



# How Safety Is Compromised When Hospital Equipment Is a Poor Fit for Patients Who Are Obese

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DOI: 10.33940/data/2020.3.4

Obesity is common, serious, and costly, and according to recent data, its prevalence is on the rise in the United States. Event reports submitted to the Pennsylvania Patient Safety Reporting System (PA-PSRS) indicate that some healthcare facilities do not have the necessary equipment to monitor and care for some individuals in this patient population, leading to embarrassment for patients, delays in care, and injuries to patients. An analysis of 107 events related to monitoring and patient care for patients who are obese submitted to PA-PSRS from 2009 through 2018 showed that imaging equipment, especially MRI and CT scanners, was most often implicated in event reports (49.5%; 53 events); other equipment included stretchers (24.3%; 26 events) and wheelchairs (11.2%; 12 events). Events most often occurred in an imaging department (30.8%; 33 events) or a medical/surgical unit (21.5%; 23 events). Analysts determined that 80 events (74.8%) resulted in a delay in care and that 44 events (41.1%) resulted in temporary harm to the patient, including skin tears and abrasions. Healthcare providers may not be able to prevent delays in care resulting from the unavailability of adequate equipment for patients who are obese, but they may be able to prevent harm and embarrassment for patients through proactive assessment.

**Keywords:** *obesity, abdominal girth, BMI, patient safety, imaging, equipment, hospital infrastructure*

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Disclosure: The author declares that they have no relevant or material financial interests.

According to the Centers for Disease Control and Prevention (CDC), obesity is common, serious, and costly.<sup>1</sup> Obesity is defined as a body mass index (BMI) equal to or greater than 30 kilograms per meter squared.<sup>2</sup> Obesity is most common among middle-aged adults (age 40 to 59), and recent statistics indicate that nearly 40% of the adult population (93.3 million individuals) in the United States is considered obese, with prevalence on the rise.<sup>1,2</sup>

A study of Medicare patients published in 2016 revealed that patients who were obese were more likely to suffer from chronic conditions affecting cardiovascular, metabolic, and psychological health and to utilize healthcare services compared to patients who were not obese.<sup>1,3</sup> An earlier study that examined patient utilization of healthcare services demonstrated that patients who were obese had higher numbers of both primary care and specialty care visits, as well as use of diagnostic services, than patients who were not obese.<sup>4</sup>

If patients who are obese have higher rates of utilization of various healthcare services, it stands to reason that healthcare facilities must provide access to equipment that will meet the needs of this patient population. A review of event reports submitted to the Pennsylvania Patient Safety Reporting System (PA-PSRS)<sup>†</sup> indicates that some healthcare facilities do not have the necessary equipment to monitor and care for this patient population, which may lead to embarrassment for patients, delays in care, and injuries to patients. In this article, we report an analysis of events submitted to PA-PSRS related to monitoring and patient care for patients who are obese. Our dual objectives were to identify trends in the data and to share best practices for preventing future events.

## Methods

We queried PA-PSRS for events that took place from January 1, 2009, through December 31, 2018. We searched the event detail for the keywords “fit” OR “fits” AND at least one of the following keywords: “girth,” “habitus,” “bariatric,” “size,” “too large,” “too small,” “obese,” “obesity,” “too heavy,” “weight,” “BMI,” “too tight,” “scan,” “MRI,” “bed,” “stretcher,” and “wheelchair.” We reviewed each event to determine if the event was related to a patient

being unable to undergo an ordered test or receive care due to the patient’s weight, size, or abdominal girth. We specifically looked for details indicating that a patient was scheduled to undergo a test that was delayed or cancelled due to the patient’s weight or size, or for other information that suggested that patient safety was compromised by use of equipment that was too small for the patient or too big to be moved from one location to another (e.g., a stretcher that would not fit through a door or into an ambulance). Events were only included in the analysis if they were determined to be the result of the patient being too large; patients who were unable to undergo an ordered test or receive care due to the patient being too small were excluded.

We classified events that met the inclusion criteria according to the type of equipment involved: imaging equipment (such as an MRI or CT scanner), a stretcher or bed, a wheelchair, or another type of equipment or clothing (which included anything that did not fit into the first three categories). We also reviewed the details of each event and assessed whether the patient experienced a delay in care and/or an injury. We performed additional analyses to identify trends in event type and subtype, care area, facility size, and patient age and gender. Two analysts independently performed all assessments and then compared those assessments to agree on classification of each event.

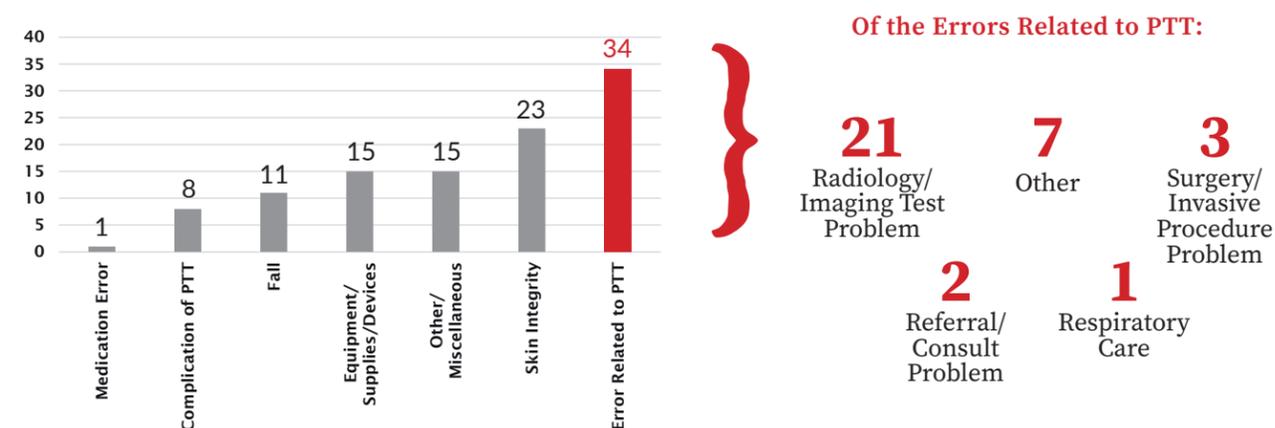
## Results

The query returned 502 event reports. After an initial independent review of each event report by two analysts, agreement was reached about the inclusion or exclusion of 466 events; a discussion of the remaining 36 events resulted in agreement about the inclusion or exclusion of those remaining events. Ultimately, 165 unique events were selected for inclusion in the analysis, including two event reports that described a single event.

Of the 165 events selected for inclusion, 58 events were reported by a

<sup>†</sup>PA-PSRS is a secure, web-based system through which Pennsylvania hospitals, ambulatory surgical facilities, abortion facilities, and birthing centers submit reports of patient safety-related incidents and serious events in accordance with mandatory reporting laws outlined in the Medical Care Availability and Reduction of Error (MCARE) Act (Act 13 of 2002).<sup>5</sup> All reports submitted through PA-PSRS are confidential and no information about individual facilities or providers is made public.

Figure 1. Event Type for All Events and Event Subtype for Errors Related to Procedure, Treatment, or Test (PTT), Assigned by Reporting Facility, N=107



single facility. These event reports all involved an MRI scanner that was too small to accommodate patients beyond a certain weight or size limit. (This limit was not specifically stated in the event reports.) After reaching out to this facility, we learned that they had acquired a new MRI scanner with a much higher weight limit. Following that acquisition, this facility did not report any additional events related to patients who were too large for the MRI scanner. We decided to exclude these events from our analysis because this subset of data had the potential to skew the larger dataset. As a result, our final analysis included only the remaining 107 events.

## Classification of Events

Events were assigned an event type and subtype(s) by the reporting facility at the time the report was submitted to PA-PSRS. Event types are summarized in Figure 1. The most common event type was an error related to procedure, treatment, or test (31.8%; 34 of 107 events). The most common subtype among errors related to procedure, treatment, or test was a radiology or imaging test problem (19.6%; 21 of 107 events), and the most common subtypes within this subgroup were test not completed (8.4%; 9 of 107 events) and test ordered but not performed (6.5%; 7 of 107 events).

We classified events according to the type of equipment involved. We subclassified imaging events as involving an MRI scanner, a CT scanner, or another type of imaging. Figure 2 summarizes our classification of events based on equipment type. We also determined that 80 events (74.8%) resulted in a delay in care for the patient.

<sup>‡</sup>The details of the PA-PSRS event narratives in this article have been modified to preserve confidentiality.

The following are examples<sup>‡</sup> of imaging events:

*Patient taken for abdominal CT scan. Due to her weight and abdominal girth, patient was unable to fit completely into the bore of the gantry, even with her arms above her head. Attempt was made to perform the scan, but table motion was impeded by the distribution of patient’s body habitus on the table. Ultimately, the table became stuck and the scan was aborted. The ordering physician was notified.*

*Patient came for MRI scan of spine, and he was sedated for the exam. Patient was placed on the table, which was then sent into the scanner. Patient was only able to be moved partially into the scanner, to the level of his upper arms, at which point the table stopped and could not be moved further. A second attempt was made after repositioning patient’s arms, but this attempt was also unsuccessful. Patient was brought out of the scanner and scan was aborted. Explained to patient that he would have to be rescheduled at another facility with a larger MRI scanner.*

The following are examples of events associated with other equipment, including a stretcher, a wheelchair, and a lift:

*Patient was transported to the operating room on a bariatric bed. Upon arrival, staff determined that the bariatric bed did not fit through the operating room door. An alternate room and table were prepared for the procedure. The patient did not fit on this table because of the patient’s body habitus, so the provider decided to perform procedure on the bariatric bed instead.*

$$BMI = \frac{kg}{m^2}$$

BMI is calculated by dividing weight in kilograms by height in meters squared.<sup>2</sup>

49.5%

of events involved imaging equipment

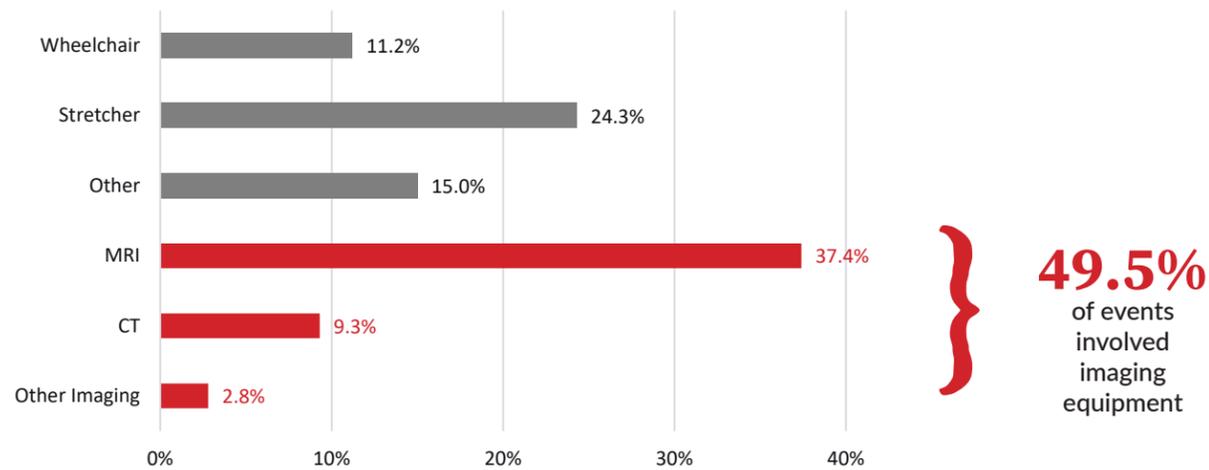
30.8%

of reports occurred on an imaging unit

21.5%

of reports occurred on a med/surg unit

Figure 2. Classification of Events by Equipment Type, Assigned by Analysts, N=107



*During physical therapy, patient who weighed 209 kg (460 lb) tried to sit in bariatric wheelchair, but patient did not fit comfortably in the chair due to her abdominal girth. Patient squeezed herself onto chair and sustained skin tears on both sides of abdomen. Wounds were treated appropriately.*

*Patient was being transferred from the operating table to a stretcher via lift due to his weight. The legs of the lift were too large to fit properly under the stretcher. As the transfer was attempted, the patient was dropped down onto the stretcher when the lift fell. Patient came to rest directly on stretcher, he did not sustain any injuries.*

The following is an example of an event in which the patient experienced temporary harm:

*Patient was received in imaging department for an MRI of the shoulder. Patient was a tight fit in the MRI scanner because of his body habitus, so he was covered by a blanket for protection. Scan was started and technician checked with the patient midway through the study, and he reported no complaints. When the patient was removed from the bore, he reported a hot feeling on his left arm. Redness on his upper arm was observed after removal of the blanket. The patient was discharged following completion of the study. Later that day, the patient was seen in the emergency department, where a provider determined that he had suffered a second-degree thermal burn as a result of the close proximity of his arm to the MRI scanner. Patient was treated and released.*

### Harm or Injury Associated With Events

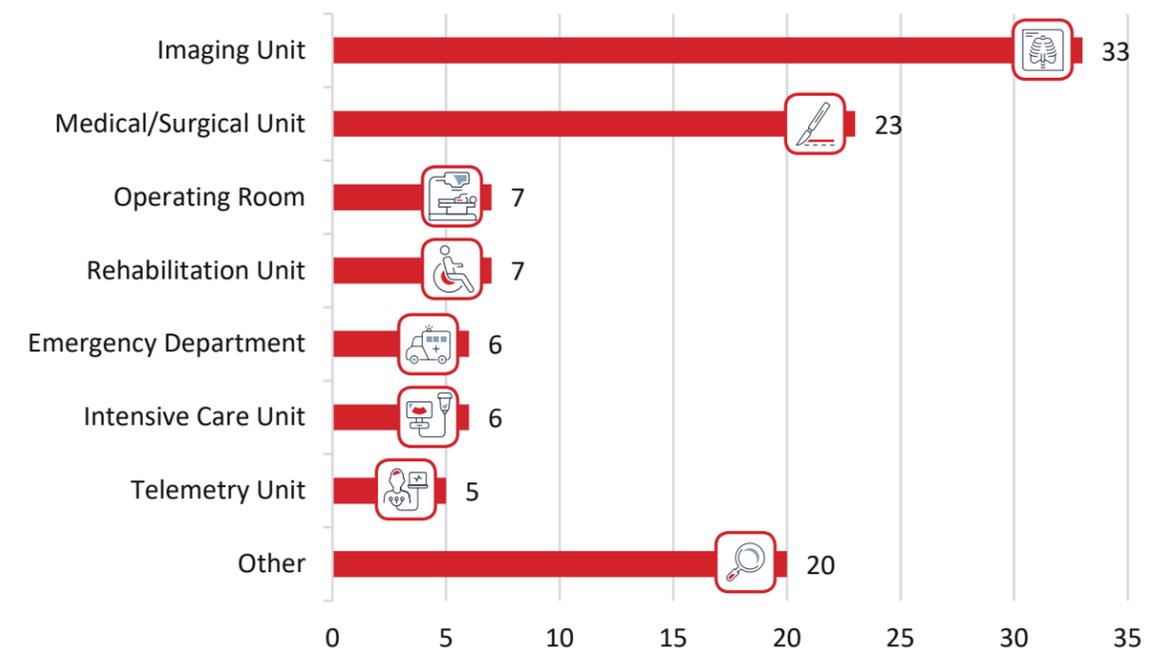
Nearly all events (97.2%; 104 of 107 events) were classified as incidents<sup>5</sup> by the reporting facilities. Event harm scores assigned by the reporting facilities at the time of reporting are based on whether the event led to temporary or permanent harm and required additional healthcare services, and none of the events in this analysis resulted in permanent harm to the patient. Because we were also interested in whether patients experienced even temporary injuries, we reviewed each event report to determine whether the patient sustained a minor injury as a result of equipment being too small for the patient. We determined that the patient sustained a minor injury in about two-fifths of events (41.1%; 44 of 107 events). Some of the injuries sustained by patients included falls, drops, pressure ulcers, burns, cuts, skin tears, abrasions, and bruises. The most serious injury mentioned in an event report was a second-degree burn that required a visit to the emergency department.

### Other Findings

The majority of events (92.5%; 99 of 107 events) occurred at an acute care facility, and the remaining events occurred at a children's hospital, a long-term acute care facility, or a rehabilitation hospital. Facilities ranged in size from fewer than 25 beds to over 1000 beds. The most common care areas in which events took place are reported in **Figure 3**. Events were split fairly evenly between males (47.7%; 51 of 107 events) and females (52.3%; 56 of 107 events). Patients ranged in age from 10 to 90 years old, and the median patient age was 57 years.

<sup>5</sup>An "incident" is defined as an event, occurrence or situation involving the clinical care of a patient in a medical facility which could have injured the patient but did not either cause an unanticipated injury or require the delivery of additional healthcare services to the patient.<sup>5</sup>

Figure 3. Number of Events by Care Area in Which Event Occurred, Assigned by Reporting Facility, N=107



Note: Other units included anesthesia, endoscopy/GI unit, orthopedic unit, pediatric intermediate unit, and psychiatric unit.

Among events involving a stretcher or bed (24.3%; 26 of 107 events), we determined that the stretcher was too small for the patient in 17 of 107 events (15.9%) and too big to fit through a door or into a room or transport vehicle in 9 of 107 events (8.4%). Among events involving a wheelchair (11.2%; 12 of 107 events), we determined that the wheelchair was too small for the patient in 7 of 107 events (6.5%) and too big to fit through a door or into a transport vehicle in 5 of 107 events (4.7%).

Sixteen of 107 events (15.0%) were classified as involving equipment other than a stretcher or bed, a wheelchair, or a scanner or other apparatus for imaging. Equipment implicated in these other events included a bedside commode (2.8%; 3 of 107 events), a lift (1.9%; 2 of 107 events), a boot (1.9%; 2 of 107 events), an immobilizer, a restraint vest, a sequential compression device, a blood pressure cuff, a chair, briefs, mittens, or stirrups.

We reviewed each event report to identify other commonalities. We found that 20 of 107 events (18.7%) involved some type of transfer or transport of the patient (either within a facility or between two facilities).

### Discussion

Beyond identifying safety events related to patient care and monitoring among patients who are obese, we also wanted to provide strategies to reduce these events

in the future. Unfortunately, our literature review did not identify any studies that provided support for best practices. What we did find in the literature were several reviews that shared best practices in use at other healthcare facilities. We blended this information with the findings from our own analysis and present this information here.

### Imaging

Imaging studies are a regular component of diagnosing and treating patients with a host of medical conditions. A patient's weight, abdominal girth, and distribution of fatty tissue must be taken into account when assessing whether a particular scanner or other type of imaging equipment can accommodate that patient.<sup>6-8</sup> Our analysis revealed that there are facilities in Pennsylvania that are not able to accommodate some patients due to their large size or weight. Reviewing the event details drew our attention to the fact that some patients were brought to an imaging department for a study without first being measured or with only their weight being measured. For example, in one event report, the technician stated that "they only go by the weight of the patient [and there is] no premeasurement of girth... to determine if the patient will fit [in the scanner]." In these instances, we learned that some staff members then attempted to force the patient's body into a scanner that was too small, which at a minimum caused embarrassment for the patient, but also frequently

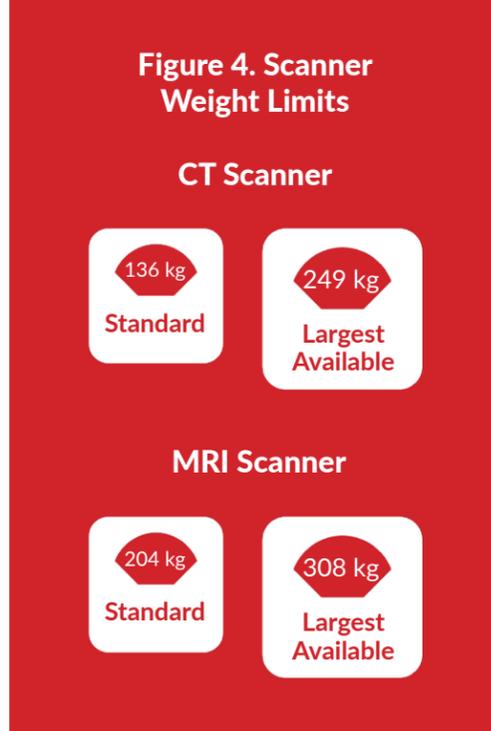
wasted time and occasionally led to patient injury. Our observations were similar to what has been observed in these events in the literature.<sup>6, 7</sup> Attempting to scan a patient with a weight in excess of a scanner's limit has the potential to cause damage to the scanner itself, though there were no reports of this in the events in our analysis.<sup>6-8</sup>

The majority of imaging events included in our analysis involved either a CT or an MRI scanner. CT scanners typically can accommodate larger patients than MRI scanners. See **Figure 4** for scanner weight limits. The weight limit on a standard MRI scanner is 158.7

kg (350 lb), while the weight limit on the largest commercially available MRI scanner is 249.5 kg (550 lb).<sup>6</sup> The weight limit on a standard CT scanner is 204.1 kg (450 lb), while the weight limit on the largest commercially available CT scanner is 308.4 kg (680 lb).<sup>6, 7</sup> The diameter of the opening of a CT or MRI scanner is often the limiting factor in whether a patient will fit into the scanner.<sup>6, 7</sup> Open MRI scanners have been suggested as a potential solution for accommodating larger patients, but in some cases they actually have a smaller diameter than a closed MRI scanner.<sup>6</sup> When open MRI scanners do have a larger diameter, the image produced may be of inferior quality compared to an image produced by a closed MRI scanner.<sup>7</sup>

In our review of the literature, we identified recommendations for best practices to alleviate some of the downstream problems (e.g., embarrassment, injuries, and delays) related to a patient being too large to fit in a CT or an MRI scanner. Before sending a patient for an imaging study, measuring both the patient's weight and abdominal girth can help the practitioner determine whether a patient will fit in the scanner prior to transporting the patient for the study.<sup>7</sup> An alternative to measuring abdominal girth in all patients is to measure abdominal girth only when the patient's BMI indicates that they are obese.<sup>7</sup> Because abdominal girth may shift in response to the patient's movement and position, another idea suggested in the literature is to order a custom hula hoop that reflects the maximum circumference that a CT or an MRI scanner can accommodate; patients can then simply try the hoop on to ensure they will fit in the scanner prior to transport.<sup>7</sup> In addition to taking measurements and assessing size, it may be beneficial for facilities to post or make readily available the weight and size limits for all available imaging scanners in the facility, and, if possible, incor-

**Figure 4. Scanner Weight Limits**



porate alerts into computerized order entry to notify healthcare providers to take certain patient measurements when imaging tests are ordered.<sup>7</sup>

### Other Equipment

Other medical equipment routinely used to care for patients in healthcare facilities includes stretchers and beds, wheelchairs, bedside commodes, lifts, blood pressure cuffs, and clothing such as briefs or mittens. While some of this equipment is generally available in a single size (e.g., one-size-fits-all or one-size-fits-most), patients who are obese may require larger equipment to ensure both

safe care for them and a safe working environment for any providers responsible for caring for them. In our analysis, we identified issues with these other types of equipment, and these could generally be categorized into one of two groups: events in which the patient was too big for the equipment and events in which equipment was too large to be moved around a facility or into a transport vehicle. Both event types have the potential to cause humiliation or distress for patients, injuries, and delays in care.

Beyond the availability of equipment necessary for care and monitoring of patients who are obese, staff sometimes lacked knowledge about how to proceed when larger equipment was needed. For example, one reporter said that the team “received no guidance on how to find” equipment large enough for the patient. Another reporter explained that “the staff was not aware of the BMI early enough to find” appropriately sized equipment. A tertiary care facility in Canada shared some of their best practices for addressing these knowledge gaps among staff at their facility.<sup>9</sup> To support the care of patients who weigh more than 160 kg (350 pounds) or who have a BMI over 49 kg per m<sup>2</sup>, the facility has focused on educating staff when they are hired and providing access to policies, procedures, algorithms, and assessments.<sup>9</sup> Promotion of education and awareness and development of these kinds of resources may improve the ability of staff to quickly identify solutions for these patients and improve their overall care.

### Hospital Infrastructure

Our analysis identified gaps in both the knowledge and availability of equipment necessary to provide safe care for all patients, including patients who are

obese, throughout our reporting facilities, suggesting that the problem is much larger than a single piece of equipment or a single department within a facility. To address problems within a hospital's infrastructure, administrators should be informed of deficiencies within their facilities so that all patients who enter can receive safe and dignified care. When decisions are being made about equipment purchases intended for use in a new or existing facility, measurements and assessments should be made in advance to ensure the equipment, especially bariatric equipment, will fit in patient rooms, through doorways, and on elevators throughout the facility.

### Limitations

Despite mandatory event-reporting laws in Pennsylvania, our data are subject to the limitations of self-reporting. In addition, because PA-PSRS only collects reports of patient safety events from hospitals, ambulatory surgical facilities, birthing centers, and abortion facilities, our analysis was unable to capture events that occurred at outpatient facilities (e.g., outpatient radiology facilities not under a hospital license). Therefore, the generalizability of our findings beyond our reporting facilities may be limited.

It is difficult to ascertain the long-term consequences of these events because our knowledge is limited to the details shared in the event report by the reporting facility. Although we know that many patients experienced delays in care or minor injuries, we do not know whether the patients mentioned in these reports followed up to receive the ordered studies at another facility or to seek further care for their injuries.

PA-PSRS only collects reports from facilities and not from individual patients, so our analysis relied on details shared by the reporting facility to assess whether patients experienced any emotional distress as a result of hospital equipment that was inadequate for patients who were too big. Some event reports did include very specific details about a patient's reaction to an event, or even direct quotes from a patient, but this information was both too rare and specific to share without potentially compromising confidentiality of a patient or facility.

Patient weight is not a mandatory field in PA-PSRS, so we were only able to indirectly determine whether events were related to patient weight or size by analyzing free-text fields. In addition, a standard taxonomy for reporting events related to monitoring and patient care for patients who are obese does not exist, so the author acknowledges that it is possible that relevant event reports were missed with our query. In addition, including more keywords in the query may have resulted in the retrieval of more events, but we felt that

the keywords selected provided an adequate sample. A situation at a facility that did not involve a specific patient may have been reported through PA-PSRS as an infrastructure failure; these event reports are received by the Pennsylvania Department of Health and were not included in this analysis.

### Conclusion

Obesity is increasingly common among adults in the United States, and patients who are obese are more likely to utilize healthcare services, so healthcare facilities should have the capability to provide safe care for this patient population. An analysis of events submitted to PA-PSRS from 2009 through 2018 revealed that there are some facilities in Pennsylvania that do not have the necessary equipment to monitor and care for all patients who are obese, and that staff at some facilities may not be aware of the appropriate next steps when the required equipment is unavailable. Events in our analysis most often involved imaging equipment, especially MRI and CT scanners. In some cases, staff may not be able to prevent events related to imaging scanner size, but they can ensure that patients are not embarrassed or harmed, and facilitate development of an action plan by clearly marking all scanners with their limits—and even making that information available on any unit that may send patients for imaging. Patients who are suspected of not being able to fit in an imaging scanner should be measured prior to transport to an imaging department. With regard to other types of equipment, the provision of education and the development of guidance documents may facilitate a more effective response on the part of staff when they are caring for patients who are obese. Ultimately, hospital administrators may have the most power to effect change in this area by ensuring the availability of equipment necessary for the safety and care of all patients. These best practices are summarized in **Figure 5**.

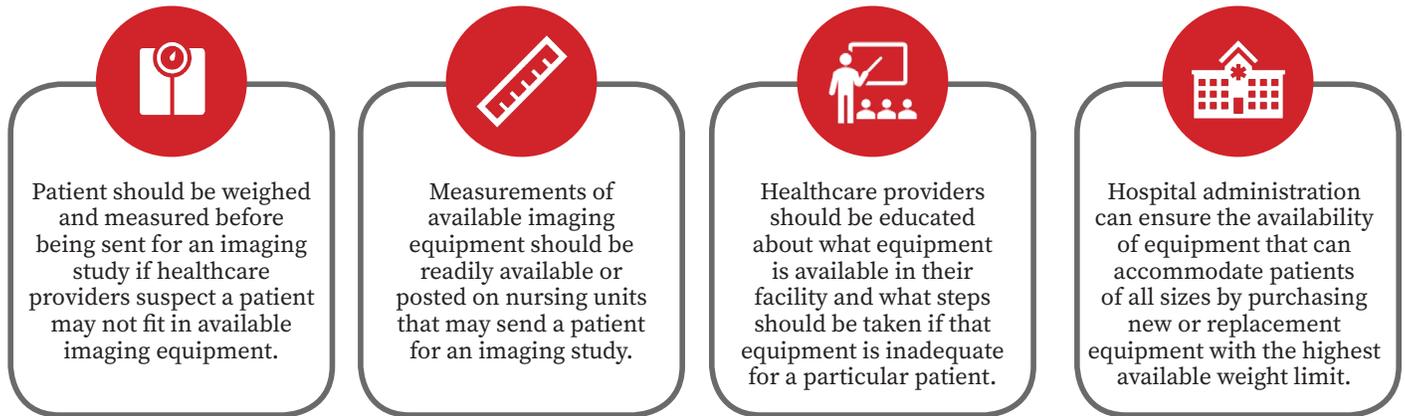
### Acknowledgments

The author would like to thank Lynette Hathaway, MSN, RN, former infection prevention analyst at the Patient Safety Authority, for her collaboration in performing the data analysis for this study, which contributed significantly to the information that was able to be gleaned on this topic.

### Notes

This analysis was exempted from review by the Advarra Institutional Review Board.

Figure 5. Best Practices for Imaging of Patients Who Are Obese



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