy/burn-calculator.html