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Implementation of a 'care bundle' improves the management of patients admitted to hospital with decompensated cirrhosis

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SUMMARY

Background
Since 1970, there has been a 400% increase in liver-related deaths due to the increasing prevalence of chronic liver disease in the United Kingdom (UK). The 2013 UK National Confidential Enquiry into Patient Outcome and Death report found that only 47% of patients who died from alcohol-related liver disease received 'good care' during their hospital stay.

Aim
To develop a 'care bundle' for patients with decompensated cirrhosis, aiming to ensure that evidence-based treatments are delivered within the first 24 h of hospital admission.

Methods
This work gives practical advice about how to implement the bundle and examines its effects on patient care at three National Health Service Hospital Trusts in the UK by collecting data on patient care before and after introduction of the bundle.

Results
Data were collected on 228 patients across three centres (59% male, median age 53 years). Alcohol-related liver disease was the aetiology of chronic liver disease in 85% of patients. The overall mortality rate during hospital admission was 15%. The audits demonstrated improvements in patient care for patients with a completed care bundle who were significantly more likely to have a diagnostic ascitic performed within the first 24 h ($P = 0.020$), have an accurate alcohol history documented ($P < 0.0001$) and be given antibiotics as prophylaxis against infection following a variceal haemorrhage ($P = 0.0096$). In Newcastle, the bundle completion rate increased from 25% to 90% during the review periods.

Conclusions
The introduction of a care bundle was associated with increased rates of diagnostic paracentesis and antibiotic prophylaxis with variceal haemorrhage in patients with decompensated cirrhosis.

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INTRODUCTION

In the UK, there has been a dramatic increase in the prevalence of chronic liver disease over the last few decades, which has resulted in a substantial increase (400% since 1970) in liver-related deaths.[1, 2] There are also significant issues with variability in management of decompensated liver disease. The Lancet commission 'Addressing liver disease in the UK' in 2014,[3] described the 'postcode lottery of specialist hepatology services and centres' with large variation in in-hospital mortality rates for cirrhosis and liver failure across the country. Data from Dr Foster, a healthcare variation and benchmarking analyst, showed that for nonelective liver admissions between 2003 and 2013 mortality rates in nonspecialist acute hospital Trusts varied between approximately 15–35%.[3] The All Party Parliamentary Hepatology Group (APPHG) raised 'grave concerns about patchy service provision across the country'.[4] Liver disease is also having an increased impact on younger people. Worryingly, data from the Global Burden of Diseases, Injuries and Risk Factors Study 2010 showed that for people aged 20–54 years cirrhosis has risen from the 8th leading cause of years of life lost (YLL) in 1990 to the 3rd leading cause by 2010.[5]

Decompensation of cirrhosis occurs when there is an acute deterioration in liver function in a patient with cirrhosis.[6] Common presenting features include jaundice, coagulopathy, ascites, hepatic encephalopathy, acute kidney injury (AKI) and gastrointestinal (GI) bleeding.[7] Patients with decompensated liver cirrhosis and organ failure are considered to have acute on chronic liver failure (ACLF), which carries an approximately 30% 28-day mortality rate.[8] Following the in-hospital diagnosis of alcohol-related cirrhosis, patients have a 30% 1-year and 60% 5-year mortality rate, respectively.[9] In 2013, 'Measuring the Units', a UK National Confidential Enquiry into Patient Outcome and Death (NCEPOD) report raised concerns about suboptimal care of patients in hospital with complications of cirrhosis due to alcohol-related liver disease (ARLD).[10] This report found that only 47% of patients who died from alcohol-related liver disease received 'good care' during their hospital stay, and avoidable deaths were identified. Similar findings were found in a region-wide audit from the North East of England.[11]

The authors of the NCEPOD report recommended that a 'toolkit' for the acute management of patients admitted with decompensated liver disease be developed and made widely available.[10] As a result, we developed a 'care bundle' for patients admitted with decompensated cirrhosis to ensure that effective evidence-based treatments are delivered within the first 24 h of admission to hospital.[6, 12] This care bundle provides a simple checklist of key investigations, and clear guidance on the management of cirrhosis-related complications, such as spontaneous bacterial peritonitis (SBP), variceal bleeding and acute kidney injury. The bundle is designed to help junior doctors and nonspecialists provide effective care for these patients, who frequently have complex medical needs, in the first 24 h, when specialist advice may not be available. Our aim was to assess the effect of the implementation of the care bundle on the care of patients admitted with decompensated cirrhosis at three National Health Service (NHS) Hospital Trusts in the UK.

MATERIALS AND METHODS

Development of the care bundle

SMc led the development of the care bundle on behalf of the British Society of Gastroenterology (BSG) and British Association for the Study of the Liver (BASL) between November 2013 and March 2014. The care bundle was developed primarily to address the first 24 h of hospital admission and is recommended to commence within 6 h of hospital admission. It comprises a simple checklist to ensure important initial investigations are conducted. In addition, the bundle provides specific 'step by step' guidance on the management of infections, spontaneous bacterial peritonitis, gastrointestinal bleeding and acute kidney injury, so that evidence-based treatments are delivered in a timely fashion, when specialist input may not be available. The evidence base for all the recommendations in the bundle was reviewed by McPherson *et al.*[6] The bundle was deliberately kept simple so that it can be completed quickly. It can be filed in the patient's notes and can also serve as an audit tool to assess patient management. The care bundle is freely available at (http://www.bsg.org.uk/care-bundles/care-bundles-general/decompensated-cirrhosis-care-bundle-first-24-hours.html). It has now been endorsed by the BSG and BASL and is recommended for use in all hospitals in the UK.[3, 12, 13]

Implementation of the care bundle in Newcastle

The care bundle was introduced in Newcastle upon Tyne Hospitals NHS Foundation Trust (NUTH) in March 2014. Development and implementation of the care bundle was adopted as one of the Trust's major Commissioning by Quality and Innovation (CQUIN) improvement projects for 2014/15. It was divided into

four areas: development of the bundle and implementation in pilot areas, review of the pilot with an action plan to roll it out across the Trust, 70% target for bundle completion and re-audit with an 85% completion target. The total value of this CQUIN for completion of all milestones was £850 000. Full details of the CQUIN targets for the care bundle implementation are shown in Table S1. The hospital clinical governance department and the hospital medical records committee approved its introduction.

The majority of patients with decompensated chronic liver disease are admitted via the medical admissions suite at the Royal Victoria Infirmary (RVI), where acute medicine physicians initially manage them for the first 24 h. The medical admissions suite was therefore the main focus for the implementation of the care bundle. The care bundle was published on the hospital intranet and all hospital clinicians were informed of its introduction via email from the lead clinician. Targeted education sessions were delivered at the Trust clinical governance meeting, medical specialist registrar teaching, medical admissions suite staff teaching sessions and Foundation and Core Medical trainees teaching. Since the initial education sessions, regular updates on progress have been delivered to medical trainees and consultants.

Review of impact of the implementation of the care bundle in Newcastle

A retrospective review of the management of consecutive patients admitted with decompensated cirrhosis to the medical admissions suite at the RVI was conducted at baseline [pre-care bundle introduction; September 2013 to February 2014 (6 months)] and following the introduction of the care bundle over two time periods [May to July 2014 (3 months) and November 2014 to June 2015 (8 months)] with on-going targeted education sessions throughout this period. Discharge summaries for patients admitted during this time period were reviewed to identify patients admitted with decompensated cirrhosis. Patients were included if they had known cirrhosis or suspected cirrhosis and were admitted with jaundice, hepatic encephalopathy, ascites, sepsis or variceal bleeding. A data collection tool (Data S1) was used that included all parameters addressed in the 'care bundle' (initial investigations, management of complications such as spontaneous bacterial peritonitis, acute kidney injury, length of stay, mortality). Data were collected from review of the medical case-notes and electronic records for each patient. As the care bundle is primarily aimed at providing advice for the nonspecialist, patients admitted directly to the tertiary liver unit were not included in the audits as they are reviewed by a hepatology registrar on admission.

Implementation and review of the care bundle in two other UK Hospitals

Royal Cornwall Hospitals NHS Trust. The care bundle was implemented in the Royal Cornwall Hospitals (RCH) NHS Trust, a large District General Hospital (DGH), in May 2015. Prior to its implementation teaching sessions were delivered to all emergency and acute medicine clinicians. The care bundle was made available on the hospital software 'MAXIMS'. Clinicians also received regular reminder emails advising of them to use the care bundle for all patients admitted with decompensated liver disease. A retrospective baseline (pre-bundle) review was conducted of consecutive admissions of patients admitted with decompensated cirrhosis between January and April 2015 (4 months). A second review was conducted following the introduction of the bundle between September and December 2015 (4 months). The same methodology was used as in Newcastle.

City Hospitals Sunderland NHS Foundation Trust. The care bundle was introduced in City Hospitals Sunderland (CHS) NHS Foundation Trust, another large District General Hospital, in September 2014. Introduction of the bundle was also adopted as a local Commissioning by Quality and Innovation target. All acute medical staff received training on the bundle. Since the initial introduction of the care bundle, an electronic version has been developed that can be completed directly on their hospital computer system. This will help generate long-term data collection on the use of the care bundle. Data were collected over a 4-month period (September to December 2013), prior to the introduction of the bundle, to collect a baseline assessment of the management of patients with decompensated cirrhosis. Following the introduction of the care bundle, data were collected for a 3-month period (February to April 2015). All the data were collected using the same methodology as in Newcastle.

Analysis methods

All statistical analyses were performed using SPSS software version 22.0 (SPSS Inc, Chicago, IL, USA). Variables were summarised as median and range. Fisher's exact test was used to determine the distribution of categorical

variables between groups and Mann–Whitney *U*-test for continuous variables.

RESULTS

Description of whole cohort

In total, data were collected on 228 patients across the three centres. Of this whole cohort, 59% were male with a median age of 53 years (range 31–87). Alcohol-related liver disease (ARLD) was the most common aetiology of liver disease, accounting for 85% of patients and 89% were already known to have chronic liver disease prior to admission. The median model for end-stage liver disease (MELD) and Child–Pugh scores were 18 (range 6–45) and 9 (range 5–14), respectively. The overall mortality rate during hospital admission was 15% with a median length of stay of 11 days (range 1–139). Table 1 shows the demographics of the patients at each centre. The aetiology of chronic liver disease was alcohol-related liver disease in over 80% of patients in all centres (Figure 1). The commonest reason for hospital admission was ascites (34%), with hepatic encephalopathy and suspicion of upper gastrointestinal bleeding each accounting for a further 20% of admissions (Table 2).

Bundle completion rates in Newcastle

Following introduction of the care bundle in Newcastle in March 2014 completion rates of the bundle were low at the first review period at only 25%. However, over time, with repeated education sessions and raising awareness of the bundle, there has been a substantial increase in rates of bundle completion to 90% in the third review period (Figure 2).

Impact of the introduction of the care bundle in Newcastle

A comparison of the demographic data and clinical management for patients with decompensated cirrhosis admitted prior to the introduction of the bundle and post implementation of the bundle is shown in Table 3. Overall, patients who had a care bundle completed were more likely to have the appropriate investigations and management conducted than patients admitted prior to the introduction of the care bundle and those who did not have one completed. Post-bundle implementation, the majority of investigations and management were conducted appropriately. The most striking improvement

Table 1 | Demographic information for patients from each centre

	Newcastle	Cornwall	Sunderland
Male gender, *n* (%)	61 (53)	16 (76)*	33 (62)*
Age, median (range)	54 (31–87)	52 (32–78)	53 (31–85)
MELD, median (range)	17 (6–45)	20 (7–40)	16 (6–30)

NA, not available.

* Gender data not available for all patients.

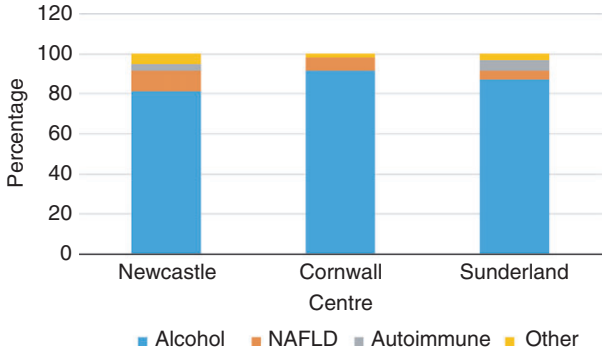

Figure 1 | Cause of liver disease according to centre. NAFLD, nonalcoholic fatty liver disease.

Table 2 | Primary reason for admission to hospital

Clinical reason for hospital admission	Percentage of cohort
Ascites	34
Hepatic encephalopathy	20
Upper gastrointestinal bleeding	20
Jaundice	15
Sepsis	5
Other	6

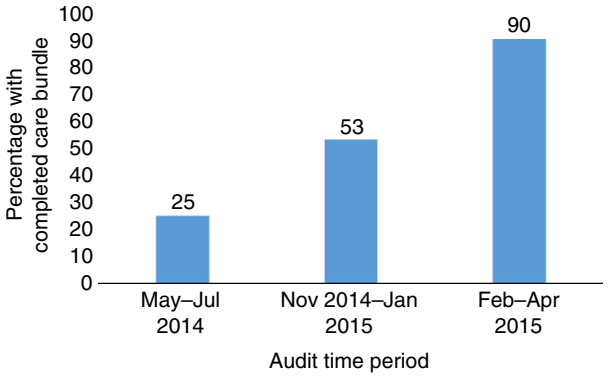

Figure 2 | Improvement in completion rates for 'the care bundle' following its implementation over successive audit periods.

Table 3 | Pre- and post-bundle audit results from Newcastle

		Post-care bundle (n = 72)	
	Pre-care bundle (n = 42)	Care bundle not completed (n = 32)	Care bundle completed (n = 40)
Median MELD	17	14.5	18.5
Diagnostic tap ≤24 h if ascites (%)	17/28 (61)	9/16 (56)	19/22 (86)
Antibiotics prescribed if SBP (%)	2/2 (100)	1/1 (100)	1/1 (100)
Albumin prescribed if SBP (%)	1/2 (50)	1/1 (100)	1/1 (100)
Alcohol consumption documented (%)	29/42 (69)	24/32 (75)	34/40 (85)
Pabrinex prescribed if appropriate (%)	25/29 (86)	19/21 (90)	22/24 (92)
CIWA prescribed if appropriate (%)	24/29 (83)	17/21 (81)	22/24 (92)
AKI on admission (%)	9/42 (21)	5/32 (16)	6/40 (15)
Diuretics/nephrotoxins stopped if AKI (%)	7/9 (78)	5/5 (100)	5/6 (83)
Appropriate fluids given if AKI (%)	8/9 (89)	5/5 (100)	6/6 (100)
Sodium <125 on admission (%)	3/42 (7)	1/32 (3)	2/40 (5)
Diuretics stopped and fluid balance if Na <125 (%)	2/3 (67)	1/1 (100)	2/2 (100)
Suspected variceal bleed (%)	2/42 (5)	6/32 (19)	4/40 (10)
Terlipressin given (%)	2/2 (100)	4/6 (67)	4/4 (100)
Antibiotics given (%)	1/2 (50)	4/6 (67)	4/4 (100)
OGD within 24 h (%)	1/2 (50)	4/6 (67)	1/2† (50)
Survived admission (%)	37/42 (88)	29/32 (91)	34/40 (85)
Median length of stay, days (range)	11 (2–31)	11.5 (2–100)	8 (2–64)
Median length of stay, days (range) – excluding patients who died during admission	11 (2–31)	13 (2–100)	8 (2–64)

MELD, model for end-stage liver disease; SBP, spontaneous bacterial peritonitis; CIWA, clinical institute withdrawal assessment for alcohol; AKI, acute kidney injury; Na, sodium; OGD, oesophago-gastro-duodenoscopy.

† 2 decided OGD not indicated, 1 at 28 h.

in patient care was the rate of diagnostic ascitic tap within 24 h of admission to exclude spontaneous bacterial peritonitis, which improved from 61% to 86%. There were also signs of improvement in the documentation of alcohol excess, management of spontaneous bacterial peritonitis and variceal bleeding.

Interestingly, data from Newcastle also showed that overall, patients who had a care bundle completed had a trend towards shorter median hospital stay [8 (2–64) days] than prior to introduction of the care bundle [11 (2–31) days] and post-bundle implementation when a bundle was not completed [13 (2–100) days] [P = 0.4413].

Successful implementation of the care bundle in two district general hospitals

Following the successful implementation of the bundle in Newcastle and demonstrating improved patient care, we aimed to establish if implementation of the care bundle could have benefits more widely in other hospitals. The same care bundle was implemented at the Royal Cornwall Hospital and City Hospitals Sunderland. A comparison of the demographic data and clinical management for patients with decompensated cirrhosis admitted to these hospitals prior to the introduction of the bundle and post implementation of the bundle are shown in Table 4. Overall, there were marked improvements in aspects of patient management post-introduction of the care bundle, most notably in patients who had a care bundle completed. Complete data for each individual centre are available in Tables S2 and S3.

Improved patient care following bundle implementation across whole cohort

A comparison of data from all three hospitals combined is shown in Table 5. When data for all three hospitals were combined, the most notable improvements in patient care were seen for patients with a completed care bundle who were significantly more likely to have a diagnostic ascitic performed within the first 24 h (P = 0.020), have an accurate alcohol history documented (P < 0.0001) and be given antibiotics as prophylaxis against infection following a variceal haemorrhage (P = 0.0096) (Figure 3).

Table 4 | Pre- and post-bundle audit data for Cornwall and Sunderland combined

	Pre-care bundle (n = 50)	Post-care bundle (n = 64)	
		Care bundle not completed (n = 24)	Bundle completed (n = 40)
Median MELD	22 (6–40)	11 (9–30)*	18.5 (9–30)
Diagnostic tap ≤24 h if ascites (%)	13/21 (62)	6/7 (86)	19/23 (83)
Antibiotics prescribed if SBP (%)	3/3 (100)	0/0 (100)	2/2 (100)
Albumin prescribed if SBP (%)	3/3 (100)	0/0 (100)	1/2 (50)
Alcohol consumption documented (%)	28/50 (56)	23/24 (96)	40/40 (100)
Pabrinex prescribed if appropriate (%)	32/36 (89)	19/20 (95)	39/40 (98)
CIWA prescribed if appropriate (%)	34/36 (94)	19/20 (95)	39/40 (98)
AKI on admission (%)	11/50 (22)	6/24 (25)	7/40 (18)
Diuretics/nephrotoxins stopped if AKI (%)	11/11 (100)	4/4 (100)	5/5 (100)
Appropriate fluids given if AKI (%)	11/11 (100)	6/6 (100)	7/7 (100)
Sodium <125 on admission (%)	7/50 (14)	6/24 (25)	7/40 (18)
Diuretics stopped and fluid balance if Na <125 (%)	5/6 (83)	5/6 (83)	7/7 (100)
Suspected variceal bleed (%)	11/50 (22)	6/24 (25)	10/40 (25)
Terlipressin given (%)	9/11 (82)	4/6 (67)	10/10 (100)
Antibiotics given (%)	3/6 (50)‡	4/6 (67)	10/10 (100)
OGD within 24 h (%)	9/11 (82)	5/6 (83)	10/10 (100)
Survived admission (%)	40/50 (80)	17/20 (85)	31/40 (80)
Median length of stay, days (range)	11 (1–139)	11 (1–139)	10 (1–62)
Median length of stay, days (range) – excluding patients who died during admission	10.5 (1–139)	10.5 (1–139)	10 (1–60)

MELD, model for end-stage liver disease; SBP, spontaneous bacterial peritonitis; CIWA, clinical institute withdrawal assessment for alcohol; AKI, acute kidney injury; Na, sodium; OGD, oesophago-gastro-duodenoscopy.

* MELD data not available on all patients.

‡ Antibiotic data not available for all patients.

CONCLUSIONS

There is an increasing body of data to show that the management of patients with decompensated cirrhosis in the UK suffers from significant variability in quality across the country. The recent National Confidential Enquiry into Patient Outcome and Death (NCEPOD) report on alcohol-related liver disease highlighted that the management of some patients with decompensated cirrhosis in the UK was suboptimal.[10] As a result, we developed a 'care bundle' for patients admitted with decompensated cirrhosis to help ensure the appropriate initial investigations and interventions are conducted at an early stage when specialist advice may not be available.[12] The aim of this study was to assess the impact of introduction of this care bundle on patient care at three UK NHS hospitals. Overall, we found that the introduction of a care bundle was associated with a clear improvement in the management of patients with decompensated cirrhosis. In particular, patients who had a care bundle completed were more likely to have accurate documentation of alcohol consumption and have a diagnostic ascitic tap to assess for spontaneous bacterial peritonitis. In addition, there were improvements in the management of spontaneous bacterial peritonitis and variceal bleeding. Importantly, we have demonstrated that the care bundle can be implemented, and lead to significant improvements in patient care, at three different hospitals across the UK, including a tertiary referral centre and two district general hospitals. This is an important example of introducing evidence-based practice into a 'real world' setting that has resulted in an improvement in clinical practice with a reduction in the variability observed. This suggests that the care bundle could have wider applicability and help improve the care of patients with decompensated liver disease admitted to other hospitals in the UK and overseas.

Our experience of introducing the bundle in these hospitals indicates that it can take time for a change to become embedded in clinical practice. In Newcastle, there was a gradual increase in the proportion of patients with had a completed bundle over a 9-month period from 25% to 90%. During the introductory period, there was a need for repeated education sessions and reinforcement for clinicians until it became 'routine' practice. Anecdotally, clinicians reported that once they used the

Table 5 | Summary of combined pre- and post-care bundle audit data for all 3 centres

		Post-care bundle (n = 136)	
	Pre-care bundle (n = 92)	Not completed (n = 56)	Completed (n = 80)
Median MELD	20 (6–40)*	13.5 (7–45)*	18.5 (6–42)*
Diagnostic tap ≤24 h if ascites (%)	**30/49 (61)**	**15/23 (65)**	**38/45 (84)**
SBP diagnosed on tap (%)	5/44 (11)	1/18 (6)	3/44 (7)
Antibiotics prescribed if SBP (%)	5/5 (100)	1/1 (100)	3/3 (100)
Albumin prescribed if SBP (%)	4/5 (80)	1/1 (100)	2/3 (67)
Alcohol consumption documented (%)	**57/92 (62)**	**47/56 (84)**	**74/80 (93)**
Pabrinex prescribed if appropriate (%)	57/65 (88)	38/41 (93)	61/64 (95)
CIWA prescribed if appropriate (%)	58/65 (89)	36/41 (88)	61/64 (95)
AKI on admission (%)	20/92 (22)	11/56 (20)	13/80 (16)
Diuretics/nephrotoxins stopped if AKI (%)	18/20 (90)	9/9 (100)	10/11 (91)
Appropriate fluids given if AKI (%)	19/20 (95)	11/11 (100)	13/13 (100)
Sodium <125 on admission (%)	10/92 (11)	7/56 (13)	9/80 (11)
Diuretics stopped + fluid balance if Na <125 (%)	7/9 (78)	6/7 (86)	9/9 (100)
Suspected variceal bleed (%)	13/92 (14)	12/56 (21)	14/80 (18)
Terlipressin given (%)	11/13 (85)	8/12 (67)	14/14 (100)
Antibiotics given (%)	**4/8 (50)‡**	**8/12 (67)**	**14/14 (100)**
OGD within 24 h (%)	10/13 (77)	9/12 (75)	11/12 (92)
Survived admission (%)	77/92 (84)	51/56 (91)	65/80 (81)
Median length of stay, days (range)	11 (1–139)	10 (1–100)	10 (1–64)
Median LOS, days (range) – excluding patients who died during admission	11 (1–139)	10 (1–100)	8 (2–64)

MELD, model for end-stage liver disease; SBP, spontaneous bacterial peritonitis; CIWA, clinical institute withdrawal assessment for alcohol; AKI, acute kidney injury; Na, sodium; OGD, oesophago-gastro-duodenoscopy; LOS, length of stay.

* Age and MELD data not available for all patients.

‡ Antibiotic data not available for all patients.

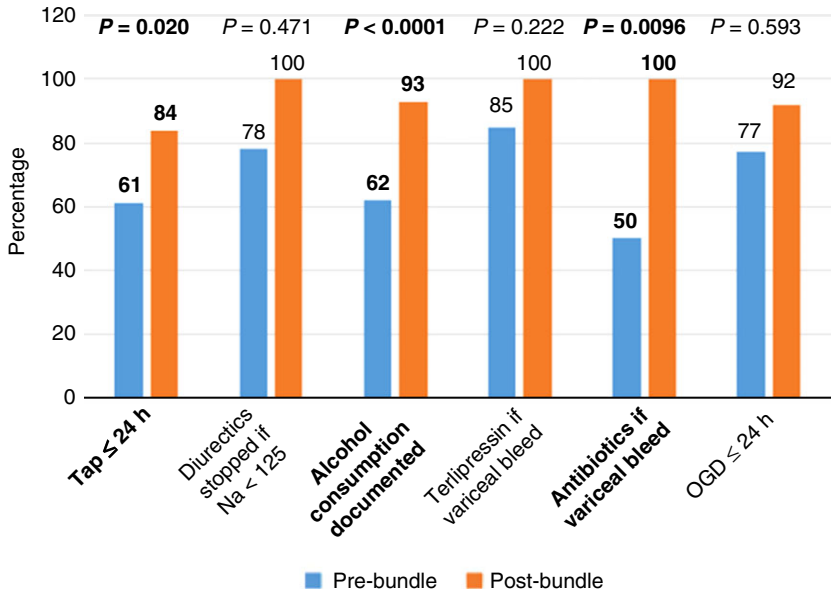

Figure 3 | The most notable aspects of patient care that were improved by introduction of the 'care bundle' across the whole cohort. Na, sodium; OGD, oesophago-gastro-duodenoscopy.

bundle they felt that it helped them manage patients with decompensated cirrhosis, who they frequently found a complex group to treat.

There were some particularly striking improvements in patient management demonstrated by the comparison pre- and post-bundle. The proportion of patients with

ascites undergoing an ascitic tap to exclude spontaneous bacterial peritonitis within 24 h of admission has increased from 61% to 84% ($P = 0.020$). It has been clearly demonstrated that spontaneous bacterial peritonitis carries a high mortality and timely diagnosis and treatment is vital.[6] Patients with suspected variceal bleeding also received improved care. Administration of terlipressin has increased from 85% to 100% and antibiotics are now administered to 100% of patients as compared to 50% in the pre-bundle audit. This compares favourably to the recent NCEPOD report, 'Gastrointestinal haemorrhage: time to get control?', which found that 37% of patients with variceal haemorrhage did not receive prophylactic antibiotics.[14] Interestingly, there has also been a shift to earlier endoscopy with 92% of patients admitted with gastrointestinal bleeding undergoing upper gastrointestinal endoscopy within 24 h of admission following the bundle being implemented (vs. 77% in the pre-bundle era). In all three centres, over 80% of patients had alcohol-related liver disease and the introduction of the care bundle has resulted in a significant improvement in documentation of alcohol intake [62% pre-bundle compared to 93% post-bundle ($P < 0.0001$)].

As well as helping ensure that patients have the key investigations conducted and treatment commenced within the first 24 h, in Newcastle, use of the care bundle appeared to suggest a trend towards a shorter hospital stay (median 8 days vs. 13 days), although patients with a completed care bundle had a higher Model for end-stage liver disease (MELD) score (18.5 as compared with 14.5). This suggests that prompt initiation of appropriate evidence-based treatments could reduce the length of hospital admission. This difference was not reproduced at the other centres, although their sample size was smaller. Unfortunately, we were not able to show that completion of the care bundle had a positive impact reducing mortality. However, the cohort was relatively small and there were clear differences in the severity of liver disease between the groups, which made it difficult to directly compare mortality between groups. Patients in the 'care bundle' group had higher MELD scores. This work describes the process of successfully introducing evidence-based care that reduces variability and it is logical to infer that if care is delivered at a consistently high level then a morbidity and mortality benefit will be observed if larger numbers were included.[15] Larger prospective controlled studies may be able to assess the impact of a care bundle on mortality.

This study does have some limitations. In particular, the data collection was a retrospective review of medical records, which is limited by how well the medical history and management were documented. There was also some missing data (gender, age and MELD score) for Sunderland. However, the same methodology was used throughout the study period to ensure the results were reflective of practice change rather than changes in data collection. Despite these limitations this study clearly demonstrates that a standardised care bundle approach helps ensure patients receive appropriate management more effectively.

The importance of the development of the decompensated cirrhosis care bundle was emphasised in the '*The Lancet* Standing Commission on Liver Disease in the UK'.[3, 13] In that report it forms part of Recommendation 3, which highlights the need to focus on developing a blueprint for improving care for acutely sick patients with liver disease. The bundle has now been introduced in a number of hospital trusts across the UK and it is recommended that use of a care bundle should be a focus for audit nationally regarding the management of patients with decompensated cirrhosis. Quality improvement is a continuous process which demands regular audit, feedback and education. It is also important to maintain the high levels of compliance with bundle completion. A continuous programme of education as junior doctors rotate between posts is important. There may also be a role for embedding the care bundle into the admission process itself. For example, City Hospitals Sunderland have incorporated the bundle into their electronic admission document (called V6) and preliminary data (not shown here) demonstrates improved completion rates.

In conclusion, we have shown that implementation of a care bundle for patients admitted to hospital with decompensated cirrhosis improved rates of diagnostic paracentesis and antibiotic prophylaxis with variceal haemorrhage. If used more widely, a decompensated cirrhosis care bundle might reduce variability in the management of decompensated cirrhosis and ensure that life-saving evidence-based treatments are given early.

SUPPORTING INFORMATION

Additional Supporting Information may be found in the online version of this article:

Table S1. Details of the CQUIN targets for the care bundle implementation (Total value of CQUIN for completion of all milestones was £850 000).

Table S2. Individual centre audit data from Sunderland.

Table S3. Individual centre audit data from Cornwall.

Data S1. Audit tool for the management of decompensated cirrhosis in the first 24 h.

AUTHORSHIP

Guarantor of the article: Stuart McPherson

Author contributions: JD helped with bundle design, collected data, undertook the data analysis and wrote the manuscript. PR collected data and contributed to the manuscript. AW, AH, SN, SP, MB CAL collected data. SM and MH helped with bundle design and contributed to the manuscript. CD, SC and HH were instrumental in implementation of the care bundle at their centres and contributed to the manuscript. SMc led the bundle design and implementation, undertook data analysis and wrote the manuscript.

All authors approved the final version of the manuscript.

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PR, AW, HA, SN, SP, MB, SC and HH have nothing to declare.

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