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ORIGINAL RESEARCH

Surveillance for Pressure Injuries on Admission to Inpatient Rehabilitation Hospitals During the COVID-19 Pandemic

Jamila A. Kendall, MD,[a,b] Jack K. Haberl, MD,[c] Caitlin Hartsgrove, MD,[a,b] Lauren F. Murphy, PhD,[d] Robert DeLuca,[b,d] Nicole Diaz-Segarra, MD,[a,b] Steven C. Kirshblum, MD[a,b,c,d,e]

From the [a]Department of Physical Medicine and Rehabilitation, Rutgers-New Jersey Medical School, Newark, NJ; [b]Kessler Institute for Rehabilitation, West Orange, NJ; [c]Rutgers New Jersey Medical School, Newark, NJ; [d]Kessler Foundation, West Orange, NJ; and [e]Select Medical Corporation, Mechanicsburg, PA.

Abstract

Objective: To determine if the incidence of pressure injuries (PIs) on admission to an inpatient rehabilitation hospital (IRH) system of care was increased during the early coronavirus disease 2019 (COVID-19) pandemic period.

Design: Retrospective survey chart review of consecutive cohorts. Admissions to 4 acute IRHs within 1 system of care over the first consecutive 6-week period of admitting patients positive for COVID-19 during the initial peak of the COVID-19 pandemic, April 1-May 9, 2020. A comparison was made with the pre−COVID-19 period, January 1-February 19, 2020.

Setting: Four acute IRHs with admissions on a referral basis from acute care hospitals.

Participants: A consecutive sample (N=1125) of pre−COVID-19 admissions (n=768) and COVID-19 period admissions (n=357), including persons who were COVID-19−positive (n=161) and COVID-19−negative (n=196).

Main Outcome Measures: Incidence of PIs on admission to IRH.

Results: Prevalence of PIs on admission during the COVID-19 pandemic was increased when compared with the pre−COVID-19 period by 14.9% ($P<.001$). There was no difference in the prevalence of PIs in the COVID-19 period between patients who were COVID-19−positive and COVID-19−negative (35.4% vs 35.7%). The severity of PIs, measured by the wound stage of the most severe PI the patient presented with, worsened during the COVID-19 period compared with pre−COVID-19 (χ^2 32.04%, $P<.001$). The length of stay in the acute care hospital before transfer to the IRH during COVID-19 was greater than pre−COVID-19 by 10.9% ($P<.001$).

Conclusions: During the early part of the COVID-19 pandemic time frame, there was an increase in the prevalence and severity of PIs noted on admission to our IRHs. This may represent the significant burden placed on the health care system by the pandemic, affecting all patients regardless of COVID-19 status. This information is important to help all facilities remain vigilant to prevent PIs as the pandemic continues and potential future pandemics that place strain on medical resources.

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On March 11, 2020, coronavirus disease 2019 (COVID-19) was labeled a global pandemic by the World Health Organization.[1] Since that date, the virus that causes the disease, severe acute respiratory syndrome coronavirus 2, has infected millions of people around the world, with more than 3 million people worldwide and over 500,000 in the United States (US) who have died as of March 28, 2021.[2] This pandemic has drastically affected all health care organizations and providers as they collectively treated the surge of new inpatient cases. New York City and northern New Jersey were particularly affected early by this pandemic.[3]

Persons with COVID-19 who survive the initial hospitalization may experience debilities secondary to COVID-19 and its associated complications that require acute rehabilitation at an inpatient rehabilitation hospital (IRH).[4-6] To date, there have been no data

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regarding the prevalence of pressure injuries (PIs) in patients being admitted to an IRH since the start of the COVID-19 pandemic.

PIs are lesions caused by unrelieved pressure that results in damage to the underlying tissue.[7] These lesions typically result when soft tissue is compressed between a bony prominence and an external surface for a prolonged period. Injuries can range from nonblanchable erythema of intact skin to deep ulcers extending to the bone. Over 100 risk factors for the development of PIs have been identified, including immobility, malnutrition, reduced perfusion, sensory loss, and the use of various medical devices[8]—all of which are commonly seen in acute care hospitals.

Accounting for approximately $10 billion in annual health care spending in the US,[9] PIs remain a significant burden for patients and the health care system; an estimated 2.5 million PIs are treated in acute care facilities each year in the US.[10] In 2008, the Centers for Medicare and Medicaid Services notably discontinued reimbursement for the treatment of health care–acquired (HA) PIs, thus increasing the emphasis on identification and prevention of PIs across the country. PIs are now a required quality indicator for all IRHs as part of the IMPACT Act of 2014.[11] PIs have been shown to have an effect on IRH outcomes, including longer length of IRH stay, lower motor function gains, lower odds of being discharged to the community and functional independence, higher rate of readmission, and higher overall hospitalization cost.[12-14]

There are many factors to suggest that PI incidence may have changed since the start of the COVID-19 pandemic. Critically ill patients with COVID-19 have risk factors for PI such as immobility, reduced perfusion, and use of medical devices such as ventilators and face masks.[15] Medical device–related PIs are commonly seen from the use of masks, cannulas, tubes, adhesive tapes, and devices themselves.[16] Patients on continuous positive airway pressure and bilevel positive airway pressure often require high head of bed elevation to facilitate breathing, thus shifting more body weight to the sacrum and potentially increasing their risk for pressure injuries.[17] Patients on mechanical ventilation are notably difficult to turn, potentially impeding routine PI care and examination. When placed in a prone position for improved oxygenation and ventilation, patients are also at an increased risk for PI of the elbows, head, genitals, knees, and toes.[18] In addition, diarrhea is a common symptom in patients with COVID-19, potentially contributing to the incidence of sacral PIs.[19]

The purpose of this study was to perform a systematic retrospective assessment to determine the prevalence of HA PIs on patients with and without COVID-19 during the COVID-19 pandemic at the time of IRH admission. We hypothesized that there would be an overall increase in prevalence of HA PIs compared with the pre-COVID-19 period. As a secondary objective, we hypothesized that there would be a higher prevalence of HA PIs in individuals who were COVID-19–positive compared with those who were negative on admission to IRH. This knowledge has important implications for acute care hospitals to emphasize skin assessments and for IRH to consider for appropriate treatment plans in patients admitted with PIs.

List of abbreviations:

CMI	**case mix index**
DTI	**deep tissue injury**
HA	**health care–acquired**
IRH	**inpatient rehabilitation hospital**
LOS	**length of stay**
PI	**pressure injury**
US	**United States**

Methods

Research design

A retrospective cohort chart review was performed at our multicenter IRH system in the Northeast.

Sample

There are 4 IRHs in our system of care, all of which began admitting patients with diagnosed COVID-19 in late March 2021. This investigation includes data from 2 cohorts of patients admitted to the IRH facilities. The pre-COVID-19 cohort includes all patients admitted from January 1-February 12, 2020 (n=687), designated as the pre-COVID period. The second cohort, the COVID-19 period, includes all admissions from the initial 6-week period of the following quarter (ie, April 1-May 9, 2020) (n=357). This time was selected to coincide with the onset of COVID-19–positive patient admissions to these IRHs. All patients in both cohorts were admitted on a referral basis from local acute care hospitals. If the patient required acute care rehospitalization during their rehabilitation course, only their first rehabilitation stay was used in the analysis. When creating the "PI stage" variable (severity) for each patient we categorized it by the wound stage of the patient's most severe PI. When analyzing PI by location, COVID-19 status, and all other biometrics, all PIs were taken into account. The study received Institutional Review Board approval prior to initiating data collection. Three trained medical professionals (J.K., C.H., and R.D.) performed chart reviews and abstractions from electronic medical records for all patients included in the sample.

Measures

Primary outcome

HA PI is a binary measure of assessing whether the patient was diagnosed as having a PI at admission to the IRH from the acute care hospital.

Additional pressure injury characteristics

PI staging was performed in accordance with the National Pressure Injury Advisory Panel staging definitions.[20] The anatomic location and stage of the PI was documented in the electronic medical record by the admission nurse team for consistency. Four analytical categories are included: stage 1, stage 2, stage 3, and stage 4/deep tissue injury (DTI)/unstageable. DTIs were combined with stage 4/unstageable wounds because of the unknown, but potentially severe, depth of the PI behind the intact skin. PI diagnoses were further subcategorized as medical device–related (wound location based on use of medical equipment that could appear on the genitals, trachea, ear, or back) or prone-related (location of forehead, chin, breast, shin, leg, or toes) PIs. Mucosal pressure injuries were not included. Lastly, for overall PI severity, we used the highest stage PI the patient presented with at IRH admission.

Covariates

Demographic characteristics include patient age at admission (in years), sex, and race. Medical risk factors for PIs included blood albumin (measured in g/dL at admission,), blood hemoglobin (measured in g/dL at admission), and designation of obesity based on body mass index (calculated as weight in kilograms divided by height in meters squared) ≥30. Case mix index (CMI) was used to compare patients in the pre−COVID-19 and COVID-19 periods by acuity level. Acute length of stay (LOS) was measured as the number of days in the acute care hospital before transfer to the IRH and includes 4 categories: 0-7, 8-14, 15-30, and >30 days. Primary diagnosis at the time admission to the IRH (brain injury−related, spinal cord−related, general debility, other) was documented. Discharge location from the IRH included home and/or discharge against medical advice, skilled nursing or subacute facility, acute care transfer, and deceased. Patients were considered COVID-19−positive if they had a positive test result during their acute care hospital stay or tested positive on admission to the IRH. The latter accounted for only 6 patients. COVID-19−negative patients had received a negative test result at both the acute care hospital and on admission to rehabilitation.

Analysis

Bivariate statistics were used to compare incidence of HA PIs and other key characteristics for pre−COVID-19 vs COVID-19 period patients and for COVID-19−positive vs negative patients in the COVID-19 period; *t* tests were used to compare groups on continuous variables. Chi-square tests were used to compare used groups on categorical variables. Logistic regression models were used to predict the odds of HA PI. A set of 3 nested models was estimated. Model 1 estimates differences in the odds of HA-PI by medical risk factors. Model 2 adjusts for the effect of demographic characteristics (age, sex, race). Finally, model 3 tests the effect of testing positive for COVID-19. All analyses were conducted using Stata/SE 16.1.[a]

Results

Pre−COVID-19 vs COVID-19 period patients

Table 1 presents the demographic data of the sample by time period. A significantly greater percentage of patients during the COVID-19 period had an HA PI at admission to the IRH (35.6% vs 20.7%; $P<.001$), as well as more severe HA PIs. Of those patients with HA PIs at admission, a significantly greater percentage of COVID-19 period patients had stage 4/DTI/unstageable wounds as their most severe wounds (28.6% vs 10.6%; $P<.001$), whereas a smaller percentage had stage 1/dressing wounds as their most severe wounds (29.4% vs 62%; $P<.001$). Patients also differed significantly by time frame in mean age, LOS in acute care, and primary diagnosis at admission. COVID-19 period patients were younger, with a mean age of 65.8±16.6 years compared with 70+15.3 years in pre−COVID-19 ($P<.001$). Although no significant difference was noted in PI location, most of the PIs in both groups were found on the sacral area and heels. A significantly higher percentage of COVID-19 period patients had an LOS in acute care that exceeded 30 days (18.2% vs 0.4%; $P<.001$).

Table 1 Sample characteristics by quarter

Characteristics	Total (N=1044)	Pre−COVID-19 (n=687)	Post−COVID-19 (n=357)	*P* Value*
Pressure injury at IRF admission (%)	25.8	20.7	35.6	<.001
Pressure injury stage (%)				<.001
Stage 1	31.7	43	19.1	
Stage 2	26.1	22.5	30.2	
Stage 3	8.2	4.9	11.9	
Stage 4/DTI/unstageable	34	29.6	38.9	
Age at admission (range, 17-101y), mean ± SD	68.5±15.9	70±15.3	65.8±16.6	<.001
LOS at acute center (%)				<.001
0-7 d	55	68.9	28.3	
8-14 d	24.6	23.6	26.6	
14-30 d	13.9	7.1	26.9	
>30 d	6.5	0.4	18.2	
Diagnosis at IRF admission (%)				<.001
Brain injury−related	41.8	41.9	40.9	
Spinal cord injury−related	5.8	5.1	7.3	
Debility	14.9	4.7	34.7	
Other	37.6	48.3	17.1	
Discharge location (%)				
Home/AMA	71.7	71.8	71.6	.98
SNF/subacute	17.5	17.5	17.4	
Acute	10.8	10.7	11	
Case mix index (range, 0.18-4.12), mean ± SD	1.6±0.5	1.6±0.5	1.7±0.5	<.001
Total (%)	100	65.8	34.2	

Abbreviations: AMA, against medical advice; IRF, inpatient rehabilitation facility; SNF, skilled nursing facility.
* *t* tests were used to compare patients by quarter on continuous variables; chi-square tests were used to compare patients by quarter on categorical variables.

Slightly more than one-third (34.7%) of COVID-19 period patients were admitted to an IRH with a debility diagnosis compared with only 4.7% of pre−COVID-19 patients.

COVID-19 period patients by COVID-19 status

Table 2 presents the descriptive statistics (ie, means, percentages) by COVID-19 status for all COVID-19 period patients. There were no statistically significant differences in rates of HA PIs, PI staging, medical device−related PIs, or PIs attributed to proning by COVID-19 status. During this time, COVID-19−positive patients had significantly longer stays in acute care than COVID-19−negative patients. Approximately half (49.4%) of all COVID-19−positive patients had an acute hospital stay between 14-30 days compared with 15.8% of COVID-19−negative patients. Most of the COVID-19−negative patients (37.2%) had an acute care stay of 7 or fewer days compared with 17.4% of COVID-19−positive patients. A significantly greater percentage of COVID-19−positive patients were admitted to IRH with a debility diagnosis compared with COVID-19−negative patients (60.3% vs 13.3%). Albumin status was not clinically significant between the groups. A significantly greater proportion of COVID-19−positive patients met the criteria for obesity (38.5% vs 27%). COVID-19−positive patients had a significantly lower mean CMI than COVID-19−negative patients (1.6 vs 1.8).

Predictors of HA PIs at admission to IRH

Table 3 summarizes the results of the logistic regression predicting HA PIs at admission for COVID-19 period patients. Obese patients had 47% lower odds of having an HA PI than nonobese patients. Regression model 2 adjusts for the effect of demographic characteristics (eg, age, race, sex). After accounting for demographic differences, an increase in CMI is associated with 89% higher odds of having an HA PI. Male patients had 81% greater odds of having an HA PI than female patients. Finally, the effect

Table 2 Sample Characteristics by COVID-19 status for quarter 2 patients

Characteristics	Total (n=357)	COVID− (n=196)	COVID+ (n=161)	*P* Value*
Pressure injury at IRF admission (%)	35.6	35.7	35.4	.95
Pressure injury stage (%)				.33
Stage 1	19.1	20.3	17.5	
Stage 2	30.2	30.4	29.8	
Stage 3	11.9	15.9	7.0	
Stage 4/DTI/unstageable	38.9	33.3	45.6	
Medical device related PI (%)	3.4	2.6	4.4	.35
Prone positioning related PI (%)	2.8	4.1	1.2	.11
Medical device− OR prone-related PI (%)	5.9	6.1	5.6	.83
Age at admission (range, 17-101y), mean ± SD	65.8±16.6	66±17.2	65.6±15.9	.86
Male (%)	56.9	56.1	57.8	.76
Race (%)				>.99
White	69.2	72.5	65.2	
Black	19.9	18.9	21.2	
Other	10.9	8.7	13.7	
LOS at acute center (%)				<.001
0-7 d	28.3	37.2	17.4	
8-14 d	26.6	31.1	21.1	
14-30 d	26.9	15.8	40.4	
>30 d	18.2	15.8	21.1	
Diagnosis at IRF admission (%)				<.001
Brain injury−related	40.9	51.5	28	
Spinal cord injury−related	7.3	10.7	3.1	
Debility	34.7	13.8	60.3	
Other	17.1	24	8.7	
Discharge location (%)				.56
Home/AMA	71.6	71.4	71.9	
SNF/subacute	17.4	18.9	15.6	
Acute	11	9.7	12.5	
Case mix index (range, 0.2-3.7), mean ± SD	1.7±0.5	1.8±0.5	1.6±0.4	<.001
Blood albumin (range, 1.9-4.7g/dL), mean ± SD	3.3±0.5	3.3±0.5	3.2±0.5	.02
Blood hemoglobin (range, 6.6-18.4g/dL), mean ± SD	11.2±2.2	11.3±2.2	11.1±2.2	.47
BMI≥30 (%)	32.2	27	38.5	.02
Total (%)	100	54.9	45.1	

Abbreviations: AMA, against medical advice; BMI, body mass index (calculated as weight in kilograms divided by height in meters squared; SNF, skilled nursing facility.

* *t* tests were used to compare patients by quarter on continuous variables; chi-square tests were used to compare patients by quarter on categorical variables.

Table 3 Logistic regression of pressure injury at admission with medical risk factors, demographic characteristics, and COVID-19 status for post–COVID-19 patients (n=357)

Variables	Odds Ratio	*P* Value	95% CI
Blood albumin (g/dL)	0.50	.04	0.26-0.98
Hemoglobin (g/dL)	0.93	.27	0.81-1.06
Acute length of stay (ref: 0-7 d)			
8-14 d	1.08	.83	0.55-2.13
14-30 d	1.93	.08	0.93-4.01
>30 d	2.24	.05	0.98-5.09
Primary diagnosis at admission (ref: Brain injury–related)			
Spinal cord–related	1.66	.30	0.64-4.28
Debility	1.43	.33	0.70-2.90
Other	1.75	.14	0.83-3.73
Case mix index	1.88	.04	1.03-3.41
Obese (vs nonobese)	0.58	.04	0.34-0.98
Male (vs female)	1.80	.02	1.08-2.99
Race (ref: White)			
Black	1.07	.84	0.57-1.99
Other	0.49	.11	0.21-1.18
Age at admission (y)	1.02	.06	0.99-1.04
COVID-19–positive (vs negative)	0.83	.53	0.47-1.48
Log likelihood	−202.00		
LR χ^2_{df}, *P* value	48.08_{15}, <.001		
Pseudo R^2	.11		

Abbreviations: CI, confidence interval; LR, likelihood ratio; ref, reference.

of COVID-19 status reveals that a positive diagnosis was not associated with presenting with an HA PI. After incorporating COVID-19 status, an LOS of >30 days is significantly associated with more than double the odds of having an HA PI. Table 4 summarizes all PIs during the COVID-19 period subcategorized by location, COVID-19 status, and severity.

Discussion

This is the first study to report on incidence of PIs on admission to an IRH during the COVID-19 pandemic. When comparing pre-COVID-19 vs COVID-19 period patients, COVID-19 period patients were significantly younger, had higher average CMI, had

Table 4 PI location by COVID-19 status and severity (n=127)

	COVID-19–Positive					COVID-19–Negative				
PI Location	Total	1 or DTI n (%)	2 n (%)	3 n (%)	4 n (%)	Total	1 or DTI n (%)	2 n (%)	3 n (%)	4 n (%)
Occiput/post parietal	5	0 (0)	0 (0)	0 (0)	5 (100)	3	0 (0)	1 (33.3)	0 (0)	2 (66.7)
Ear	7	0 (0)	1 (14.3)	0 (0)	6 (85.7)	3	3 (100)	0 (0)	0 (0)	0 (0)
Chin	1	0 (0)	1 (100)	0 (0)	0 (0)	0	0 (0)	0 (0)	0 (0)	0 (0)
Trach site	0	0 (0)	0 (0)	0 (0)	0 (0)	1	0 (0)	0 (0)	0 (0)	1 (100)
Shoulder	1	0 (0)	0 (0)	0 (0)	1 (100)	2	0 (0)	0 (0)	1 (50)	1 (50)
upper ext/elbow	0	0 (0)	0 (0)	0 (0)	0 (0)	13	5 (38.5)	4 (30.8)	3 (23.1)	1 (7.7)
Breast	0	0 (0)	0 (0)	0 (0)	0 (0)	1	0 (0)	1 (100)	0 (0)	0 (0)
Spine/back	3	1 (33.3)	0 (0)	1 (33.3)	1 (33.3)	2	1 (50)	0 (0)	1 (50)	0 (0)
Labia/vulva	1	0 (0)	0 (0)	0 (0)	1 (100)	1	0 (0)	1 (100)	0 (0)	0 (0)
Penis	0	0 (0)	0 (0)	0 (0)	0 (0)	1	0 (0)	1 (100)	0 (0)	0 (0)
Groin	0	0 (0)	0 (0)	0 (0)	0 (0)	7	4 (57.1)	1 (14.3)	2 (28.6)	0 (0)
Sacral	30	15 (50)	7 (23.3)	1 (3.3)	7 (23.3)	31	11 (35.5)	9 (29)	2 (6.5)	9 (29)
Coccyx	5	1 (20)	2 (40)	0 (0)	2 (40)	5	2 (40)	2 (40)	0 (0)	1 (20)
Perineum	1	1 (100)	0 (0)	0 (0)	0 (0)	1	0 (0)	1 (100)	0 (0)	0 (0)
Gluteal	11	2 (18.2)	5 (45.5)	2 (18.2)	2 (18.2)	19	7 (36.8)	9 (47.4)	0 (0)	3 (15.8)
Ischium	4	3 (75)	1 (25)	0 (0)	0 (0)	4	1 (25)	1 (25)	0 (0)	2 (50)
IGF	3	1 (33.3)	2 (66.7)	0 (0)	0 (0)	3	0 (0)	1 (33.3)	0 (0)	2 (66.7)
Shin/leg	1	0 (0)	0 (0)	1 (100)	0 (0)	10	0 (0)	4 (40)	2 (20)	4 (40)
Heels	20	17 (85)	2 (10)	0 (0)	1 (5)	33	25 (75.8)	4 (12.1)	1 (3)	3 (9.1)
Ankle/foot	4	1 (25)	2 (50)	0 (0)	1 (25)	14	10 (71.4)	1 (7.1)	0 (0)	3 (21.4)
Toes	0	0 (0)	0 (0)	0 (0)	0 (0)	3	2 (66.7)	0 (0)	0 (0)	1 (33.3)
Totals	97	42	23	5	27	157	71	41	12	33

Abbreviations: ext, upper extremity; IGF, intergluteal fold; Trach, tracheotomy.

longer LOS in acute care hospitals, were more likely to have a debility diagnosis, and had an increased incidence rate of PIs and more severe PIs present at IRH admission. An important reason for an increase in the debility diagnosis may be from waivers granted by Center for Medicaid and Medicare Services because of the Public Health Emergency, allowing IRHs to accept patients that would otherwise not fit the criteria for admission. When focusing on the COVID-19 period, the difference in incidence rates of PI and PI severity among COVID-19−positive and COVID-19−negative patients was not statistically significant. COVID-19−positive patients had significantly longer LOS in acute care hospitals, lower CMI, and higher rates of obesity. Regression analyses also confirmed that male sex was significantly associated with higher odds of PI.[21] Obesity seemed to offer some protection for PIs, which is consistent with previous reports.

There are a number of potential reasons for the increase in HA PIs on admission to an IRH during the COVID-19 pandemic. The US health care system, particularly in New York and New Jersey, was overwhelmed with the wave of patients with COVID-19 during the early period of the pandemic. Providers were often relocated and tasked with monitoring patients outside of their scope of practice and preventing decompensation with respiratory distress. Frequent skin checks for PIs likely became difficult under these circumstances. Patients' family members who often play a role in monitoring for PIs were restricted from visitation.[22,23] In addition, increased LOS in the acute care hospitals during the pandemic also may have played a role in the increased PIs. A previous study found that the occurrence of pneumonia (pre-2020 and pre−COVID-19) was significantly associated with longer acute care time and increased occurrence of PIs in persons who sustained a traumatic spinal cord injury, further highlighting the increased need for PI prevention strategies in patients with pneumonia.[24] Although these extrinsic factors may have contributed to the increased incidence of PIs, there are also many intrinsic factors to COVID-19 that may cause an increased risk of PIs, such as hypoxemia, microvascular injury, and thrombosis.[25,26] This study found that male sex was a risk factor for development of a PI during the acute hospital stay.[21] This variable has limited evidence in the literature to support their classification as risk factors for PIs.[11,14,27-30] However, these factors have been shown to play a role in the severity of COVID-19 morbidity, which may play a role in the development of PIs, in the case of malnutrition (low blood albumin levels), and in PI severity.[31-33]

There are many relevant future directions for research of PIs on admission to IRHs during the COVID-19 pandemic. PI incidence should be further evaluated in a prospective study during the upcoming months of 2021 as COVID-19 cases continue across the US. More research is needed in prevention strategies to help overwhelmed health care systems combat the rise of PI incidence during the pandemic. Further investigation is necessary to determine how physiatrists can help with interdisciplinary rehabilitation early on in the care for these patients at the acute stages, including monitoring and caring for PIs in the acute care and intensive care unit settings, increased patient and family education on PIs, and expanded use of telehealth consultations in these settings to expand access to PI care during the pandemic.[34-36]

Study limitations

Persons used in this study reflected a population accepted at 4 IRHs within 1 system of care and may not be fully representative of all IRHs. Although our focus was during the early part of the pandemic and may not reflect occurrences after hospitals became accustomed to care of persons with COVID-19, this represents a valuable opportunity to learn from this experience. We defined overall severity of PI based on the highest stage of an individual's presentation at IRH admission. This might dilute the true degree of severity of PIs at admission because a person presenting with 1 stage 4 PI would be would considered more severe than 2 stage 3 PIs. Lastly, the COVID-19 period sample size was smaller than the pre−COVID-19 time period group. At the beginning of the pandemic, our center admitted at 50% of full capacity to assure private rooms for all patients. The center's reduced capacity is a potentially confounding variable in the logistic regression model predicting odds of PIs in the COVID-19 sample that could not be accounted for because of the lack of available data on covariates for pre−COVID-19 patients.

Conclusions

There was an increased prevalence and severity of PIs on admission to an IRH at the beginning of the COVID-19 pandemic compared with the prepandemic period. Key risk factors included a higher CMI and longer length of acute hospital stay before transfer to the IRH. No differences were found in the incidence of PIs between COVID-19−positive and COVID-19−negative patients, potentially highlighting a downstream effect of the pandemic on PI management for all patients treated in acute care hospitals before being transferred to an IRH. Although having a positive diagnosis of COVID-19 did not increase the PI risk, hospitalization during this time period did possibly because of an overwhelmed acute care system and widespread ventilator use. This information is extremely important and instructive in future mass health events, particularly those that have an effect on pulmonary health. Key PI prevention strategies should be implemented where possible to prevent injuries in critically ill patients. On a larger scale the results of our study show the intimate relationship between acute care resources and PIs. The study also brought to our attention the relationship between PIs and widespread pulmonary problems requiring ventilator assistance.

Supplier

a. Stata/SE 16.1; StataCorp.

Keywords

COVID-19 pandemic; COVID-19 virus disease; COVID-19 virus infection; Infection; Pneumonia, viral; Physical medicine; Rehabilitation; Skin ulcer; Ulcer; Viral disease

Corresponding author

Jamila A. Kendall, MD, Kessler Institute for Rehabilitation, 1199 Pleasant Valley Way, West Orange, New Jersey 07052. *E-mail address:* jkendallrn2md@gmail.com.

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References

1. World Health Organization. WHO Director-General's opening remarks at the media briefing on COVID-19 - 11 March 2020. Available at: https://www.who.int/dg/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19—;11-march-2020. Accessed May 16, 2020.
2. Johns Hopkins Coronavirus Resource Center. COVID-19 dashboard by the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University. Available at: https://coronavirus.jhu.edu/map.html. Accessed March 28, 2021.
3. Centers for Disease Control and Prevention. Coronavirus disease 2019 (COVID-19) in the U.S. Centers for Disease Control and Prevention. Available at: https://www.cdc.gov/coronavirus/2019-ncov/cases-updates/cases-in-us.html. Accessed May 16, 2020.
4. Phillips M, Turner-Stokes L, Wade D, Walton K. Rehabilitation in the wake of COVID-19 - a phoenix from the ashes. Br Soc Rehabil Med 2020;1:1–20.
5. Mao L, Jin H, Wang M, et al. Neurologic manifestations of hospitalized patients with coronavirus disease 2019 in Wuhan, China. JAMA Neurol 2020;77:683–90.
6. Li J. Rehabilitation management of patients with COVID-19: lessons learned from the first experiences in China. Eur J Phys Rehabil Med 2020;56:335–8.
7. Pressure ulcers get new terminology and staging definitions. Nursing 2017;47:68–9.
8. Lyder CH. Pressure ulcer prevention and management. JAMA 2003;289:223–6.
9. Leaf Healthcare. White paper: the impact of pressure ulcers on patient care. Available at: http://www.leafhealthcare.com/pdfs/LH_WP_ClinicalOverview_1562AA_PDF_081114.pdf. Accessed May 16, 2020.
10. Reddy M, Gill SS, Rochon PA. Preventing pressure ulcers: a systematic review. JAMA 2006;296:974–84.
11. DiVita MA, Granger CV, Goldstein R, Niewczyk P, Freudenheim JL. Risk factors for development of new or worsened pressure ulcers among patients in inpatient rehabilitation facilities in the United States: data from the Uniform Data System for Medical Rehabilitation. PM R 2015;7:599–612.
12. Wang H, Niewczyk P, Divita M, et al. Impact of pressure ulcers on outcomes in inpatient rehabilitation facilities. Am J Phys Med Rehabil 2014;93:207–16.
13. DiVita MA, Granger CV, Goldstein R, Niewczyk PM, Freudenheim JL. Mandated quality of care metrics for Medicare patients: examining new or worsened pressure ulcers and rehabilitation outcomes in United States inpatient rehabilitation facilities. Arch Phys Med Rehabil 2018;99:1514–24.
14. Dreyfus J, Gayle J, Trueman P, Delhougne G, Siddiqui A. Assessment of risk factors associated with hospital-acquired pressure injuries and impact on health care utilization and cost outcomes in US hospitals. Am J Med Qual 2018;33:348–58.
15. Tang J, Li B, Gong J, Li W, Yang J. Challenges in the management of critical ill COVID-19 patients with pressure ulcer. Int Wound J 2020;17:1523–4.
16. Kayser SA, VanGilder CA, Ayello EA, Lachenbruch C. Prevalence and analysis of medical device-related pressure injuries: results from the International Pressure Ulcer Prevalence Survey. Adv Skin Wound Care 2018;31:276–85.
17. Peterson M, Schwab W, McCutcheon K, van Oostrom JH, Gravenstein N, Caruso L. Effects of elevating the head of bed on interface pressure in volunteers. Crit Care Med 2008;36:3038–42.
18. Girard R, Baboi L, Ayzac L, Richard JC, Guérin C. Proseva trial group. The impact of patient positioning on pressure ulcers in patients with severe ARDS: results from a multicentre randomised controlled trial on prone positioning. Intensive Care Med 2014;40:397–403.
19. Keller BPJA, Wille J, van Ramshorst B, van der Werken C. Pressure ulcers in intensive care patients: a review of risks and prevention. Intensive Care Med 2002;28:1379–88.
20. Edsberg LE, Black JM, Goldberg M, McNichol L, Moore L, Sieggreen M. Revised National Pressure Ulcer Advisory Panel pressure injury staging system: revised pressure injury staging system. J Wound Ostomy Continence Nurs 2016;43:585–97.
21. Seibert J, Barch D, Bernacet A, et al. Examining social risk factors in a pressure ulcer quality measure for three post-acute care settings. Adv Skin Wound Care 2020;33:156–63.
22. Bergstrom N, Braden BJ, Laguzza A, Holman V. The Braden Scale for Predicting Pressure Sore Risk. Nurs Res 1987;36:205–10.
23. Gefen A, Ousey K. Update to device-related pressure ulcers: SECURE prevention. COVID-19, face masks and skin damage. J Wound Care 2020;29:245–59.
24. Martel T, Orgill DP. Medical device-related pressure injuries during the COVID-19 pandemic. J Wound Ostomy Continence Nurs 2020;47:430–4.
25. Gour-Provencal G, Mac-Thiong JM, Feldman DE, Bégin J, Richard-Denis A. Decreasing pressure injuries and acute care length of stay in patients with acute traumatic spinal cord injury. J Spinal Cord Med 2020 Feb 11. [Epub ahead of print].
26. Perrillat A, Foletti JM, Lacagne AS, Guyot L, Graillon N. Facial pressure ulcers in COVID-19 patients undergoing prone positioning: how to prevent an underestimated epidemic? J Stomatol Oral Maxillofac Surg 2020;121:442–4.
27. Coleman S, Gorecki C, Nelson EA, et al. Patient risk factors for pressure ulcer development: systematic review. Int J Nurs Stud 2013;50:974–1003.
28. Sugino H, Hashimoto I, Tanaka Y, Ishida S, Abe Y, Nakanishi H. Relation between the serum albumin level and nutrition supply in patients with pressure ulcers: retrospective study in an acute care setting. J Med Invest 2014;61:15–21.
29. Serra R, Caroleo S, Buffone G, et al. Low serum albumin level as an independent risk factor for the onset of pressure ulcers in intensive care unit patients. Int Wound J 2014;11:550–3.
30. Liu Y, Wu X, Ma Y, et al. The prevalence, incidence, and associated factors of pressure injuries among immobile inpatients: a multicentre, cross-sectional, exploratory descriptive study in China. Int Wound J 2019;16:459–66.
31. Peckham H, de Gruijter NM, Raine C, et al. Male sex identified by global COVID-19 meta-analysis as a risk factor for death and ITU admission. Nat Commun 2020;11:6317.
32. Tartof SY, Qian L, Hong V, et al. Obesity and mortality among patients diagnosed with COVID-19: results from an integrated health care organization. Ann Intern Med 2020;173:773–81.
33. Huang J, Cheng A, Kumar R, et al. Hypoalbuminemia predicts the outcome of COVID-19 independent of age and co-morbidity. J Med Virol 2020;92:2152–8.
34. Turcu RP, Polich GR, Steere HK, Schneider JC, Borg-Stein J, Silver JK. Letter to the editor on "rehabilitation following critical illness in people with COVID-19 infection. Am J Phys Med Rehabil 2020;99:787–8.
35. Sheehy LM. Considerations for postacute rehabilitation for survivors of COVID-19. JMIR Public Health Surveill 2020;6:e19462.
36. Barker-Davies RM, O'Sullivan O, Senaratne KPP, et al. The Stanford Hall consensus statement for post-COVID-19 rehabilitation. Br J Sports Med 2020;54:949–59.