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Improving pressure ulcer risk identification, prognosis and prophylaxis: outcomes from a pilot intervention by North East Ambulance Service personnel

--Manuscript Draft--

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Abstract:	This study investigated the outcomes of a quality improvement initiative, designed to identify patients at risk of compromised tissue viability, due to prolonged immobility, prior to hospital admission. This entailed educating paramedics to better identify patients with existing pressure ulcers (PU) or pressure damage. Predisposing risk markers were identified with a PU assessment tool, and highlighted to Emergency Department staff at handover using a PU ALERT bracelet worn by patients.
Response to Reviewers:	Journal of Paramedic Practice - Decision on Submission jpar.2019-10-2018-0119 [EMID:5923884d90e1583e] General Author Commentary We are sincerely grateful to the reviewers of our paper- their insightful comments have enabled us to undertake these corrections in a straightforward manner, which we are pleased to re-submit in the latest version of our manuscript. All of our updates have been highlighted across the manuscript in yellow, so that these can easily be tracked. Reviewer #1 Comments: Reviewer #1: Thanks for the chance to review this work. I think it is an excellent initiative, exactly the sort of thing that the profession needs to be doing more of, and I would like to see it accepted for publication but feel a few amendments would improve it further. a) Section 3.3 EPCR documentation - be careful in stating "an upward trend was clearly demonstrated". This is only a three month sample and whilst it is likely that the training contributed positively, it might be simply natural variation or that pressure ulcers 'spike' in the autumn/winter months. Author Response a): Thank you for pointing this out to us, we agree with you absolutely and have amended the manuscript to reflect what could potentially be a

natural variation in the incidence and hence rise of the pressure ulcer function reporting on EPCR. We have also added a citation to substantiate this claim from research undertaken by Rodrigues et al, 2019 and have incorporated this into our reference list (Rodrigues, F. S., de Luca, F. C., da Cunha, A. R., & Fortaleza, C. M. C. B. (2019). Season, weather and predictors of healthcare-associated Gram-negative bloodstream infections: a case-only study. Journal of Hospital Infection, 101(2), 134-141.)
b) In the section beginning "Of the 127 patients admitted with a PU risk alert bracelet ……" you mention the various measurements surrounding PURA completion. Do you have any pre-study statistics to put these in to context as there is nothing to compare them to? Are these good? Bad?
Author Response b): Thank you, we acknowledge here (and have now added into the manuscript) that a lack of pre-study statistics means that benchmarking was impossible and that in any full consequent study following on from the pilot, that this would provide a meaningful source of comparison.
c) The sentence beginning "The cost associated with pressure ulcer care and hospitalisation ……." - the full sentence doesn't make sense. Please rewrite.
Author Response c): Thank you so much for pointing this out, this sentence and the one following it have now been rewritten

d) it's a shame that no information is presented regarding time spent on the floor, as that would also be an interesting side point. Do you have any data? Even if could be part of an appendix?
Author Response d): Thank you, we agree with this observation, although for the purposes of this study, this is not something that we recorded as part of the pilot study. We have now added a comment to this effect in the discussion, alongside our previous comment of being able to benchmark data, so that this might also be added to any full consequent study using the PU bracelets.

Reviewer #2

Comments:
Reviewer #2: Thank you for your submission. This was a really interesting pilot, with a great potential for other organisations and individuals to learn from. I would very much like to see this this work published for others to review, and my comments below are hopefully constructive. I think by increasing the simplicity in places and making the scientific rigour a little more robust, this could be an excellent article.

a) You conclude that paramedics effectively identified potential risk factors to PU development, indicating a need for immediate intervention. I agree that your study indicates that they have largely completed appropriate risk assessment within the pilot, but to state that they have effectively identified potential risk factors, I would suggest that you would have had to have looked at the potential numbers of missed patients (i.e. false-negatives). What about patients that did not get the wrist alarm bands? Did you review all falls to check for compliance or just examine those that were given the bands?

Author Response a): Thank you, we can acknowledge the points raised here absolutely and have added a section into our discussion to highlight and reflect this as an area for address in any consequent study undertaken as a result of the pilot.

b) Materials and methods section. In my opinion, it is important to use the simplest, concise and clear language available without compromising technical accuracy. This will ensure that your work is read and understand by as many people as possible. In this section you appear to include an academic passage on the Donabedian model. I am not sure this contributes anything to the publication value of the work. I would have rather seen a more pragmatic logistical explanation of how you carried out the study. Is it necessary to include most of the detail on page 4?
Author Response b): Thank you, we considered this critique and agree that there was overemphasis on the theoretical underpinning of the work. We have removed this and significantly streamlined the materials and methods section.

c) EPCR Pressure Ulcer Documentation: I am not sure that it is accurate to state that

	the upward trend of documentation completion demonstrates success. Is it not possible that the increased use was linked with winter where falls or other acute events may increase the frequency of the types of patients most likely to receive the wristbands? Consideration of this as a minimum would show more critical analysis. Author Response c): Thank you for pointing this out to us, we agree with this comment absolutely (which was also pointed out by Reviewer #1) and have amended the manuscript to reflect what could potentially be a natural variation in the incidence and hence rise of the pressure ulcer function reporting on EPCR. We have also added a citation to substantiate this claim from research undertaken by Rodrigues et al, 2019 and have incorporated this into our reference list (Rodrigues, F. S., de Luca, F. C., da Cunha, A. R., & Fortaleza, C. M. C. B. (2019). Season, weather and predictors of healthcare-associated Gram-negative bloodstream infections: a case-only study. Journal of Hospital Infection, 101(2), 134-141.) d) Also, brief mention of any ethical considerations is important - did the patient's consent to their records being used in this way? Author Response d): Thank you we had omitted to do this and have now incorporated a short section prior to our acknowledgements and then also within the acknowledgements thanking patients for consenting to take part in the study. At times there is a lack of methodological rigor. You state on page 17 that ambulance crews verbally reported opinions on perceived benefit. How did you collect these views? Through structured interviews or through anecdotal event? What about bias in this regard? Author Response e): Thank you, we do acknowledge these as subjective standpoints in the amended manuscript. Their positionality is something that we have also acknowledged in relation to the potential for epistemological bias in the discussion section. We have provided an additional heading of 'Acknowledged Limitations to the Pilot Study' to incorporate this fully.
Additional Information:	
Question	**Response**
Please enter the word count of your manuscript **excluding references and tables**	38236

Title: 'Improving pressure ulcer risk identification: outcomes from a pilot intervention by Ambulance Service personnel'

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Article Key Points:

- ✓ Paramedics appropriately assessed patients' pressure damage and predisposition of risk
- ✓ A simple ALERT bracelet was used effectively to identify at risk patients to ED staff
- ✓ Home circumstances identified the vulnerability of those living alone being at risk
- ✓ Patients over the age of 70 years were identified as most at risk
- ✓ Patients who had fallen or immobility was impaired were identified as most at risk
- ✓ Paramedics improved their transferring handover documentation to ED staff

Improving pressure ulcer risk identification, prognosis and prophylaxis: outcomes from a pilot intervention by North East Ambulance Service personnel

Abstract

This study investigated the outcomes of a quality improvement initiative, designed to identify patients at risk of compromised tissue viability, due to prolonged immobility, prior to hospital admission. This entailed educating paramedics to better identify patients with existing pressure ulcers (PU) or pressure damage. Predisposing risk markers were identified with a PU assessment tool, and highlighted to Emergency Department staff at handover using a PU ALERT bracelet worn by patients.

Aim

To educate paramedics to better identify patients with existing pressure ulcers or those at risk of compromise tissue viability to ED staff. To use an PU ALERT bracelet on patients to highlight to ED staff the patients increased risk of pressure damage to initiate prompt intervention.

Materials and Methods

Data was retrospectively analysed from a three month period underpinned by a recognised Plan, Do, Study, Act (PDSA) improvement methodology. Patients were identified as being at increased risk of compromised tissue viability, flagged as requiring assessment via a Pressure Ulcer Risk Assessment (PURA) tool, enabling appropriate responses to prevention and prophylactic intervention.

Results

Paramedics identified 130 at-risk patients (aged 23 – 100 years), with data analysed from 127 patients. Most at-risk patients fitted with PU alert bracelets were aged 70+ years with an even gender spilt.. 53% of patients were identified as having a pressure ulcer and alerted to Emergency Department (ED) staff upon transfer to hospital; 27% of patients identified as at-risk of PU ulceration lived in nursing or residential homes and 43% of patients lived alone or in warden controlled accomodation.

Conclusion

Paramedics effectively identified potential risk factors to PU development, indicating a need for immediate intervention. This study provides insight into how PU risk assessment using an alert bracelet may be used in paramedic practice in ED handovers. Success was reliant on hospital staff acting upon recommendations of paramedic practice.

Keywords: Pressure ulcer prevention; immobility; paramedic practice; emergency department; service improvement

1.Introduction

Immobility is a key predisposing factor for patients already at an elevated risk of the development of pressure ulceration. The capacity to monitor and assess patients at an elevated risk of tissue viability breakdown is one means of effectively contributing to a reduction in the overall number of patients who progress to the stage of either pre-ulcerative or ulcerative conditions, both of which significantly impact on quality of life. This report details a small scale quality improvement pilot intervention study designed to minimise the risk of either the development or deterioration of tissue viability status in patients of a regional ambulance service in the North East of England. The study was conducted between October – December 2017. This entailed the introduction of a 'Pressure Ulcer Alert' bracelet by paramedic practitioners of North East Ambulance Service (NEAS) who implemented a pressure ulcer risk assessment tool with those patients whose individual health needs meant a necessary admission to an acute hospital trust. The project was part of a pressure ulcer collaborative intervention facilitated by the Academic & Health Science Network North East and Cumbria using a recognised quality improvement methodology.

The NHS Safety Thermometer (PHE 2015) reported from April 2014 - March 2015 that 25,000 patients had developed new pressure ulceration. This is an average of 2000 newly acquired pressure ulcers each month within the NHS in England. The financial cost to the NHS varies depending on the severity of the pressure ulcer and likelihood of complications but was estimated as £1,214 to £14,108 per patient. Emergency Departments (ED) winter pressures and delayed ambulance responses have been identified as potentially detrimental

contributory factors to patients at risk of pressure damage. NICE (2014) guidance recommends Health Care Workers to be aware that all patients are potentially at risk of developing a pressure ulcer.

Multivariate logistic regression analyses undertaken as part of scientific interventions have provided the illumination of several salient risk factors in cases of immobility, to the development of pressure ulceration, namely, being aged 75 years or over, being female, having a BMI of less than 23 and a Braden score of 14 or less, anaemia, respiratory disease, and a pre-existing diagnosis of hypertension (Aloweni, et al, 2018; Ladd, Ekanem and Caffrey, 2018). These are clearly important indicators for multi and interdisciplinary healthcare professionals whose recognition of the risk of tissue breakdown and interventions can play a pivotal role in preventing mortality and morbidity (Smith et al, 2018). A key example of this work is evident in paramedic practice, where paramedics' identification of an actual or potentially compromised tissue viability status and the elevation of awareness of risk status can make the difference between the avoidance of tissue viability breakdown or epithelial breech. The North East Ambulance Service (NEAS) is at the forefront of changing its model of service provision from traditional ambulance transport to emergency care provision. Recognising patients at risk of developing pressure ulcers (PUs) is a new challenge for NEAS staff. An increasing number of patients being transferred to hospitals are at risk of developing a pressure ulcer as categorised by NICE (2016). Immobility as a main risk factor attributed to pressure damage could also be associated with patients who have fallen and are unable to move. A discussion at the Northern Directors of Nursing Forum in 2017 outlined the potential for NEAS to lead the way in the early identification of patients at risk of developing pressure ulceration and prompting ED staff to initiate early interventions. It was proposed that paramedics could identify patients at risk, with the fitting of a straightforward

PU alert bracelet prior to being handed over to ED. The aim was to educate paramedics to better identify patients with existing PUs or those patients at risk of tissue damage.

2. Materials and Methods

The project adopted a pragmatic and systematic approach to methods. Using a formal Plan Do Study Act Improvement Methodology. This was influenced by traditional models of quality and safety advocated by Codman, Deming and Donabedian Model (2012) (see Figure 1).

Figure 1: Diagrammatic Representation of Plan, Do, Study, Act (PDSA) Improvement
[Adapted from Langley et al (2009) The Model for Improvement, pg 24]

Methodology

The Infection Prevention & Control Manager, liaised with twelve Clinical Care Managers (CCMs) from three local geographical clusters in the Sunderland area. A formal cascade methodology (see Table 1) was implemented to provide teams with pressure ulcer awareness training and pilot information to their teams, to ensure parity and equity in the pedagogical

underpinning of the intervention strategy (Byrne et al, 2008). A pressure ulcer awareness booklet, aide de memoire and a supply of PU Alert bracelets and paper risk assessments were given to all staff at the time of their training for future use in paramedic practice. Posters explaining the nature and purpose of the pilot were placed in all participating ambulance stations and information went out in internal information bulletins to NEAS staff. The identification of these risks were made using the pressure ulcer assessment tool and identified to ED staff via handover and the use of a PU Alert bracelet, placed around the patients' wrist.

Table 1 Cascade methodology showing phases of education and training

Phase 1: Selection of suitable Pressure Ulceration prevention guidelines for Standardisation in Clinical Practice for MDT care Provision	▪ Factors to be considered pertaining to the selection of Pressure Ulcer Prevention:
	▪ Epidemiology/Demographic Characteristics
	▪ Relative interdependence on resourcing of the project and funding opportunity
	▪ Availability of discipline specific tissue viability experts to substantiate the proposal of additive interventions in practice
Phase 2: Identification and Selection of the Target Working Groups for the Intervention	▪ Key Practice Based Experts: Emergency Department Personnel / Hospital Trusts / Ambulance Service Personnel / Infection Control and Prevention Manager/ Clinical Care Managers

Phase 3: Definition of the level of resources required for each level of intervention with the Pressure Ulceration Prevention Bracelet	▪ Basic level Core resources or fundamental services absolutely necessary for Pressure Ulcer Prevention Scheme to become operational (i.e. Incorporation of the PURA intervention screening).
	▪ Provision of colour coded Pressure Ulcer Alert Bracelets
	▪ Interdisciplinary referral to specialist care for pressure ulceration intervention where necessary
Phase 4: Adaptation of intervention according to the level of resources	**Specific factors to be Considered:**
	▪ Cost and Funding of Overall Project
	▪ Media Production (Short Film) https://www.youtube.com/embed/yNSz4mlU4hM?rel=0
	▪ Resource Implications
	▪ Infrastructure Barriers and Enablers
	▪ Pragmatic Issues
	▪ Professional Practice Issues / Interprofessional Communication
	▪ Training and Education Provision
Modified Delphi process:	Local experts who are representative of different contexts (geographical, level of resources, etc.)

Prior to this, Pressure Ulcer Awareness training had been introduced in NEAS as mandatory training during April 2016 – March 2017. A pressure ulcer risk assessment (PURA) tool for paramedics to use was ratified by the Patient Safety Group in May 2017. In September 2017 NEAS joined a pressure ulcer project PROACT, facilitated by Sunderland Clinical Commissioning Group (CCG) that augmented the collaboration between NEAS and Sunderland Royal Hospital the participating Emergency Department piloting the PU ALERT bracelet. This pilot intervention, introducing a Pressure ulcer Alert Bracelet, was then carried out over a three month period from October to December 2017.

Emergency Department (ED) staff and the Tissue Viability Team at City Hospitals Sunderland Foundation Trust supported the pilot. Information was provided to ED staff using posters and the NEAS IPC manager visited the participating emergency department, and formally discussed the project with staff. A short film was made to demonstrate ambulance and ED staff using the ALERT bracelet for the PROACT project https://www.youtube.com/embed/yNSz4mlU4hM?rel=0.

112 NEAS crew were trained by cascade training facilitated by the CCM's from the three local geographical cluster areas involved and the IPC Manager assisted by a paramedic facilitated training onsite at the ED.

The PURA baseline questions gave a choice of three risk factors, which are further subdivided (see Table 2)

Table 2: North East Ambulance Service Pressure Ulcer Risk Assessment (PURA) Baseline Questions

1	**Has the patient a pressure ulcer?** Is there evidence of pressure damage / skin breakdown, bruising, blistering or wounds (check under existing medical devices)
2	**Has the patient had a pressure ulcer or bed sore in the past?** If so, where?
3	**Is the patient immobile and been lying for more than 20 minutes?** If so, for approximately how long?

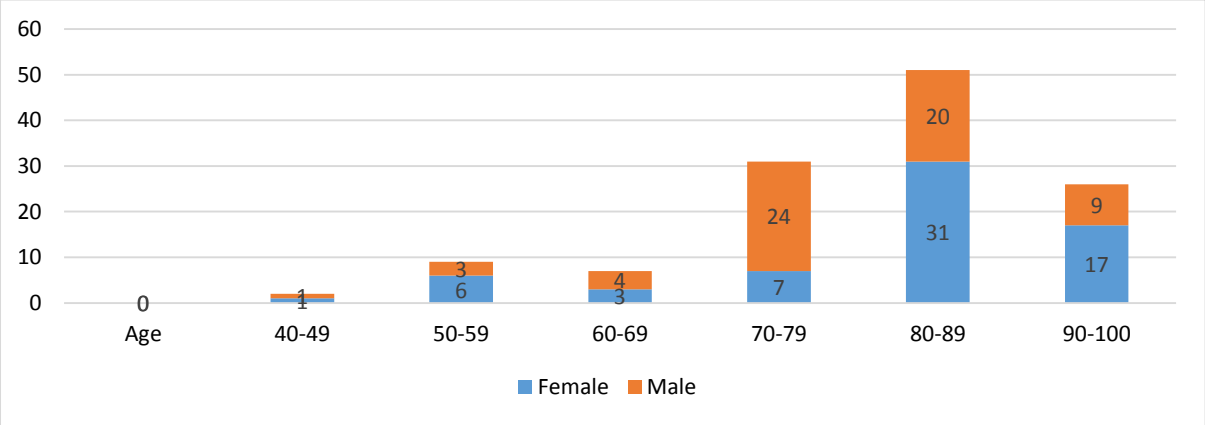
3. Results

Data was collected from 130 patient records, all of whom were identified with a PU ALERT bracelet. The patient information used to analyse the data included the NEAS PURA, EPCR and the hospital in-patient records. Three patient records were excluded from the analysis, as two were admitted to other hospitals in the area, and the third patient's records were excluded as the EPCR was not completed correctly. The records of the remaining 127 patients were included in the data analysis. Sixty five (51%) females and sixty two (49%) male patients were identified at risk by ambulance crew. Ambulance crew identified patients at risk from the age of 23 years to 100 years. The majority of patients (85%) identified at risk with a PU alert bracelet were over the age of 70 years.

3.1 Graphical illustrations of findings

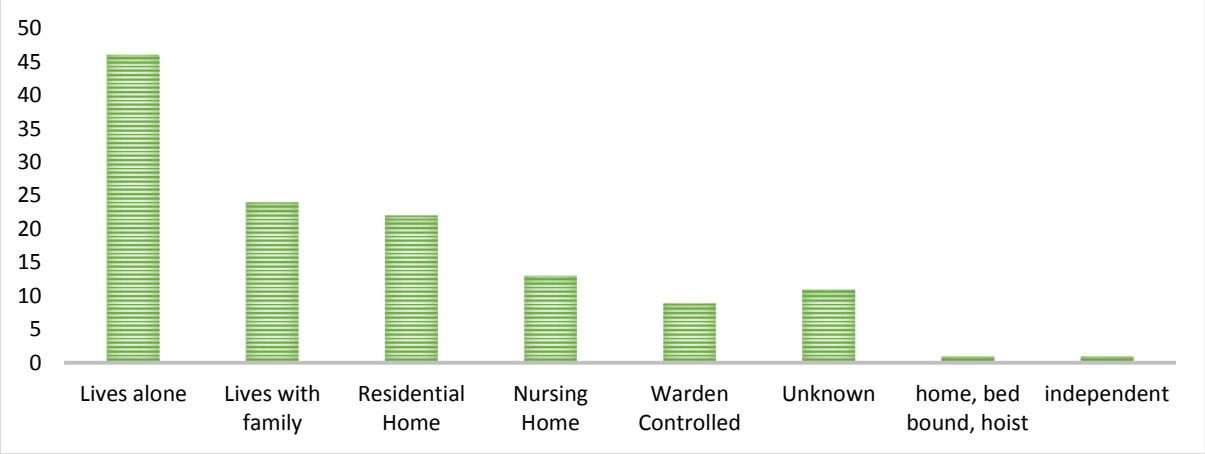
The following tables illustrate the demographics and findings of the study. The gender breakdown appears in Table 2.

Table 2 Breakdown by gender



The living circumstances of each participant is presented in Table 3.

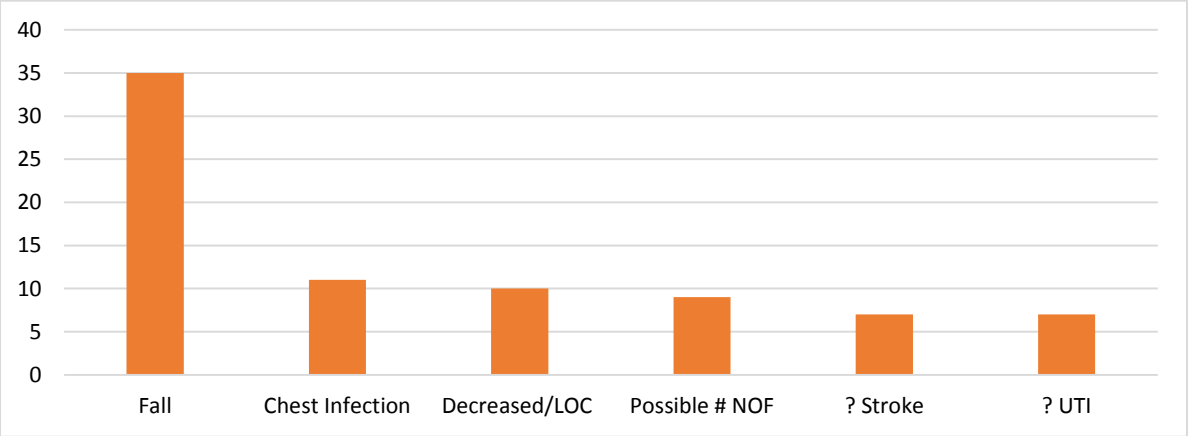
Table 3 Living arrangements of patients



The home circumstances of patients at risk demonstrates the vulnerability of those living alone with only one patient having been recorded as independent. The majority of patients lived alone or in warden controlled accommodation (43%). Patients assessed at risk living in nursing homes or residential homes accounted for 27% of study population.

The reasons documented by ambulance crew for initial call out generated multiple responses; however falls represented the greatest number (see Table 4).

Table 4 Reasons for calling the ambulance service

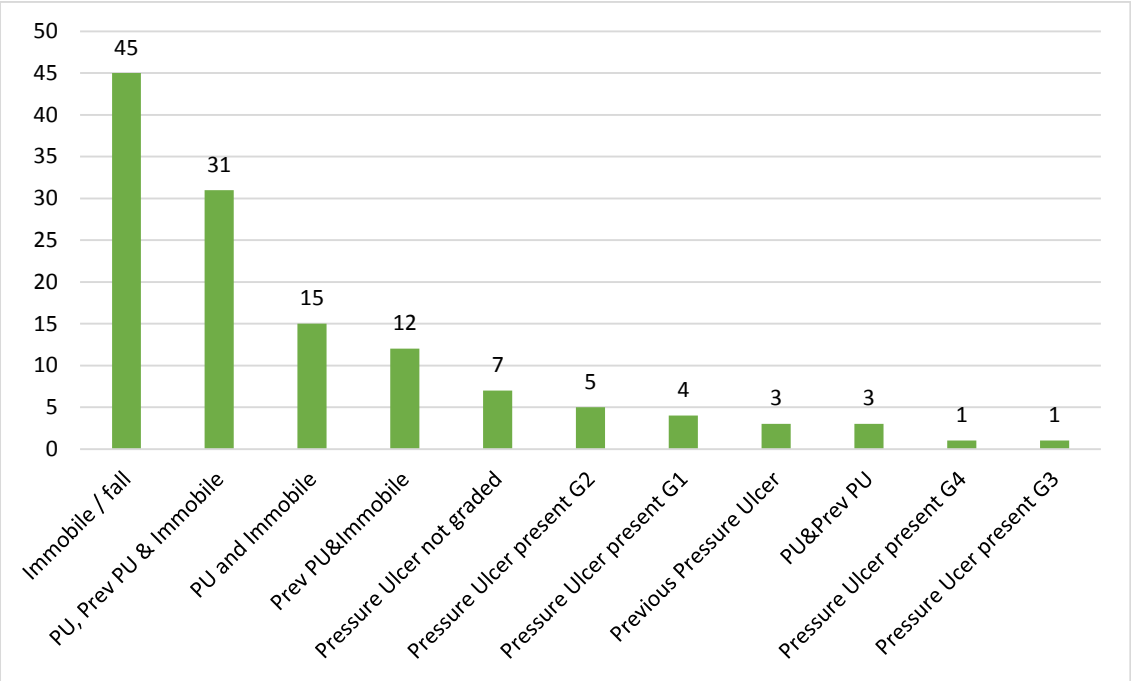


Key

LOC - Loss of Consciousness, #NOF - Fracture Neck of Femur, UTI - Urinary tract Infection, ? Stroke - Suspected stroke,? UTI- Suspected Urinary Tract Infection

The ambulance crew often chose more than one risk factor when assessing patients; this included combinations of all three risk factors. This could be seen as paramedics identifying patients with multifactorial conditions, placing them at increased risk of the development of PUs (see Table 5).

Table 5 Identified predisposing risk factors for PUs



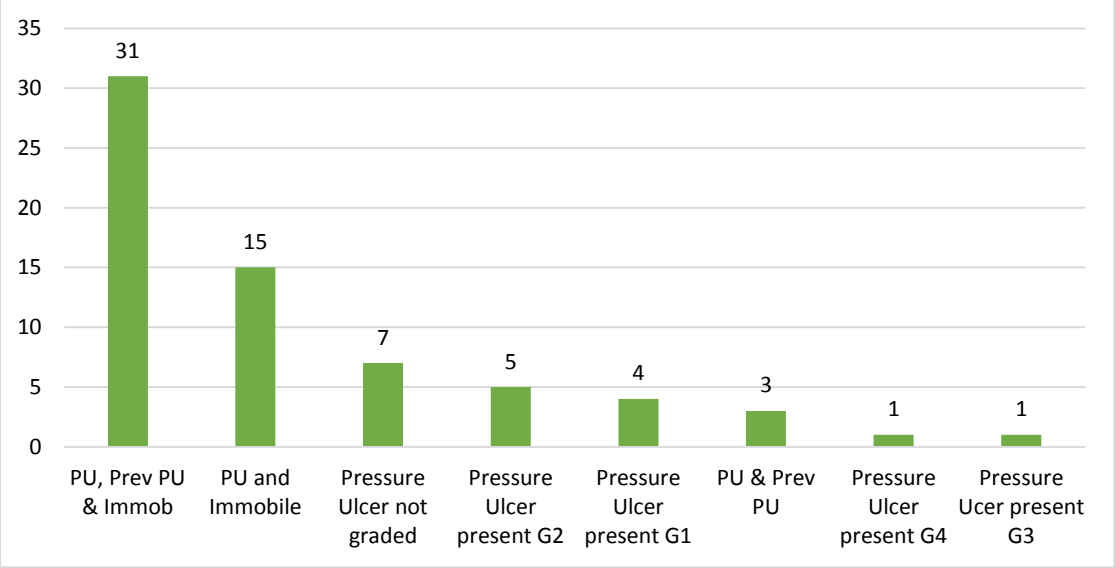
3.2 Findings in the context of the PURA tool

Findings are presented alongside graphical illustrations, of the findings according to each questions in the PURA tool.

3.2.1 PURA question 1: has the patient a pressure ulcer?

Crew reported sixty seven (53%) of patients as having a pressure ulcer and were identified to ED Staff on transfer.

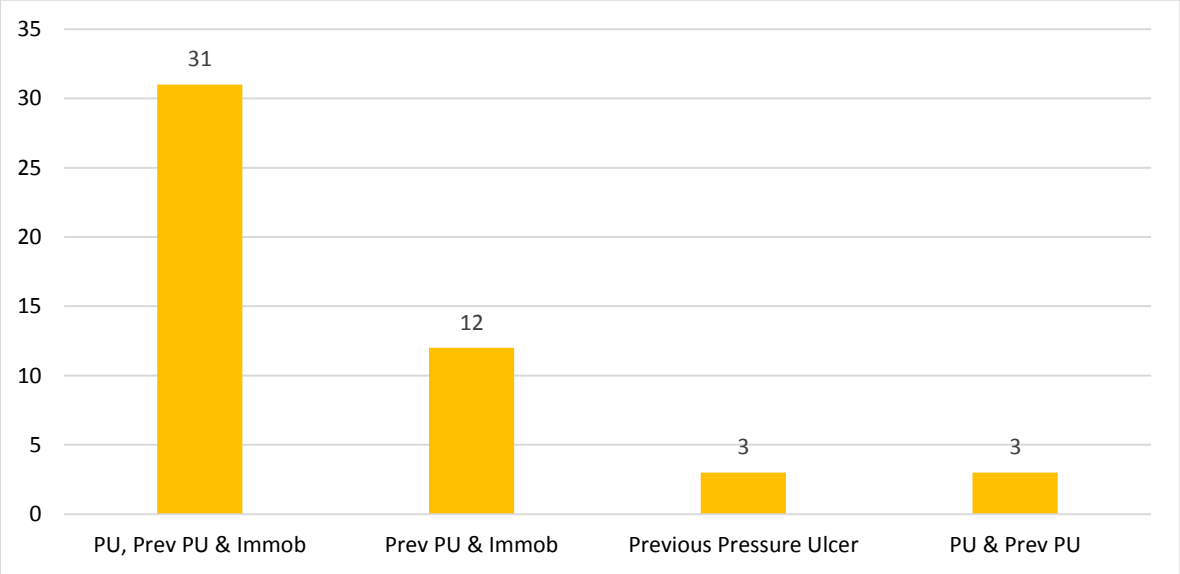
Table 6 Presence of existing PUs



Thirty one (24%) patients were assessed as having all three risk factors of, a pressure ulcer, a history of pressure ulcers and immobility. Fifteen (12%) patients were assessed as having a pressure ulcer and were also immobile. Eighteen (14%) patients were assessed as having a pressure ulcer. NEAS crews documented grading of pressure ulcers from patient care records and history taking from patient carers or district nurse documentation.

3.2.2 PURA question 2: has the patient had a PU or bedsore in the past?

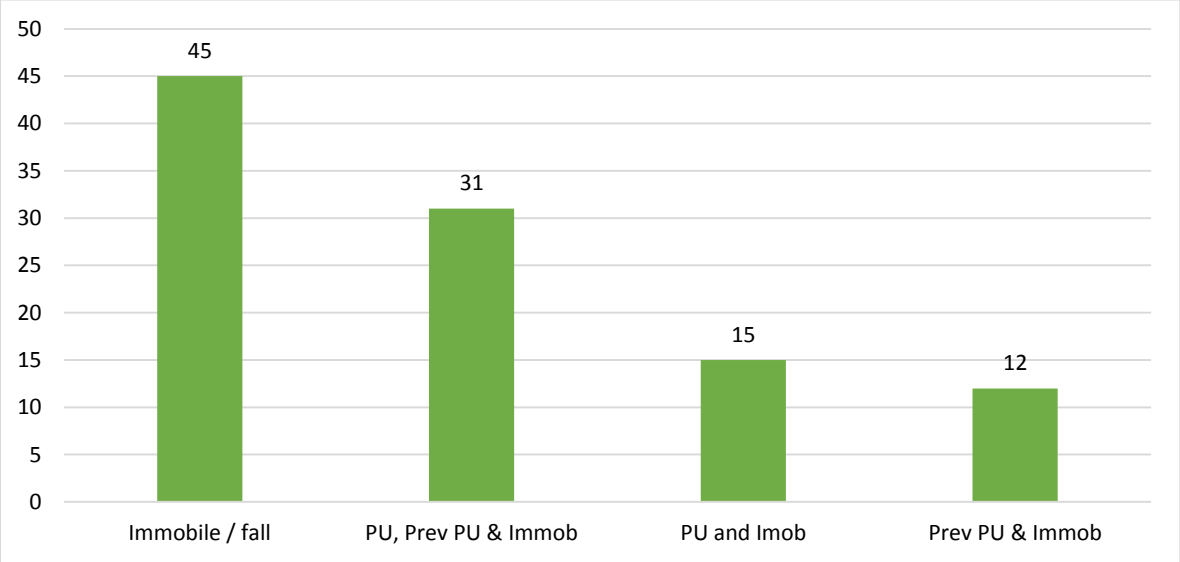
Table 7 Previous PU and other predisposing risk factors



Ambulance crews documented forty nine (38%) of patients having a history of pressure ulcers. Three patients identified as being at risk because they had a history of pressure ulcers, and a further twelve identified as presently immobile with a history of pressure ulcers. This is a total of fifteen patients 12% identified by using an ALERT bracelet to ED staff as having history of previous pressure ulcer highlighting them as being at increased risk.

3.2.3 PURA question 3: is the patient immobile and been lying for more than 20 minutes?

Table 8 Predisposing risk factors

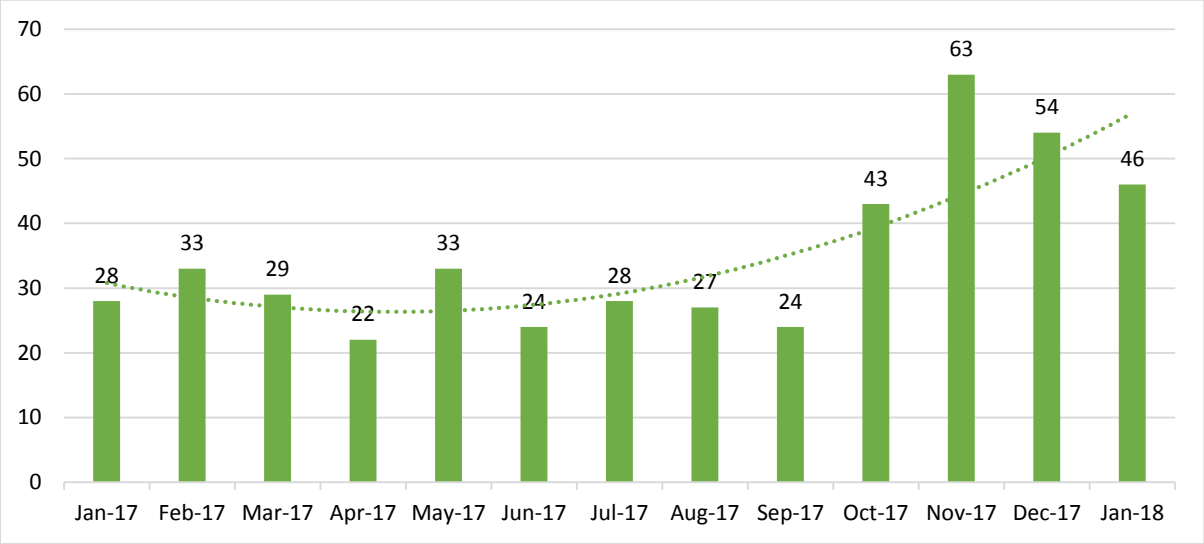


Immobility (where patients had been lying for 20 minutes or over) was the most commonly reported risk factor by paramedic practitioners. A total of 103 (81%) patients were assessed as being immobile or having fallen and been lying for a sustained time period. 45 (35%) patients were identified as being immobile and/ or been lying for 20 minutes or over, including falls patients although this evaluation did not collate the length of time patients had been lying for, however some crew documented, estimated times including overnight.

3.3 EPCR Pressure Ulcer Documentation

A key objective of the pilot was to improve the documentation of pressure ulcers by ambulance staff to document pressure ulcers, using the existing pressure sore function on the EPCR when a patient with a pressure ulcer was identified. Instructions for this were included in the pressure ulcer awareness training booklet crews received. Whilst a rise in the use of the pressure ulcer function reporting on EPCR is clearly demonstrated during the three pilot months (October to December 2017), this might also realistically indicate a natural variation or simply that incidence of pressure ulcerations peaks in the autumn and winter months (Rodrigues et al, 2019). (see Table 9).

Table 9 PU count on ECPR



3.4 Findings from ED records

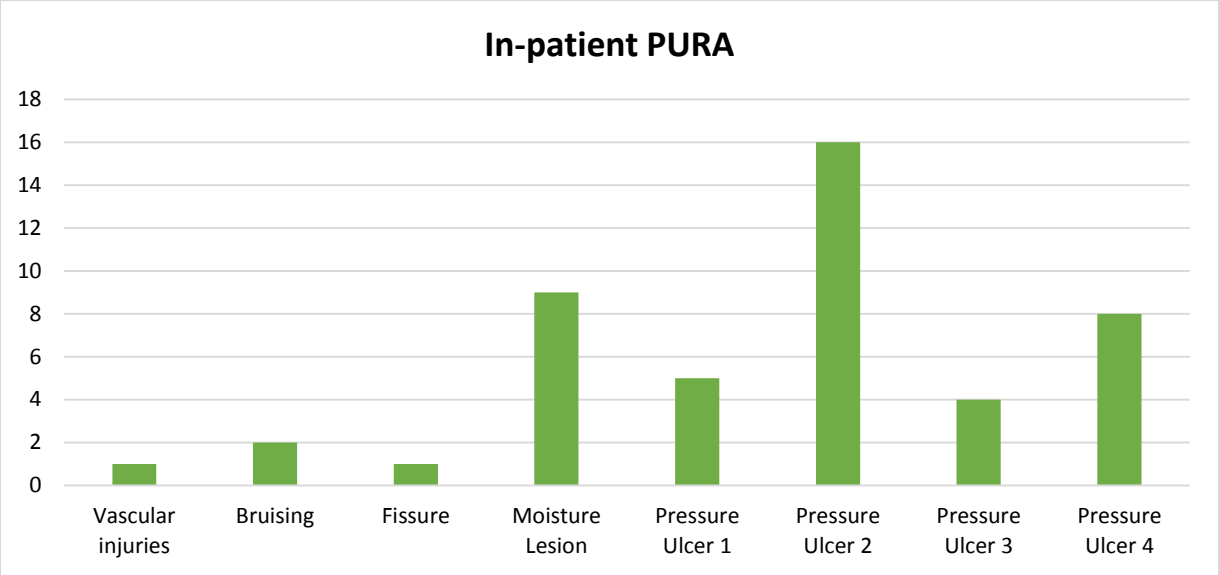
The pilot aimed to educate ambulance crews to identify patients at risk of pressure damage. As a consequence this also ensured that the prompt identification of at risk patients to hospital staff meant that a correspondingly prompt Pressure Ulcer Risk Assessment (PURA) would follow. The need for a prompt pressure ulcer assessment was the message relayed

verbally to ED and IAU nurses and this was reinforced beyond the immediate interaction of personnel via the display of posters detailing the same information.

Of the 127 patients admitted with a PU risk Alert bracelet:

101(80%) patient records documented times when a PURA was completed or not completed and of these 101 patients, 50 (49.5%) had a PURA completed within 6 hours. The average time for completion of a PURA between arrival at the ED was 06:35hours. 26 (10%) patents did not have a PURA completed including 17 (13%) patients who were discharged from hospital within 24 hours of admission. We acknowledge here that a lack of pre-study statistics means that benchmarking was impossible and that in any full consequent study following on from the pilot, that this would provide a meaningful source of comparison.

Table 10 Hospital in-patient PURA



Forty six (36%) patients were assessed during their hospital stay as having tissue damage, including pressure ulcers and moisture lesions. Thirty three (25%) patients were assessed as having a pressure ulcer. Ambulance crews had risk assessed sixty seven (53%) patients with pressure ulcers and whilst this may appear to be over reporting, twenty seven (21%) patients did not have a PURA completed, including seventeen (13%) patients who were discharged on

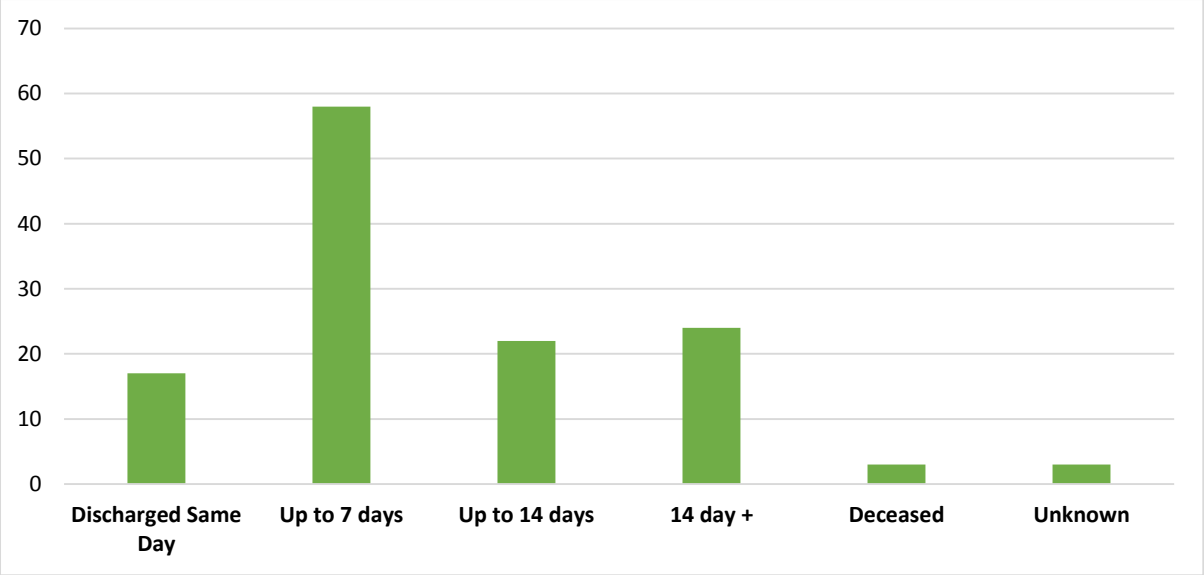
the same day of admission therefore the numbers assessed by both services are not as misaligned.

PU training was introduced as part of NEAS mandatory training for a twelve month period (April 2016 to March 2017); In addition to this, further training was delivered to the crews identified within the pilot area, this did not include training to differentially diagnose the existence of moisture lesions.

Three (2%) patients were assessed as having a hospital acquired pressure ulcer verified by the hospital TVN, these included;

- Patient 1 who had been assessed by ambulance staff as having a grade 1 sacral pressure ulcer documented on the EPCR, the patient's first hospital PURA was completed within 6 hours however this patient went on to develop a grade2 pressure ulcer
- Patient 2 who was assessed by ambulance staff as at risk due to being immobile and haven fallen: this patient had their first hospital PURA within 6hours however this patient went on to develop a grade 2 pressure ulcer.
- Patient 3 who was assessed as at risk due to having a previous pressure ulcer and being immobile by ambulance staff: this patient had their first hospital PURA within 6 hours and went on to develop a grade 2

Table 11 Inpatient time



The cost associated with pressure ulcer care and hospitalisation has been previously identified by PHE (2015). Within the context of this pilot study costs associated with the timings of inpatient stays for patients could also be considered by crews using the ALERT bracelets, which acted as accurate and pragmatic predictors of length of hospital stay.

The pilot initiative could be viewed as successful; the risk assessment was used appropriately by ambulance crew, this was demonstrated when reviewing the clinical records of the patients who were given an alert bracelet to wear. Ambulance crew also significantly increased their documentation of pressure ulcers in the Electronic Patient Clinical Record (EPCR) indicating training was effective. Ambulance crew verbally reported they thought the initiative to place an alert bracelet on at risk patients would be beneficial to alert Emergency Department staff. The acute trust staff evaluation from ED and Integrated Admission Unit (IAU) nurses reported 82% thought the initiative would benefit patients.

4. Discussion

The PU ALERT pilot was initiated from a straightforward idea that the use of identification bracelets could potentially help identify at risk patients to Emergency Department staff. This

resulted in an educational intervention which aimed to equip paramedics in the use of a risk assessment tool to facilitate the identification of patients at risk of compromised tissue viability.

Consistent with extant literature in the field of tissue viability, patient demographics collated from study revealed that the majority of patients were aged over 70 years. There was also evidence that paramedic practitioners had risk assessed patients across a relatively wide age range including patients as young as 23.

From the data collected it was evident that patient falls were the commonest reason for transfer to Emergency Departments, however, overall clinical reasons for call out were diverse. This indicated that ambulance crew were assessing patients for pressure damage on an entirely individual basis and that they were also considering pressure damage for co-morbid patients whose main complaints included such conditions as chest infections and Urinary Tract Infections (UTI's), who may not necessarily have also fallen.

It is notable that this evaluation did not gather information on the exact time that patients had fallen, however it was also noted that ambulance crew frequently documented the approximate time that patients had been lying on hard surfaces, before they had reached them. The increased vulnerability of patients living alone was apparent from this data.

Ambulance crews often indicated more than one risk factor was evident in the patients they assessed. The identification of sixty seven (53%) patients reported as having a pressure ulcer by ambulance crews, was supported by hospital PU assessments. Ambulance staff did not often grade pressure ulcers although grading of PU was included in the training pack, it was articulated that reporting was more important than grading. There was evidence that ambulance crew documented pressure ulcers that had been graded by district nurses.

Documented evidence in electronic patient clinical records could be found in all 127 cases it was appropriate for patients to have an ALERT bracelet.

Acknowledged Limitations to the Pilot Study

In any consequent studies, as previously outlined, the research team would recommend that since this pilot incorporated no information regarding time spent on the floor, by patients, this would be an extremely useful adjunct set of data. As outlined previously in the study, a lack of pre-study statistics means that benchmarking data was also impossible and that in any full consequent study following on from the pilot, that this would provide a meaningful source of comparison.

The evidence that ambulance crews were also identifying the high risk factor of patients having had a pressure ulcer in the past was supportive that training of the risk factors was potentially successful. However what also ought to be acknowledged was the lack of regard in the pilot study for the potential numbers of missed patients (i.e. false-negatives). The research approach also failed to account for those patients who were not filled with the PU bracelets, hence we acknowledge that no indication of non-compliance was possible within this pilot study. Again this is an area for potential address in any full consequent study undertaken as a result of this initial pilot. We also acknowledge these as subjective verbal reports from the ambulance crews, rather than structured interviews, since pragmatically the project offered no scope for this. Their positionality as participants with an embedded stance in paramedic practice is something that we fully acknowledge in relation to the potential for epistemological bias.

This is information that ED staff could use to help prevent further pressure damage occurring. The intervention of using a PU risk assessment and using an ALERT bracelet is

therefore useful, how effective it is in minimising risk of patients developing further tissue damage, relies on hospital staff acting upon information ambulance crew can provide.

5. Conclusions

The findings of the study reveal the identification of NEAS to have a formally recognised and implemented Pressure Ulcer care strategy. As part of this process, Pressure ulcer awareness training will continue on a mandatory training basis and will be extended to incorporate further information on pressure relieving interventions that can minimise the risk of the development of pressure ulceration for vulnerable patients in their care. Monitoring of those identified as being at risk was also an aspect of care provision highlighted for extension. It can be concluded that Pressure ulcer ALERT Bracelets for patients being admitted to hospitals were beneficial in facilitating ED nurses to pragmatically and quickly identify patients at risk from pressure damage including alerting them of patients having a history of pressure ulcers. The pilot intervention also successfully increased collaborative working with service providers, including communication between ambulance staff and ED staff. Future work in this context will seek to undertake further collaborative work with Academic Health Science Networks and regional Pressure Ulcer collaborative partnerships with front line staff from both NEAS and EDs included in projects. As a longer term plan it may also be possible to develop the scheme so that there is more effective collaboration between NEAS staff and primary care teams who may also be intervene and support the prevention of pressure ulceration in vulnerable patients. The study also highlighted the need for the potential integration of pressure reduction equipment to be integrated into use by paramedics in practice, thus minimising risk and potentially improving outcomes. Most importantly this initial small scale pilot study highlighted the potential transferability of this scheme to other ambulance services in the prevention of pressure ulcers, over a much wider geographical area. This raises important questions about how the education and training of the future

paramedic workforce ought to ensure their knowledge and practical experience in the prevention of pressure ulceration in practice. As authors we warmly welcome academic and pedagogical debate about how this might best be achieved in relation to our ongoing work in the context of health services research and health professions pedagogy.

Ethical Approval

Formal ethical approval for this study was granted by the University of Sunderland institutional ethics committee. All data collection was undertaken with the informed consent of participating staff and patients.

Acknowledgements

The research team would like to acknowledge the Tissue Viability Nursing Team at City Hospitals Sunderland NHS Foundation Trust for their sacrificial commitment to ensuring successful completion of this project, with patients for whom emergency paramedic services were required. We are also sincerely grateful to patients who consented to taking part in the study.

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General Author Commentary

We are sincerely grateful to the reviewers of our paper- their insightful comments have enabled us to undertake these corrections in a straightforward manner, which we are pleased to re-submit in the latest version of our manuscript. All of our updates have been highlighted across the manuscript in yellow, so that these can easily be tracked.

Reviewer #1

Comments:

Reviewer #1: Thanks for the chance to review this work. I think it is an excellent initiative, exactly the sort of thing that the profession needs to be doing more of, and I would like to see it accepted for publication but feel a few amendments would improve it further.

a) Section 3.3 EPCR documentation - be careful in stating "an upward trend was clearly demonstrated". This is only a three month sample and whilst it is likely that the training contributed positively, it might be simply natural variation or that pressure ulcers 'spike' in the autumn/winter months.

Author Response a): Thank you for pointing this out to us, we agree with you absolutely and have amended the manuscript to reflect what could potentially be a natural variation in the incidence and hence rise of the pressure ulcer function reporting on EPCR. We have also added a citation to substantiate this claim from research undertaken by Rodrigues et al, 2019 and have incorporated this into our reference list (Rodrigues, F. S., de Luca, F. C., da Cunha, A. R., & Fortaleza, C. M. C. B. (2019). Season, weather and predictors of healthcare-associated Gram-negative bloodstream infections: a case-only study. *Journal of Hospital Infection*, *101*(2), 134-141.)

b) In the section beginning "Of the 127 patients admitted with a PU risk alert bracelet ……" you mention the various measurements surrounding PURA completion. Do you have any pre-study statistics to put these in to context as there is nothing to compare them to? Are these good? Bad?

Author Response b): *Thank you, we acknowledge here (and have now added into the manuscript) that a lack of pre-study statistics means that benchmarking was impossible and that in any full consequent study following on from the pilot, that this would provide a meaningful source of comparison.*

c) The sentence beginning "The cost associated with pressure ulcer care and hospitalisation ……." - the full sentence doesn't make sense. Please rewrite.

Author Response c): *Thank you so much for pointing this out, this sentence and the one following it have now been rewritten*

d) it's a shame that no information is presented regarding time spent on the floor, as that would also be an interesting side point. Do you have any data? Even if could be part of an appendix?

Author Response d): Thank you, we agree with this observation, although for the purposes of this study, this is not something that we recorded as part of the pilot study. We have now added a comment to this effect in the discussion, alongside our previous comment of being able to benchmark data, so that this might also be added to any full consequent study using the PU bracelets.

Reviewer #2

Comments:
Reviewer #2: Thank you for your submission. This was a really interesting pilot, with a great potential for other organisations and individuals to learn from. I would very much like to see this this work published for others to review, and my comments below are hopefully constructive. I think by increasing the simplicity in places and making the scientific rigour a little more robust, this could be an excellent article.

a) You conclude that paramedics effectively identified potential risk factors to PU development, indicating a need for immediate intervention. I agree that your study indicates that they have largely completed appropriate risk assessment within the pilot, but to state that they have effectively identified potential risk factors, I would suggest that you would have had to have looked at the potential numbers of missed patients (i.e. false-negatives). What about patients that did not get the wrist alarm bands? Did you review all falls to check for compliance or just examine those that were given the bands?

Author Response a): Thank you, we can acknowledge the points raised here absolutely and have added a section into our discussion to highlight and reflect this as an area for address in any consequent study undertaken as a result of the pilot.

b) Materials and methods section. In my opinion, it is important to use the simplest, concise and clear language available without compromising technical accuracy. This will ensure that your work is read and understand by as many people as possible. In this section you appear to include an academic passage on the Donabedian model. I am not sure this contributes anything to the publication value of the work. I would have rather seen a more pragmatic logistical explanation of how you carried out the study. Is it necessary to include most of the detail on page 4?

Author Response b): Thank you, we considered this critique and agree that there was overemphasis on the theoretical underpinning of the work. We have removed this and significantly streamlined the materials and methods section.

c) EPCR Pressure Ulcer Documentation: I am not sure that it is accurate to state that the upward trend of documentation completion demonstrates success. Is it not possible that the increased use was linked with winter where falls or other acute events may increase the frequency of the types of patients most likely to receive the wristbands? Consideration of this as a minimum would show more critical analysis.

Author Response c): Thank you for pointing this out to us, we agree with this comment absolutely (which was also pointed out by Reviewer #1) and have amended the manuscript to reflect what could potentially be a natural variation in the incidence and hence rise of the pressure ulcer function reporting on EPCR. We have also added a citation to substantiate this claim from research undertaken by Rodrigues et al, 2019 and have incorporated this into our reference list (Rodrigues, F. S., de Luca, F. C., da Cunha, A. R., & Fortaleza, C. M. C. B. (2019). Season, weather and predictors of healthcare-associated Gram-negative bloodstream infections: a case-only study. *Journal of Hospital Infection*, *101*(2), 134-141.)

d) Also, brief mention of any ethical considerations is important - did the patient's consent to their records being used in this way?

Author Response d): Thank you we had omitted to do this and have now incorporated a short section prior to our acknowledgements and then also within the acknowledgements thanking patients for consenting to take part in the study.

At times there is a lack of methodological rigor. You state on page 17 that ambulance crews verbally reported

opinions on perceived benefit. How did you collect these views? Through structured interviews or through anecdotal event? What about bias in this regard?

Author Response e): Thank you, we do acknowledge these as subjective standpoints in the amended manuscript. Their positionality is something that we have also acknowledged in relation to the potential for epistemological bias in the discussion section. We have provided an additional heading of 'Acknowledged Limitations to the Pilot Study' to incorporate this fully.