



Improving Code Response Time through Strategic Positioning of Nursing House Supervisors: Results of a Nurse-Led Intervention

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ABSTRACT

Background: In many settings, the nursing house supervisors (NHS) are a critical part of the entity's code response team. To date, much of the research on code response has focused on improving response times through staff-focused interventions such as simulation training. However, use of data to determine where to physically place NHS in the building to optimize code response times has received little attention, especially in an outpatient oncology setting.

Purpose: To test whether using data on code frequency/location to strategically position NHS could reduce mean code response times in large (450,000-ft²) outpatient cancer center.

Methods: Data on code volume, type, distance and estimated response time before and after strategic repositioning was collected by staff over a 238-day period occurring between September, 2019 and April, 2020.

Results: Over an eight-month period, NHS staff responded to 64 codes. Prior to repositioning, 77.3% of codes required NHS to travel to a different building and through at least one floor and/or departments to arrive at the code. After strategic repositioning, mean code response times at our center fell from 3.4±0.7 min, on average, to 1.5 ± 0.6 min ($p < .000$). Improvements in code response times and distance travelled were observed regardless of code type, time of day, or individual NHS responding to the code.

Conclusions: Results suggest that a data-driven strategy for determining where to place NHS in the building based on code frequency and location may be a useful way for oncology centers to improve code response times.

Keywords: Nursing house supervisor, code response, oncology

INTRODUCTION

Ensuring that first responders are in a position to respond quickly to emergencies that can occur to patients, family, or staff visiting healthcare facilities is essential (Gu, Li, He, Zhao, & Liu, 2016; Schiavone, 2009)). In many settings, Nursing House Supervisors (NHS) play a central part of the facility's emergency response teams. While the roles and responsibilities of the NHS can vary by organization, in most settings NHS are responsible for a combination of leadership, administrative, and emergency response roles, including responding to unplanned emergency events (known as 'codes') (Crincoli & Weaver, 2019; Weaver & Lindgren, 2016). In addition, in some settings NHS are the sole responders to certain types of codes, especially during evening and weekend hours (Weaver & Lindgren, 2016).

While literature describing the importance of NHS in code response goes back decades (Crawford, 1991), NHS-led efforts to improve code response are rare (Glasofer & Bertino Lapinsky, 2019). While attempts to shorten the precious window of time between when NHS and other first responders are notified about a potential emergency and when they arrive on the scene (i.e., code response time) have been described extensively in the inpatient setting (Huseman, 2012), less has been written about efforts to improve code response in the ambulatory/outpatient setting.

In particular, much of the research that has been performed exploring code response to date has focused on efforts to improve staff performance, either through the use of simulation, communication training, clarifying staff roles, changing the composition and/or increasing the experience level of code response teams, and/or increasing access to

equipment access (Prince, Hines, Chyou, & Heegeman, 2014; Couloures & Allen, 2017; Gaca et al., 2007; Herbers & Heaser, 2016; Huseman, 2012; Palmisano, Akingbola, Moler, & Custer, 1994). However, efforts to reduce code response time by using data to determine where to place staff have received little attention.

In March of 2019, leaders and staff identified an opportunity to improve code response times in our cancer center following a review of internal data. Specifically, review of data on the location and number of codes taking place throughout our center over the previous year revealed that the location housing NHS was far from many of the locations with the highest incidence of codes, causing us to question whether placing NHS in areas with the highest code volumes could be an effective strategy for reducing mean code response times.

PURPOSE

The purpose of this nurse-led quality improvement project was to evaluate the effect of a nurse-led intervention on code response times in the ambulatory oncology setting. Specifically, the goal of the project was to determine whether strategically repositioning NHS in the areas with the highest code volumes could reduce mean code response times.

Our aim in performing this project was not only to determine whether using data on code volume to determine *where* to place emergency first responders could be an effective strategy for reducing mean code response times, but to provide information about the volumes, times, and types of codes taking place in the ambulatory oncology setting needed to continue to streamline code response in our center. We think this data may be of interest to healthcare administrators and clinicians in other cancer centers, where delays in code response can be associated with poor outcomes.

METHODS

Project Setting

The setting for this quality improvement project was a large (450,000-ft²) ambulatory comprehensive cancer center located in Miami, Florida.

Description of Code Response

For the purposes of this project, we elected to focus on the positioning of NHS only, whose primary focus in our center is code response. A list of code types with corresponding definitions can be found in Table 1. In our center, NHS are the first responders for all non-patient injuries that occur inside and outside the building (known as Code 9's and Code 250's, respectively), and serve as team leads for the large code response team, which includes transporters, security, an emergency dept (ED) nurse and a tech.

For codes involving combative individuals (Code Greens), a code response team consisting of the NHS,

a social worker, patient experience representative, transportation, and security is called. For Code Reds (potential/actual fire), the code response is led by the NHS with staff from engineering and security. For Code Rescues (which are called in response to rapid deterioration in the patient's clinical status), NHS are the first responder, who are then followed by an advanced practice provider (i.e., Nurse Practitioner or Physician Assistant), staff nurse, medical assistant, recorder, transport, and security.

Data Collection

Nursing house supervisor (NHS) staff collected data for the project between September 3, 2019 and April 28, 2020. Data for the project included the date (dd-mm-yy) and time (hh:mm) each code occurred in our facility; the estimated time (in minutes) between when NHS were first notified about the code and when they arrived (i.e., code response time); the general area (e.g., first floor, third floor) and specific location (e.g., greeter desk, main hallway) the code took place, and code type (Code 250, Code 9, etc).

| Code Name | Definition |
|-------------|--------------------------------------|
| Code Blue | Cardiac arrest |
| Code 9 | Non-patient injury, inside building |
| Code 250 | Non-patient injury, outside building |
| Code Green | Combative person |
| Code Red | Potential or actual fire |
| Code Rescue | Patient clinical deterioration |

To accommodate the relocation of the NHS staff during the project from their original location on the third floor of our research building (in a separate wing of our cancer center) to their new, more central location on the third floor of our main building (directly above our main entrance), during the project we paused data collection between the pre-intervention phase (which extended from September 3 to December 19, 2019) to the post-intervention phase, February 3 to April 28, 2020.

Next, to determine if the distance NHS had to travel to reach codes was affecting code response times, we developed a system for classifying code distance, summarized in Table 2. Briefly, codes were divided into four categories – very close, close, far, very far – based on the number of buildings, floors, or departments (i.e., physical distance) that NHS had to travel to reach the code from their offices.

ANALYSIS

Analyses for the project were performed in SPSS, Ver. 25 (Armonk, NY: IBM Corporation). Prior to analysis, data were checked for outliers and missing data. Complete data on code date, time, type, distance, area, and location was available for 100% of the sample ($n = 64$ codes). Data on which NHS staff responded

to codes was missing from seven of 22 codes (31.2%) that took place during the pre-intervention period, (10.9% of total sample). To avoid the potential to unintentionally skew data, missing data points were not imputed.

Descriptive statistics (counts, frequencies, means, and standard deviations) were used to report code volume and type, and mean response times before and after strategic repositioning of NHS. Two-tailed Pearson Chi Squared tests were used to compare code type and distance traveled (very far, far, close, very close) that NHS had to travel pre- and post-intervention. Likewise, two-tailed, independent sample *t*-tests were used to compare mean code response times for NHS before and after the intervention.

To ensure that any differences in mean response times we might observe during the post-intervention phase were not due to differences in response times among staff, the four NHS were randomly assigned a letter (A, B, C, D) and one-way analysis of variance (ANOVA) models were used to compare code response times between staff both before and after the intervention. Unless otherwise stated, all tests were two-tailed tests and $\alpha = .05$ was used as the threshold for statistical significance.

RESULTS

| Distance | Definition |
|------------|---|
| Very Close | Code located in same building, and same floor/department |
| Close | Code located in same building, but NHS must travel through at least 1 floor/department to reach |
| Far | Code located in different building and NHS must travel through at 1 floor/department to reach |
| Very Far | Code located in different building and must travel through ≥ 2 floors/ departments to reach code |

Code Volumes, Type, Frequency, Distances and Locations

Over a 238-day period (eight months) occurring between September 3, 2019 and April 28, 2020, NHS in our cancer center responded to 64 codes. Approximately one-third (34.2%) of these codes occurred before the strategic repositioning intervention; and two-thirds (65.6%) took place after the strategic repositioning (Figure 1).

On average, NHS at the center responded to 9.1 ± 5.0 codes per month. Comparison of code volume before and after strategic repositioning found that code volume was significantly higher during the post-

intervention period (February through April 2020) compared to before (September to mid December 2019) (Pre: 5.5 ± 1.4 vs. Post: 14.0 ± 2.8).

Closer inspection found that the period between February and March had the highest volume of codes, accounting for half of codes occurring during the eight-month period. By contrast, November and December had the lowest volume, making up just 14.1% of total code volumes during the project.

Details on the types of codes that NHS responded to during the project are summarized in Table 3. During the eight-month period, only six of the 14 code types described in Table 1 occurred in our center. Of these, more than 90.0% were related to just three code types: Code Rescues, Code 250, and Code 9. Code Rescues (sudden deterioration in patient clinical status) were the most common, accounting for 53.7% of all codes. Non-patient injuries occurring either inside the building (Code 9) and outside the building (Code 250) accounted for another 39.1% of code volume. Code Reds (potential or actual fire) accounted for 6.3% of total code volume. Just one code (1.6%) was related to a combative individual (Code Green).

Differences in code frequency before and after the intervention are summarized in Table 3. Results found that while the percentage of Code Rescues was identical before and after the intervention ($n=17$ during each phase of the project ($N=34$ total)), the frequency of other code types varied. For example, Code 9's made up just 6.3% of codes before the intervention, but made up 14.1% of codes post-intervention ($\chi^2 (2) 6.48, p < .039$). Similarly, Code 250's made up just 1.6% of codes during the pre-intervention period, but 4.1% of codes during the post-intervention period.

Details about the distance NHS had to travel to codes before and after the intervention are summarized in Table 3. Prior to strategic repositioning, half of codes required NHS to travel to a different building and through two or more floors and/or departments to arrive at the code ('very far'), and nearly a third (27.3%) required NHS to travel to a different building and through a least one other floor or department ('far'), with only 22.0% of codes occurring in the same building in which NHS were housed ('close' or 'very close').

After repositioning the NHS, the percentage of codes classified as 'close' (i.e., occurring in the same building) increased from 22.0% to 78.6% ($p < .001$). Similarly, the percentage of codes requiring NHS to travel to a different building and through at least one dept/floor ('far') fell from 27.3% to 14.3% ($p < .001$). The percentage of codes that required NHS to travel to a different building and through two or more floors/departments ('very far') also fell from 50.0% to 4.8% ($p < .001$). However, the percentage of codes classified as 'very close' (same building and same floor) was essentially unchanged (pre-intervention: 0.0% vs. post-intervention: 2.9%).

Differences in Mean Code Response Time Before and After Strategic Repositioning of NHS

Mean code response times for the sample are summarized in Table 2. Following the intervention, mean code response times fell by nearly a minute and a half, from 3.4 ± 0.7 minutes, on average, to 1.5 ± 0.6 minutes, ($t(1, 62) = 10.5, p < .001$).

When we compared mean response times for codes based on how far NHS had to travel to reach the code ('very close,' 'close,' 'far,' or 'very far'), results showed that repositioning NHS improved mean response times across all categories. Mean response times for codes taking place in the same building/different floor (close) decreased by approximately one minute, on average (Pre: $2.60 \pm .89$ min vs. Post: $1.48 \pm .51$ min ($p < .001$)). Mean response time for codes requiring NHS to travel to a different building and through at least one department/floors (far) decreased by even more, dropping by two minutes, on average (pre: $3.64 \pm .50$ min vs. post: $1.50 \pm .84$ min; $p < .001$).

Response times for codes classified as 'very far' also improved following strategic repositioning of the NHS (Pre: 3.67 ± 0.5 min vs. Post: 2.00 min), but could not be analyzed statistically because there were only two instances during the post-intervention period. Similarly, differences in codes taking place on the same building/same floor could not be analyzed because only one instance occurred during the study period.

Mean code response times, by code type are summarized in Table 2. Mean response times for Code 250s decreased from 3.0 min to 1.9 ± 0.3 min, following strategic repositioning, but statistical analysis was not possible because only one of the 11 Code 250s that took place during the eight-month period took place before the intervention. Similarly, comparison of response times for Code Reds was not possible because all Code Reds took place after the intervention had been implemented, and analysis of Code Greens was not possible because only one instance occurred.

Differences in Code Response Time, by NHS

To determine whether any of the differences in code response times observed during the project could be due to differences in how quickly individual NHSs on our team responded to codes, we compared mean response times for the four NHS that took part in the project using one-way analysis of variance (ANOVA), (DV: mean code response time, IV: NHS staff member). Because information on individual code response times could be potentially sensitive, to protect NHS, staff were randomly assigned a letter (Staff A, B, C and D, respectively) by team member in charge of analysis (NZ). All stakeholders were blinded to the assignment schema, and information that could potentially identify individual NHS was withheld.

Results did not find a significant difference in mean response times between any of the four NHS before [$F(2, 12) = .747, p = .495$] or after [$F(3, 38) = 2.56, p = .485$] the intervention. As expected, the bal-

ance of code types that each NHS responded to varied both before and after the intervention, which was likely due to differences in work shift, which types of codes occurred on specific days, etc. However, testing revealed these differences in mean response times for individual staff were not statistically significant either before ($\chi^2(12) = 10.1, p < .609$) or after the intervention: ($\chi^2(6) = 6.24, p < .396$). Follow up testing with one-univariate model testing found no association between mean response times and individual staff member, after co-varying for code type (data not shown).

DISCUSSION

Achieving fast, consistent code response times is critical for maintaining patient safety (Gu et al., 2016; Schiavone, 2009). Studies show that in many settings, NHS play a critical role in code response, often being among the first to arrive (Cricoli & Weaver, 2019; Glasofer & Bertino Lapinsky, 2019; Weaver & Lindgren, 2016). Results of this NHS-driven, quality improvement project using data on code frequency to determine where to position NHS in our cancer center to put them as close as possible to the areas with the highest code volumes was able to significantly reduce the distance that NHS had to travel to reach codes, reducing code response times by approximately 1.5 minutes, on average. More importantly, this decrease in mean code response times was visible regardless of code type, individual NHS responding to the code, or time of day.

Throughout the years, many strategies have been used to reduce code response times and code team performance (Couloures & Allen, 2017; Gaca et al., 2007; Herbers & Heaser, 2016; Huseman, 2012; Palmisano et al., 1994). However, to our knowledge this may be one of the first attempts to use staff placement based on the code location and frequency to improve code response times.

While these findings represent a significant improvement in mean code response times for our institution, the lack of published data on code volumes, types, or mean response times in the ambulatory setting (particularly the ambulatory oncology setting) makes it difficult to interpret our findings fully. Nonetheless, studies from non-oncology settings can provide some insight. For example, a recent seven year study of non-hospitalized patients needing unexpected medical assistance in a tertiary academic medical center reported mean code response times of approximately 3.6 minutes (interquartile range: 2, 5) (Nett et al., 2018), which is similar to the pre-intervention code response times we observed. Similarly, a recent longitudinal study of code response times in the inpatient setting reported initial time-to-defibrillation of 3.7 ± 3.6 minutes, which fell to 1.5 ± 1.8 minutes following a multi-year, simulation-based staff-training program (Prince et al., 2014). While these findings provide some context for understanding our data, the overall lack of data in this area underscores the need for research studies investigating both mean code re-

sponse time and interventions to improve code response times in the ambulatory setting.

Another potentially important set of findings from this analysis have to do with high volume of codes (40.0%) we observed related to non-patients. While not surprising given the volume of non-patients we serve (approximately 800 to a 1,000 per day), this finding is important for several reasons. First, as with other community-based cancer centers, a significant portion of the people that come through our doors are non-patients (Alansari, Althenayan, Hijazi, & Maghrabi, 2015). These individuals, which include family, friends, caregivers, vendors, and fellow healthcare providers from other institutions, are vital to the success and well-being of our patients. Analysis of our data revealed that many of our non-patient codes were taking place in areas such as the visitor garage, front entrance, and valet services, which is likely to be similar to other centers. However, unlike codes that involve patients (which include a coordinated response, and which includes the NHS, APPs code response nurses and others, NHS are the team leads on all non-patient codes (Code 250's/Code 9's). This makes timely code response by NHS especially critical for these code types.

IMPLICATIONS

Results of this nurse-led quality improvement project have several implications for other centers. At the most basic level, findings underscore the critical importance of positioning emergency first responders as close as possible to the location(s) where codes are occurring as a strategy for reducing code response times. At a broader level, the success of the intervention suggests that using a data-driven strategy for determining where to place NHS and other first responders within the healthcare center based on routine analysis of code frequency and location may be a viable way to for centers to optimize code response times.

In addition (as illustrated in Figure 2a), review of our initial data on code frequency and location showed that almost 70% of the codes taking place in our cancer center took place in the main building, which is a considerable distance from the research building where NHS were originally housed. Closer inspection of our data revealed that nearly 40% of our Codes Rescues and 20% of our Code 250s and Codes 9s (each) were occurring in high-traffic areas such as the front entrance and visitor parking garages (both located in our main building), suggesting that moving staff to the main building could help reduce mean code response times.

Using this data as a starting point, our team identified several potential locations within our main building that would allow NHS to reach the areas with the highest code frequency quickly. Considerations included not only location of NHS relative to codes, but proximity to elevators, stairs, and equipment NHS and other staff would need during codes such as crash carts. Once a new location was identified (on the third floor of our main building), NHS were repositioned and data collection resumed. Results of

this project suggest that using data to strategically position NHS staff may be a viable strategy for improving code response times.

LIMITATIONS

While encouraging, results of this quality improvement project need to be interpreted in light of several limitations. First, data on response times collected during the project was estimated and reported in minute intervals only (i.e., 1 min, 2 min). We intentionally adopted this strategy at the start of the project to improve the feasibility of the data collection by busy NHS during code. More precise tracking will be needed to establish true benchmarks for code response in centers such as ours. Second, NHS staff were not able to account for their exact starting point during data collection. Because of this, it is unclear whether some of the improvement in response times we observed could have been influenced by some staff starting closer to codes than others. While this is possible, the high degree of consistency observed in code response times across code types and different staff following strategic repositioning suggest that location in the building is likely to be a stronger predictor of mean code response times than individual starting points. Further study will be needed to determine the degree to which differences in staff location over the course of the day impact overall code response times.

Third, some of the variations in patient and visitor volume we reported were likely to be influenced by holidays (as evidenced by lower code volumes in November and December). In addition, it is possible that that arrival of COVID-19 to our region in March affected some of the volumes of codes occurring in March, April, and May. In light of this, although the volume of codes observed during the project was consistent with code volume in our center from previous years, caution should be exercised in extrapolating this data; longer-term tracking of code volume and type will be needed to determine if the trends observed during the project were representative of overall code response trends at our cancer center.

CONCLUSIONS

Results from our analysis provide evidence that using data on code volume and location to determine where to position nurses that play key roles in code response may be an effective strategy for reducing mean code response times in the outpatient setting.

DECLARATION OF INTEREST

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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Table 3.
Difference in Code Response Times in the Ambulatory Oncology Setting, Before and Strategic Repositioning of Nursing House Supervisors (NHS), By Distance Nursing House Supervisors Had to Travel to Reach the Code and Type of Code (N = 64)

| Distance From Code | Combined Sample | | Before Strategic Repositioning | | After Strategic Repositioning | | Difference Before and After Repositioning | |
|--------------------|-----------------|-------|--------------------------------|-------|-------------------------------|------|---|------|
| | N | % | N | % | N | % | | |
| Very Close | 1 | 1.6 | 0 | 0.0 | 1 | 2.9 | n/a | |
| Close | 38 | 59.4 | 5 | 22.0 | 33 | 78.6 | 4.1 (36) | |
| Far | 12 | 18.8 | 6 | 27.3 | 6 | 14.3 | 5.4 (10) | |
| Very Far | 13 | 20.3 | 11 | 50.0 | 2 | 4.8 | 10.8 (10) | |
| Totals | 64 | 100.0 | 22 | 100.0 | 42 | 65.6 | 10.5 (62) | |
| | | | | | | | | |
| Type Of Code | N | % | N | % | N | % | t (df) | Sig. |
| Code Rescue | 28 | 43.8 | 11 | 25.6 | 17 | 26.5 | 10.6 (32) | .001 |
| Code 9 | 13 | 20.4 | 4 | 6.3 | 9 | 14.1 | 2.5 (3.3) | .080 |
| Code 250 | 12 | 15.7 | 1 | 1.6 | 11 | 14.1 | n/a | -- |
| Code Red | 4 | 3.1 | 0 | 0.0 | 4 | 3.1 | n/a | -- |
| Code Green | 1 | 1.6 | 0 | 0.0 | 1 | 1.6 | n/a | -- |
| Totals | 64 | 100.0 | 22 | 34.0 | 42 | 65.6 | 10.5 (62) | .001 |

Legend: Time to reach codes listed as mean ± standard deviations. Codes were classified as 'very close' if they occurred not only in same building, but also in same floor as the NHS. Codes were classified as 'close' that occurred in the same building, but were on a different floor as NHS. Codes were classified as 'far' if they required NHS to travel to a different building and travel through a least one floor/depts to arrive at the code. Finally, codes were classified as 'very far'; required NHS to travel to a different building and travel through two or more departments to arrive at the code. Code Rescue = Clinical deterioration in-patient or visitor; Code 9= non-patient injury, inside building Code 250 = non-patient injury, outside building; Code Red = potential or actual fire; Code Green= Combative individual. Cells were marked with 'n/a' if no calculation was possible.

Figure 1.
Percentage of Codes Nursing House Supervisors (NHS) Responded To During Pre- and Post-Intervention Phases of Strategic Repositioning Project, by Month (N=64 Codes)

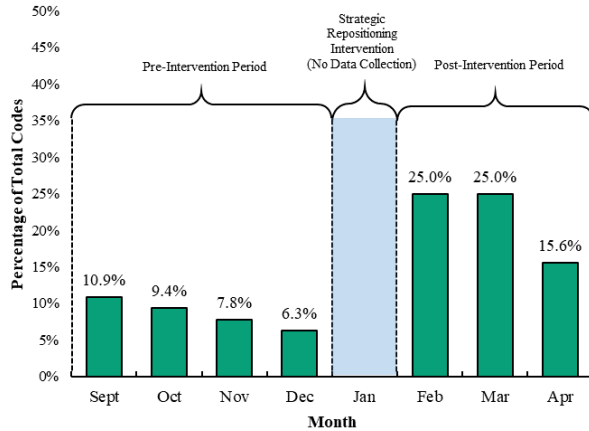


Figure 2.
Code Volume, Before and After Strategic Repositioning Intervention, by Location in Ambulatory Oncology Setting that Code Occurred (N=64 Codes)

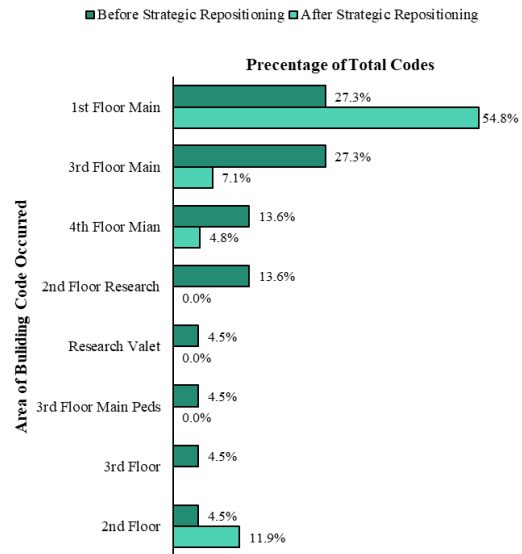


Figure 3.
Comparison of Mean Code Response Times for Nursing House Supervisors Before and After Strategic Repositioning Intervention, Separated by Code Type (Code Rescue, Code 9, Code 250) (Sept, 2019 to April, 2020; N = 64 Codes)

