Upper-limb specialist input into intensive care to prevent proning associated complications during the COVID-19 pandemic: Leicester's experience

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Abstract

Background

Unilateral upper-limb complaints associated with proning presented during the COVID-19 pandemic.

The impact of musculoskeletal upper-limb specialist physiotherapy into intensive care unit (ICU) on patient outcomes, during the second wave of the pandemic, is presented.

Method

Following the first wave of the COVID-19 pandemic, an electronic referral pathway was implemented directly to an extended scope physiotherapist (ESP) to assess/treat upper-limb complaints in post COVID-19 patients. The proning standard operating procedure was amended in response.

January 2021, the COVID-19 second wave, dramatically increased numbers on ICU. Direct musculoskeletal (MSK) therapy input on ICU was initiated focussing on optimal positioning, risks of sustained positions/compression and traction risks to the brachial plexus. Ideal positioning visual references and peripheral nerve injury screening tools were created and distributed on all units.

MSK therapists assisted with proning, repositioning and directly educating ICU staff. Sedated patients were assessed for joint stiffness/restrictions and mobilisations performed. Upon sedation reduction, assessments addressed specific upper-limb deficits, patients engaged in active upper-limb rehabilitation, and individual programmes created.

The main aims of the paper are:

1 To present a comparison of incidence of shoulder injuries in wave one to wave two, of the COVID-19 pandemic, and present the measures put in place in response to findings in wave one.
2 Review the pathologies/types of shoulder injuries presenting in wave one and two, and review if associated with proning complications. Patients' demographics and comorbidities are also reviewed, to see if any factors may predispose patients to such injuries.

Results

Between March 2020–2021, 598 COVID-19 positive patients were treated in Leicester's ICU's, many with prolonged length of stay. Two comparable six-week windows were examined, reflecting wave one and two of the pandemic (survivor's data). Wave one: 11 patients (19%) were identified/treated in physiotherapy post ICU discharge, (all proned) (four neuropathies, three frozen shoulder, four rotator cuff weakness/impingement presentation). In comparison, Wave two: three patients (6.9%) required post discharge follow up, for overhead weakness (cuff) and loss of elbow extension. Such presentations can be associated with prolonged length of stay, (average of 53.3 days) rather than proning complications.

Conclusion

Musculoskeletal therapy input to ICU focusing on education, proning, assessing and commencing early upper-limb rehabilitation was extremely positive. This has identified a role for MSK input in the acutely critically unwell patient.

Introduction

The COVID-19 pandemic has seen immense strain put on the NHS between March 2020 to the present day (1). In severe cases, COVID-19 triggers the inflammatory process, also known as a cytokine storm (2), resulting in wide-spread diffuse alveolar damage, leading to acute lung injury and acute respiratory distress syndrome (ARDS).

Proning is recommended in the treatment of moderate or severe ARDS and was a technique widely utilised during the COVID-19 pandemic (3). Early application of the prolonged prone position may significantly decrease mortality compared to conventional supine ventilation (4). Proning is recommended for more than 16 hours to maximise effectiveness (5). However, use of proning is not without risk with associated complications including pressure sores, facial/periorbital oedema, intravenous/endotracheal tube displacement, cardiovascular system instability, ocular injury/corneal abrasions, brachial plexus injury and staff injury (5).

During the COVID-19 pandemic focal neuropathies have been identified, with a possible cause being the result of compression or traction of the plexus, peripheral nerves or arterial

structures (3). It is assumed that such presentations are possibly related to the use of prone positioning. The faculty of intensive care medicine (FICM) guidelines for prone positioning (5), recommend the elbow should be maintained at 90°, however this is a potential stretch position for the ulnar nerve at the elbow (6). Miller et al (3) also notes that the abducted and laterally rotated position of the shoulder causes traction on the infraclavicular plexus.

Locally an existing standard operating procedure (SOP) for proning was adapted to be used during the first wave of the pandemic which included head turns every eight hours and regular limb repositioning. A pathway to manage patients presenting with upper-limb complaints following discharge from intensive care (ICU) was also created. Due to the high incidence and an increased understanding of the risk of upper-limb dysfunction, several interventions aimed at reducing the prevalence of upper-limb complaints were implemented prior to and during the second wave of the pandemic.

The aims of this paper are:

1 To compare the prevalence of shoulder injuries between the first and second waves of the pandemic following the introduction of an upper-limb management intervention for patients being proned.
2 To describe the types of shoulder injuries and their presentations in the first and second waves of the pandemic.

Method

This service evaluation was registered and approved by the University Hospitals of Leicester NHS Trust as a clinical audit (reference number 10674).

Setting

This service evaluation was undertaken in a large U.K. University Teaching NHS Trust, with ICUs at three separate sites, one of which is an extra corporeal membrane oxygenation (ECMO) centre.

Upper-limb management intervention

The upper-limb management intervention was implemented across all three sites prior to and during the second wave of the pandemic. In addition to the interventions outlined below, the original COVID-19 proning SOP was updated to include head turns every four to eight hours.

Staff education

Education provided via Microsoft Teams was recorded and delivered to therapy, nursing and medical staff. Optimal patient positioning, the rationale for such positions and the risks that could be imposed by sustained positions of compression or traction on the brachial plexus was discussed. In addition to these sessions, laminated documents with a quick visual reference for the ideal position were produced and put with the proning SOPs in use on all units or in bed spaces (Figure 1).

Figure 1: Swimmers position for proning to prevent upper limb/neck problems.

Therapists across all in-patient wards were also informed of the referral pathway to ensure early identification of any upper-limb MSK problems. Peripheral nerve injury (PNI) screening tools, were created for staff to use (Appendix 1).

Patient assessment and intervention

To support the management of prone positioning, musculoskeletal (MSK) physiotherapy input directly on to ICU was initiated. Assistance with proning was provided, with discussion and education regarding optimal positions with nursing and medical staff. Additionally aid in general repositioning and assistance with head turns was provided. Whilst patients were still sedated, assessments for joint stiffness/restrictions were performed and passive movements provided to maintain flexibility. If there were any concerns regarding unilateral stiffness or cervical stiffness that could potentially impact on proning, assessment was made, and advice offered accordingly. As patients' sedation levels were decreased, assessments were made to review for any specific upper-limb deficit. Patients were engaged in active upper-limb rehabilitation, alongside mobility progression, and individual rehabilitation programmes created.

Data collection

Data was collected retrospectively from the hospitals electronic database, mainly from critical care discharge letters, and prospectively from patients referred into physiotherapy requiring upper-limb treatment. Data collected included demographics, baseline comorbidities, whether they were treated with proning (conscious or unconscious) and ICU length of stay.

Data was collected during a six-week period during the height of the first (1st April–13th May 2020), and second (1st February–15th March 2021) waves of the pandemic. These six-week time periods reflect time that the trust was under the highest level of operating pressure for each wave.

Data analysis

Data is presented as descriptive statistics and narrative commentary of the presenting pathologies.

Results

During the data collection periods, 58 patients (69% male) were treated in ICU with COVID-19 and survived in the first wave, compared to 44 patients (66% male) in the second wave. The average ICU length of stay for these patients was longer in wave one (25.5 versus 18.9 days). The mean age was 51.8 years old (range 30–71) in the first wave, and 51.6 (range 27–76) in the second wave. The prevalence of shoulder injury was greater in the first wave (19%, $n = 11$ versus 6.9%, $n = 3$). The number of patients treated with proning was lower in the second wave (43.2%, $n = 19$ versus 50%, $n = 24$). Results are presented in Table 1.

Table 1: Comparison of wave 1 to wave 2 patient load.

	Wave 1	Wave 2
Number of patients	55 patients	44 patients
Average length of stay	25.5 days	18.9 days
Male, Female	M = 69, F = 31	M = 66, F = 34
Average age	51.8	51.6
Proned	50%	43.2%
Comorbidities most common	DM, HTN	DM, HTN

Main comorbidities in wave two were relatively comparable to wave one (Table 1).

During the first wave, 11 patients (19%) were identified as presenting with unilateral upper limb problems, and referred through the electronic referral pathway. Four patients (6.9%) presented with brachial neuropathies (presentation of neuropathic pain, pins and needles/numbness, weakness and wasting), three (5.2%) with frozen shoulders (stiffness and pain in the absence of glenohumeral osteoarthritis), and four (6.9%) with painful shoulders with rotator cuff weakness (subacromial impingement presentation).

All 11 of the patients that were referred into the MSK service with upper-limb conditions, were proned as part of their treatment for COVID-19. The majority were unconsciously proned while on the intensive care unit ($n = 9$) for at least one 16-hour period with repetition of proning at least five times. The other two patients were conscious and able to self-prone. One of the patients presenting with significant neural deficit following their recovery on ICU was transferred to UHL from an external centre for ECMO cannulation. It was documented in the medical notes that the patient had been prone at the referring centre for a single period of more than 24 hours prior to their transfer.

Analysis of the past medical history of those patients from wave one with shoulder pathology identified three patients had vascular related comorbidities (diabetes, hypertension and hypercholesterolaemia); six had obesity or a high body mass index; one diverticulitis; two had asthma; one had non-alcoholic fatty liver disease; one had a history of alcohol dependence and three had no significant past medical history recorded. We did not analyse whether this differed from those without shoulder pathology.

Frozen shoulder

Two of the patients diagnosed as having developed capsulitis had vascular associated risk factors (type 2 diabetes, hypertension/hypercholesterolemia, smoking history). The third individual to present with a frozen shoulder was female in her fourth decade. These patients required outpatient physiotherapy treatment for an average of six to eight months.

Neuropathy

There were four suspected brachial plexopathies referred for further treatment, two of whom had diagnoses of obesity and one had a past medical history of type 2 diabetes, smoking and alcohol dependence. These patients have required over one year of treatment in physiotherapy outpatients and continue to have significant pain and functional deficit.

Weak/painful shoulder

All patients presenting with weak and painful shoulders suggestive of rotator cuff pathology ($n = 4$) resolved with physiotherapy, and were discharged from the service (treatment time four to eight months), except one out-of-area patient who was not followed up locally after repatriation to the referring centre. No comorbidities of clinical relevance were identified in this group of patients in relation to shoulder pathology.

From wave two, three patients were identified with unilateral upper-limb problems requiring outpatient input (6.9%). These were identified whilst in-patients on ICU or on step down wards and treatment initiated immediately. Two of these patients were treated in the prone position during their admission (with proning for a 16-hour period and repetition at least five times), however one was not.

Two of these patients presented with no comorbidities. One patient was initially admitted for emergency laparotomy for hernia/perforation, but contracted COVID-19 and developed pneumonitis.

Two of these patients presented with bilateral overhead weakness, and unilateral stiffness on the ventilator side. Two had loss of end of range elbow extension (30° deficit). All three patients required physiotherapy out-patient treatment, for less than one month.

Discussion

This review found the prevalence of shoulder injury in COVID-19 survivors decreased between the first and second wave. Concluding why is difficult to ascertain, as full information regarding proning frequency, duration and numbers affected was not available for those who were not captured as having upper-limb problems and requiring follow up from our service. Preventative measures such as education regarding optimal positioning, increasing repositioning frequency and early implementation of rehabilitation may have been helpful to reduce incidences, although length of stay was lower in wave two so may have influenced outcomes.

The COVID-19 pandemic placed unprecedented demands on intensive care units, with our units expanding from usual maximum of 20 beds at two sites, up to 100 beds. With patient numbers and length of stay dramatically increasing, placing immense demands on staffing, proning SOPs were written to be feasible under the pressures. Despite the suggested links between proning and potential brachial plexus injury, only four patients were identified as having potential nerve related problems in our unit from wave one. In response to the

increasing pressures of wave two, and with the knowledge acquired from wave one, input from MSK specialists into the ICU department was initiated. Patients were also identified immediately with any upper-limb deficit and treated accordingly. Once patients are alert and stable, physiotherapy tends to focus on getting the patient up and out of bed. For many patients recovering from critical illness, once a day mobilisation is as much as can be tolerated (primarily focusing on sitting balance, progressing to sit-to-stand practice, transferring and mobilisation), but an additional session of bed exercises focusing on the upper-limb was added to help recover function in these patients. Patients reported this helped maintain their motivation for rehab. Future research on the patient experience would be beneficial to guide what functional tasks are important to them to guide rehabilitation programs. Anecdotally, especially during times of no visitors, patients regularly had a goal to be able to reach their own mobile phone and call friends and family independently without needing assistance. No data was collected on this however, but may be something to bear in mind, in terms of the requirement for reaching, grasping and using fine motor skills to operate the mobile phone.

Many patients were found to demonstrate generalised weakness and struggled with overhead activity, hand-to-mouth and elbow extension. By assessing patients on sedation reduction, individualised treatment was commenced, and programmes created.

From the identification of these three main deficits, an in-patient leaflet was developed for use for patients to help work on recovering independent functional movement (Appendix 2).

The evaluation found there was a higher prevalence of shoulder injury during the first wave. One observation made was a link with higher rates of vascular related disease (diabetes and hypertension) and obesity. Data collected on comorbidities such as raised body mass index (BMI) or obesity was gathered from documentation in medical notes, however anecdotally this number was likely to be greater in both samples. Drawing comparison with the second wave, far fewer patients presented with specific shoulder pathology, but rather generalised upper-limb weakness and unilateral glenohumeral joint and elbow joint stiffness, that is more likely to be associated with the prolonged length of stay. In addition, no clinically relevant comorbidities were identified in these patients.

Many of the comorbidities observed in the sample are established risk factors for developing shoulder pathology and are also in-keeping with those identified as risk factors for developing severe illness from COVID-19 (7).

Miller et al. (3) presented a case series of 15 patients identified as having brachial plexus neuropathies post critical care stay and found that 30 nerve injuries presented. Thirteen had multiple nerve injuries within their upper-limbs (range 1–4). Nine had injuries involving the ulnar nerve at the cubital tunnel, with 10 out of 30, having a peripheral nerve injury at the level of the cords in the infraclavicular plexus. All patients had been treated with

proning. Our results showed a much lower incidence of peripheral nerve injury, with only four presenting in wave one, and none in wave two. This may be due to our unit's experience with proning, and could be related to the implementations put in place. Miller's (3) work was very useful to provide guidance for education on positions to avoid.

Limitations

This study is presented retrospectively, so is limited in nature. Baseline data regarding upper-limb function for each group compared was not collected, so we cannot be sure they were equal. Most of the data was collected from hospital notes and discharge letters, that is likely to have had missing data, and certainly information such as increased body mass index was limited. It would have been beneficial to have collected patient related outcome measures, both specific to their upper-limb function, and general health and anxiety, to improve depth of the data. Data has not been collected on patients who were treated in the prone position without COVID-19 either, so it is difficult to ascertain whether this problem is specifically relevant to this population.

Conclusion

The input of musculoskeletal therapists into ICU, can help with education, proning, identify possible problems early and facilitate rehabilitation. This has identified a role for MSK input in the acutely critically unwell patient, specifically rehabilitating upper-limb function in the early days on ICU, and preventing deconditioning and common presentations of stiffness and weakness. Future research is recommended into the prevention of MSK problems, associated with proning and prolonged length of stay.

Neuropathic screening tool

1 Pain: Yes/no

If yes:

- Neuropathic (stinging/burning/shooting/squeezing)
    - Yes/no

2 Weakness (circle if present)

Shoulder

- Flex
- Abd
- ER

Elbow

- Flex
- Ext

Wrist/hand

- Finger flexion
- Finger extension
- Finger Abduction
- Finger adduction

3 Sensation

- Normal (N)
- Absent (A)
- Decreased (D)
- Strange (S)

Regimental badge
Thumb
Middle finger
Little finger
Inner arm

Caring at its best

NHS
University Hospitals of Leicester
NHS Trust

Getting strength back in your arms during and after your hospital stay

Department of Physiotherapy

Information for Patients

Produced: July 2021
Review: July 2024
Leaflet number: 1208 Version: 1

Introduction

During your stay in hospital, it is very common to lose strength and struggle with moving your arms on your own. The following exercises are meant to help you build up your strength so that you can get back your independence.

Try to do them little and often, and even if you cannot get the full movement, you will be moving the muscles which will help you to recover.

Your therapist will tell you on how many times you need to do the exercises each session. As you get stronger you will be able to build this number up as the exercises get easier.

Doing the exercises lying down is easier than upright, so the exercises do start in this position. You can gradually raise yourself to sit in a more upright position. This makes the exercises harder. Try to add pillows to aim for an upright position as the exercises get easier for you to do.

Shoulder raises (elevation):

Start position

- Lying on your back (as flat as you can manage).
- Start with your elbow bent hand pointing up towards the ceiling.

Action

- Reach arm up towards the ceiling.
- Make a circle as big as you can clockwise, not letting your arm flop .
- Repeat the other way (anti-clockwise).
- Lower the arm by bending your elbow and return to the start position slowly.

Repeat _____ times

Build up to _____

Elbow exercises

Start position

- Lying on your back support your upper arm with elbow bent and point elbow towards the ceiling.

Action

- Straighten your arm as much as you can taking your hand towards the ceiling.
- Bend the elbow to take hand down towards shoulder (return to start position).

Repeat _____ times

Build up to _____

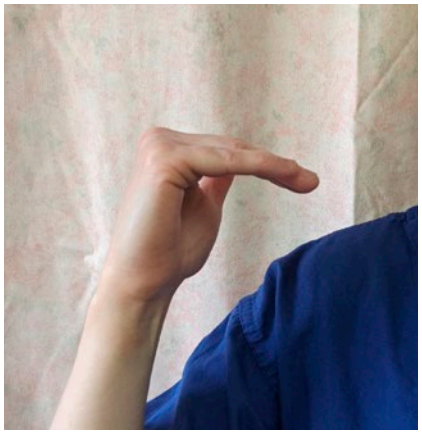
Hand exercises

Start position

Straighten your fingers as much as you can

Action

Bend your fingers at the knuckles, keeping ends of your fingers straight, before continuing in to a full fist



Repeat _____ times

Build up to _____

Contact details

If you have any questions speak to the staff on your ward or call

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