BMJ Open

AmReS - an observational retrospective time- to-event analysis of staff voluntary turnover in an English ambulance trust

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2024-098174
Article Type:	Original research
Date Submitted by the Author:	18-Dec-2024
Complete List of Authors:	Cook, Robert; University of Staffordshire Shabuz, Zillur Rahman; Lancaster University Bennett, Matthew; London Ambulance Service NHS Trust East, Abigail; North West London Cancer Network Dube, Alisen; Staffordshire University Miller, Josh; West Midlands Ambulance Service NHS Foundation Trust Asaduzzman, Md; Staffordshire University, Department of Engineering Radford, Mark; NHS England Leary, Alison; London South Bank University, 412928 Jones, Sarahjane; Staffordshire University - Stafford Campus, School of Health and Social Care
Keywords:	ACCIDENT & EMERGENCY MEDICINE, Burnout, Health Services, Health Workforce

I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our licence.

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which Creative Commons licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

AmReS - an observational retrospective time- to-event analysis of staff voluntary turnover in an English ambulance trust

Abstract

Objective

The purpose of this study was to identify which, and to what extent, demographic and operational factors are indicative of likelihood for a new Call Handler or Paramedic to remain in-role within the first two years of employment at an Ambulance Trust using data held in the Trusts bespoke data warehouse.

Design

The study uses a retrospective observational cohort design using routinely collected data.

Setting

One Ambulance Trust focussed on a large, predominantly urban area in the UK.

Participants

The study used the data of all employees of the Trust that started employment as Call Handlers (869) or Paramedics (1,672) between the 1st of January 2018 to 31st July 2023.

Primary and secondary outcome measures

'Time to event' analysis of 'likelihood to remain in-post within the first two years of employment' as Call Handlers or Paramedics via Accelerated Failure Time (AFT) regression.

Results

Several factors showed a significant contribution to the likelihood of remaining in-post within an Ambulance NHS Trust. Among the findings, short term sick leave in the first two years of employment was associated with increased retention for Paramedics. In addition, female Call Handlers were found to have increased retention, and Paramedic retention increased with time outside of 'Job Cycle Time' activities (i.e. activities other than responding to calls).

Conclusion

This study presents a method for extracting new insights from routinely collected operational data, identifying common drivers and specific predictors for retention among the Ambulance NHS workforce. It emphasises the importance of workforce-centred retention strategies, highlighting the need for paramedics to have time to reflect and recuperate to avoid burnout and attrition. The study also suggests that a lack of sick leave might indicate a lack of trust and self-care culture, potentially leading to paramedic staff attrition. The study findings are limited to a single, densely populated ambulance Trust but the methodology will be transferrable to diverse settings

Strengths and limitations of this study

Limitations:

- This was a single centre study, with an ambulance Trust focussed on a high population density urban area. However, the methodology will be transferrable to diverse settings.
- The study is an observational retrospective analysis, hence findings and patterns found in the data may be correlational not causational. Operational interventions taken from such findings need to be tracked to confirm the scale of the effect.

Strengths:

- The study has made use of real in-situ data reflective of the data and tasks as done. Hence, the replication of the work at other Trusts either as one-off insights or as part of their operational oversight is relatively resource inexpensive.
- The study makes use of routinely collected data so translation to different ambulance trusts is straightforward.
- The data continues to be collected, so the analytics can be deployed as a live intelligence tool.

Introduction

The National Health Service (NHS) stands as the largest employer in England, employing a workforce of over 1.3 million individuals[1,2]. As of June 2024, there were over 100,000 job vacancies in the NHS [3]. Staff shortages directly impact the quality and safety of care, patient experience, and staff work experience[4]. The increasing demand following the COVID-19 pandemic poses additional threats to staff retention, patient outcomes, and staff well-being [3,5]. Therefore, workforce retention is a key priority for the NHS, as outlined in the People Plan [6] and the NHS Long Term Workforce Plan [2].

Emergency call handlers and paramedics both play vital roles in the healthcare system, particularly in life threatening situations. However, their skill sets differ due to the nature of their roles. 'Emergency call handlers' are responsible for managing and logging calls, assessing patient condition, providing advice, and dispatching staff and vehicles as necessary. Paramedics are healthcare providers who are traditionally associated with the provision of emergency care within the emergency medical service (EMS), respond to incidents through the 999-call system and provide prehospital care to those in need. In addition, they ensure continuity of care from the scene to a hospital setting. Effective pre-hospital care by paramedics can significantly impact patient outcomes, particularly in cases of cardiac arrests, sepsis, stroke, and severe trauma [7,8]. Early interventions and rapid transport to appropriate facilities are key to improving patient survival rates and recovery [9]. Although associated with emergency prehospital care, paramedics also exercise reflection in action to decide if a patient needs further treatment or conveyance to hospital. In England in 2015/16, ambulance services responded to nearly 11 million calls. Half of the patients receiving a response by telephone or face to face were not conveyed to an emergency department [10].

Emergency medical services, particularly in the UK, are faced with significant workforce shortages that affect their efficiency and effectiveness. Between 2021/22 and 2022/23 the average workforce vacancy rates for the ambulance sector increased from 3.6% to 6.6%[11] with vacancy rates reaching a maximum of 5,502 full time equivalents (fte) in the third quarter of 2023/2024. This situation is exacerbated by the fact that at least one in four paramedics have considered leaving their roles due to frustrations with inadequate patient services [12]. Furthermore, in January 2024, ambulance trusts reported the highest sickness absence rate across NHS staff groups at 7.4%, with most absences related to poor mental health (NHS

Digital, 2024). High turnover rates among paramedics present a significant challenge to the healthcare system, with poor retention linked to high levels of burnout, depersonalisation, difficulties finishing work on time, lack of proper breaks, heavy workloads, and feelings of being unsupported or regularly endangered [13–15] These high attrition rates further exacerbate staff shortages in an already pressured profession.

The demand for EMS has been amplified by the rising demand due to COVID-19, influenza, and norovirus [5] thus further growing the gap between demand for EMS and the available workforce. In December 2022, the NHS Ambulance service for England reported a 60% increase in the number of calls received over a one-week period compared to the previous week and the highest number on record excluding the beginning of the COVID-19 pandemic [5]. Between 2016 and 2020, Health Education England (HEE) estimated that the NHS would require to recruit at least twice as many new paramedic trainees each year to meet future demand [16]. Simply recruiting more staff may improve the situation short-term but leaves the underlying issues unresolved with the subsequent retention of staff potentially affected.

Emergency call handlers often serve as the first responders and are an under-researched group, their critical role often overlooked until a major communication breakdown occurs [17,18]. In addition, they face significant challenges, including stress and demanding workloads [17]. Specific data on emergency call handlers' retention rates varies, but it's crucial for maintaining a skilled workforce. In the broader 911 sector in America, the average vacancy rate was about 25% over a four-year period, indicating ongoing challenges [19]. Whilst in the UK, turnover rates have increased in some NHS ambulance trusts. For instance, one trust experienced a rise from 17.5% during 2020/21 to 28.3% during 2021/22 amongst call handlers [20]. These figures highlight the importance of addressing retention and well-being to maintain a skilled workforce in emergency call centres.

In the ambulance service there is significant evidence of failure demand, for example in December 2022, the average response time to a Category 2 call (e.g. suspected heart attacks and strokes) increased to over 1 hour 30 minutes compared with a target of 18 minutes[1].Thus insight to identify factors contributing to increased turnover to inform long term sustainable solutions is necessary. Whilst there is vast research focusing on acute or short-term challenges, they fail to detect long-term chronic predictors of workforce retention. Addressing workforce shortages requires a multifaceted approach with enhanced recruitment and retention efforts as well as strategic workforce planning.

Routinely collected data can be a valuable resource that complements current commonly used research methods that focus on staff feedback; healthcare providers can leverage readily available big data and specific analytical techniques to understand, monitor, and address issues related with workforce retention. Use of such data can provide a comprehensive view and insight into the contributory factors associated with retention or staff turnover over time thus facilitate evidence-based development of retention strategies based on real time monitoring. Consequently, fostering a positive work environment that ensures a continuity of high-quality care. This study analyses operational data from a major English Ambulance Service to identify which, and to what extent, demographic and operational factors are indicative of likelihood for a new Call Handler or Paramedic to remain in-role within the first two years of employment at an Ambulance Trust.

Methods

This is a single centre retrospective observational study using anonymised routinely collected data from an Ambulance NHS Trust in England. The study period was set from the 1st January 2018 to 31st July 2023.

Data preparation

Seven data sets (see Table 1) were extracted from the Ambulance Trust's data warehouse using bespoke structured query language (SQL) scripts developed by the research team in collaboration with the ambulance trust's nominated business analysts. The business analysts were responsible for extracting the data and ensuring it was deidentified before sharing with the research team for analysis. 'Deidentification' was performed using an anonymization technique, replacing free text by a randomly generated alpha-numeric string which was then reused when the same free text reappeared and was outlined in the ethics application for the study.

Table -1: Summary of extracted data sets and variables

Dataset	**Description**	**File size‡**	**Variables of interest**
Employment records	Periods of employment for each member of staff. Each row represents one continuous period of employment.	2.1 MB N = 11,803	• Employee ID • Start/ end dates of 'employment' • Staff demographics.
Historical assignments	Time series of positions for each employee of the Trust. Each row represents one 'Assignment' (a period working in a given post and location) with periods of employment made up of multiple 'Assignments'.	12.1MB N = 104,852	• Employee ID • Start/ end dates of each 'Assignment' • Job title • Pay band • Indication if this was a period of active work or not (nonactive assignments including maternity leave and secondments)
Shifts	Time series of rostered and planned overtime shifts of individuals. Each row represents one shift of one individual.	191 MB N = 2,714,042	• Employee ID • Shift start/ end time • Assigned ambulance callsign (if applicable).
Incidents	Record of emergency service calls responded to by the ambulance service. Each row represents a call attended.	1.3 GB N = 11,382,236	• Responding ambulance callsign(s) • 'Job Cycle Times' (JCT)* • Conveyance† status • Index of Multiple deprivation (IMD) decile of response location.
Contacts	Record of all calls made to the ambulance service. Each row represents one call to the ambulance service.	548 MB N = 11,401,902	• Incident ID • Incident category
Overtime	Time series of work done beyond the rostered shifts. Each row is one period of overtime for one member of staff	186.5 MB N = 2,379,485	• Employee ID • Type of overtime (planned, unplanned, payments in lieu of breaks, etc.) • Time spent on overtime.
Staff Absence/ Sickness	Time series of short-term employee absences due to illness. Each row represents one period of sickness for one employee.	4 MB N = 63,125	• Employee ID • Start/ end data of absence.

*See SI-1 for descriptions of individual JCTs

†'Conveyance' refers to the transfer of a patient from the incident site to a hospital or equivalent location.

‡`N` refers to the number of rows of the data set.

Two separate datasets ('Call Handler' and 'Paramedic') were constructed from the historical assignment dataset using the job type variable. Using the employee identification number as assigned in Electronic Staff Record (ESR), the 'call handlers' and 'paramedics' historical assignment datasets were each aligned to the employment records, incidents, shift pattern, overtime, and staff absence/sickness. For analysis, each dataset by job type was subdivided into monthly units to create the time series structure required for the time-varying covariates in Accelerated Failure Time (AFT) and Cox Proportional Hazards (PH) analysis.

Prior to analysis the demographic taxonomies were aggregated, combining values with low representation in the data set (see SI-2 for the transformations and frequencies). The operational variables of interest (staff absence, time spent on each aspect of job cycle time (JCT), index of multiple deprivation (IMD) of incident location, and acuity category of incidents) were each corrected for an exposure to allow for their relative size. 'Time spent on each aspect of JCT' and 'incidents responded to by acuity category' were corrected for the number of shifts worked in that month. 'Time lost to absence' was corrected for the relative length of the month (length of month in days, unless assignment began or was terminated during the month). The 'jobs completed by IMD decile' were converted to 'percentage of incidents responded to within a given decile'. In the cases where no incidents were responded to in each month, e.g. during on boarding for newly qualified paramedics, IMD percentages were imputed via mean imputation (first by employee ID and then the data set average should an employee have never responded to an incident).

Inclusion criteria were judged against unique ESR numbers based on employment history. Data were included for those that were employed and working as a call handler or paramedic between the 1*st* of January 2018 and 31*st* July 2023 (inclusive of limits), exclusive of individuals that had moved down in pay bands to commence the post. The data set comprised all variables as described above for the first two years of employment within the specific role (call handler or paramedic) within the study period (i.e. an individual beginning a role on the 1*st of* July 2023 would have a censored observation after 31*st* July 2023). All data preparation was performed in R, making use of the 'tidyverse' framework [21]. Data was analyzed as it was recorded within the Truts database systems and the period for data extraction was dictated by the data available at the Trust.

Data Analysis

Data were analysed using time-varying covariates in 'Accelerated Failure Time' (AFT) regression (a type of survival analysis) following testing, and rejection of Cox Proportional Hazards (PH) regression (see SI-3 for Cox PH diagnostic tests). AFT regression utilised the 'aftreg' function implemented in the 'eha: Event History Analysis' package [22]. Six distributions were considered as parameterisations of the AFT model ("Weibull", "Gompertz", "Extreme Value", "Log-logistic", "Log-normal", and "Exponential") with the optimal model selected using Bayesian Information Criteria (BIC) scores [see SI-4]. For this analysis, an event is defined as an employee quitting their job, being fired, or moved to a different role, and a nonevent is when an employee remained in their role either as a call handler or paramedic.

The study obtained both university level and Health Research Authority (HRA) approval (IRAS ID: 301066).

Patient and Public Involvement and Engagement

Two lay representatives have been integral members of the research team, contributing to the project funding application, study design, delivery, and dissemination. Two further lay representatives have been members of the project's independent steering committee.

Results

Table 2 provides a summary of the Ambulance Trust data by job type (call handler and paramedic), percentages represent a proportion of the monthly data.

Call handler staff

Data for 868 call handlers were analysed, comprising a total of approximately 925 years of combined employment. The average age for call handlers was 31 years (standard deviation 9.4 years), 70.2% of the staff were recorded as female, 76.9% were single and 89.7% were declared as British nationals. In this study, 64.8% of call handlers were employed at 'Agenda for Change' (AfC) band 3 and on average each call handler worked 15 minutes extra as planned overtime per month. Time lost due to absence and sickness averaged 6.9% of each month (approximately 2.1 days). Due to the nature of their work, call handler data did not include Index of Multiple Deprivation (IMD), Job Cycle Time (JCT), and category of incidents per shift.

Paramedic staff

Data for 1,672 paramedics were analysed, comprising a total of approximately 2,567 years of combined employment. The average age of the paramedic workforce was 28 years (standard deviation 6.8 years), 52.2% of the staff were recorded as female, 80.3% were single and 47.2% declared as British nationals. In this study, 96.0% of paramedics were employed at band 5 and on average each worked 45.6 minutes extra as planned overtime and 12 minutes extra as unplanned overtime per month. Time lost due to absence and sickness amongst the paramedic staff averaged 3.9% of a month (approximately 1.2 days).

The paramedic staff responded to calls from a variety of locations representing different levels of deprivation as measured using the IMD; locations with IMD 2 and 3 recorded the highest percentage of incidents (18.0% and 20.0%, respectively), whereas locations with IMD 10 had the least percentage of incidents reported (2.1%).

During a shift, the paramedic spent most of their time actively responding to calls with this activity broken down into six 'Job Cycle Time' descriptions ('Mobilisation', 'Running', 'On scene', 'To hospital', 'Arrived at hospital to patient handover', and 'Patient handover to clear' with full definitions given in SI-1). Amongst these, on average most of their time was spent 'On Scene', i.e. with/ treating patients at the site of the incident, with the least time spent in 'Mobilisation'. The time spent on shift not responding to an incident (e.g. between incidents, attending meetings/training, or performing maintenance) is 'non-JCT time' which accounted for 3.2 hours of each shift on average.

Each call that is made to the ambulance service is triaged and assigned a 'categorisation' according to a nationally devised description. The greater the risk to patient life, the higher the categorisation, with Category 1 calls described as "Calls from people with life-threatening illnesses or injuries". Which calls receive an ambulance response, and hence become 'incidents', is decided by the Trust's dispatch team with priority given based on the categorisation. On shift, the paramedics mostly experience Category 2 incidents ("Emergency calls", 3.2 incidents per shift on average) and would be expected to respond to one Category 1 incident ("life-threatening illnesses or injuries") for every 3 shifts worked (0.37 incidents per shift on average).

Table 2: Composition of the monthly data for Call Handler and Paramedic analyses. Each term reports 'mean (standard deviation)' unless otherwise stated.

Variable		**Monthly staff data**	
	Value	**Call handlers**	**Paramedics**
Staff demographics			
Age, years		31.0 (9.4)	28.0 (6.8)
Gender, %	Female	70.2%	52.2%
Nationality, %	British	89.7%	47.2%
	Not Declared	2.1%	1.4%
	Other	8.2%	51.4%
Marital Status, %	Divorced/ Legally Separated/Widowed	3.2%	1.9%
	Married/Civil Partnership	15.1%	13.2%
	Single	76.9%	80.3%
	Unknown	4.8%	4.6%
Staff pay scale			
Call handler, %	Band 3	64.8%	NA
	Band 4	35.2%	NA
Paramedic, %	Band 5	NA	96.0%
	Band 6+	NA	4.0%
Sickness/absence			
Staff Absence Duration (ratio of month)		0.069 (0.19)	0.039 (0.14)
Percentage of incidents attended in a month by Index of Multiple Deprivation (IMD) of incident location			
IMD: 1 (%)		NA	3.3 (4.2)
IMD: 2 (%)		NA	18.0 (10.0)
IMD: 3 (%)		NA	20.0 (10.0)
IMD: 4 (%)		NA	15.0 (7.7)
IMD: 5 (%)		NA	12.0 (7.1)
IMD: 6 (%)		NA	10.0 (6.8)
IMD: 7 (%)		NA	7.6 (6.1)
IMD: 8 (%)		NA	6.2 (5.5)
IMD: 9 (%)		NA	5.1 (5.9)
IMD: 10 (%)		NA	2.1 (3.8)
Job Cycle Time (JCT) -hours per shift worked			
'Mobilisation'		NA	0.079 (0.058)
'Running'		NA	0.62 (0.36)
'On scene'		NA	3.1 0(1.70)
'To hospital'		NA	0.62 (0.37)
'Arrived at hospital to patient handover'		NA	0.82 (0.59)
'Patient handover to clear'		NA	0.63 (0.40)
Non JCT Time per Shift Worked		NA	3.20 (2.00)
Overtime (hours)			

Payment in lieu of break		NA	2.70 (3.10)
Planned		0.26 (2.3)	0.76 (2.20)
Unplanned		NA	0.20 (0.80)
Incident category per shift worked*			
Calls from people with life-threatening illnesses or injuries (Cat 1)		NA	0.37 (0.70)
Emergency calls (Cat 2)		NA	3.20 (1.90)
Urgent calls (Cat 3)		NA	1.20 (0.92)
Incidents (All categories) per Shift Worked		NA	5.10 (2.90)

*Calls of category 4 and above were removed from analysis due to rarity.

Ambulance workforce turnover

Factors affecting the ambulance workforce turnover were identified using the AFT regression models considering time-varying covariates with the BIC metric selecting the 'extreme value' and 'log-logistic' families for the Call Handler and Paramedic models respectively. The results of both analyses are reported in Tables 3 and 4 for Call Handlers and Paramedics respectively.

Factors impacting call handler turnover rates

Four factors were found to be associated with call handler workforce turnover: gender, nationality, pay scale, and average absence duration. There was strong evidence to suggest that call handlers employed at Band 4 were more likely to remain with their current employer longer (that is a reduced risk of turnover) compared to those employed at band 3 (0.61, CI: 0.33 to 0.89, p-value <0.005). A correlation between pay and retention was to be expected due to the pay progression structure of the Ambulance Trust; following their first-year employees move from Band 3 to Band 4 (with minimal exceptions) hence increased retention time may not be due to the higher banding, but instead the higher banding is an outcome of retention. There is evidence to suggest female call handlers were less likely to leave compared to their male counterparts (0.29, CI: 0.043 to 0.54; p-value <0.05). There was evidence to support a link between retention and call handler's nationality and absence duration (p-value <0.05); individuals who don't identify as 'British' have a higher risk of attrition and individuals with an increased level of sick leave have a reduced probability of remaining in the service.

Table 3. Summary of AFT* regression ('extreme value') for Job Type: Call handler.

Variable		**Estimate**	**95% CI**	**P-value †**	**Direction interpretation‡**
Age		-0.0079	(-0.021, 0.006)	-	-
Gender	Male (reference)	-	-	-	-
	Female	0.29	(0.043, 0.54)	< 0.05	...that time to leaving role increases if employee is female
Nationality	British (reference)	-	-	-	-
	Not Declared	0.26	(-0.8, 1.30)	-	-
	Other	-0.38	(-0.74, -0.025)	< 0.05	...that time to leaving role decreases if people do not identify as British
Marital Status	Single (reference)	-	-	-	-
	Divorced/ Legally Separated/Widowed	0.28	(-0.51, 1.10)	-	-
	Married/ Civil Partnership	0.00033	(-0.51, 1.1)	-	-
	Not Declared	0.21	(-0.38, 0.80)	-	-
Pay scale	Band 3 (reference)	-	-	-	-
	Band 4	0.61	(0.33, 0.89)	< 0.005	...that time to leaving role increases as pay increases
Staff Absence Duration (ratio of month)		-0.79	(-1.3, -0.3)	< 0.05	...that time to leaving role decreases as time lost to short term absences increases
Overtime: Planned (HRS)		0.16	(-0.065, 0.38)	-	-

*The AFT model is operating as a survival model in the implementation reported and hence a significant positive coefficient is indicative of an increased average survival time as the covariate increases.

†P-value limits have been drawn from 'An Introduction to Medical Statistics (Bland 2015)'[23].

‡Coefficients with p-value > 0.1 are represented by "-".

Factors impacting paramedic turnover rates

There was strong evidence to suggest that paramedic staff who worked more planned overtime or took sick leave were more likely to remain in service (p value < 0.005). Likelihood to leave the service was, for the most part, unaffected by the level of deprivation (as measured using IMD deciles) associated with the location of the incident except for the lower IMDs (locations with low levels of deprivation). The data suggests attending to incidents in least deprived areas (IMD 9 and 10) reduces turnover but attending incidents in the next lowest (IMD 8) bracket increases turnover. Responding to high calls from people with life-threatening and emergency illnesses or injuries results in high paramedic turnover. With the increase of time spent on driving patients to hospital there is a greater risk of attrition (-0.68, CI: -1.10 to -0.22; p-value < 0.005) whereas increased time spent at the scene of an incident, and between incidents (i.e. Non-JCT time) was linked to a reduced risk of attrition. There was evidence to suggest that paramedics employed at band 6 or above were more likely to leave compared to those employed at band 5 (-0.23, CI: -0.44 to -0.019, p-value <0.05). However, none of the paramedic staff demographics (age, gender, marital status, nationality) were found to be associated with staff turnover.

Table 4. Summary of AFT* regression ('log-logistic') for Job Type: Paramedic.

Variable		**Estimate**	**95% CI**	**P-value†**	**Direction interpretation‡**
Age		-0.0047	(-0.013, 0.0039)	-	-
Gender	Male (reference)				
	Female	0.061	(-0.038, 0.16)	-	-
Nationality	British (reference)				
	Not Declared	-0.21	(-0.54, 0.13)	-	-
	Other	0.018	(-0.084, 0.12)	-	-
Marital Status	Single (reference)				
	Divorced/ Legally Separated/ Widowed	0.14	(-0.24, 0.52)	-	-
	Married/ Civil Partnership	0.031	(-0.12, 0.18)	-	-
	Not Declared	-0.16	(-0.38, 0.05)	-	-
Pay Scale	Band 5 (reference)				
	Band 6+	-0.23	(-0.44, -0.019)	< 0.05	...that time to leaving role decreases as pay increases
Staff Absence Duration (ratio of month)		0.04	(0.03, 0.06)	< 0.005	...that time to leaving role increases as time lost to short term absences increases
Over time (hours)	Payment in lieu of breaks	0.28	(0.23, 0.34)	< 0.005	…that time to leaving role increases for employees who work through breaks
	Planned	0.25	(0.18, 0.32)	< 0.005	…that time to leaving role increases for employees who work planned overtime
	Unplanned	0.14	(-0.015, 0.3)	< 0.1	…that time to leaving role increases where employees work unplanned overtime
Incidents (per Shift Worked)		0.18	(-0.13, 0.5)	-	-
Percentage of incidents attended in a month by IMD of incident location[α]	IMD: 1(%)	0.0049	(-0.013, 0.023)	-	-
	IMD: 2 (%)	0.0042	(-0.0066, 0.015)	-	-
	IMD: 3 (%) (excluded)[¥]				
	IMD: 4 (%)	0.0083	(-0.0031, 0.02)	-	-
	IMD: 5 (%)	0.0006	(-0.01, 0.012)	-	-
	IMD: 6 (%)	-0.0037	(-0.015, 0.0072)	-	-
	IMD: 7 (%)	-0.0084	(-0.021, 0.004)	-	-
	IMD: 8 (%)	-0.028	(-0.038, -0.017)	< 0.005	…that time to leaving role decreases for employees who respond to more incidents at IMD:8 locales

	IMD: 9 (%)	0.014	(-0.00081, 0.03)	< 0.1	…that time to leaving role increases for employees who respond to more incidents at IMD:9 locales
	IMD: 10 (%)	0.034	(0.0079, 0.06)	< 0.05	…that time to leaving role increases for employees who respond to more incidents at IMD:10 locales
Job Cycle Time (Hours per Shift Worked)	'Mobilisation'	1.4	(-0.74, 3.6)	-	-
	'Running'	0.29	(-0.4, 0.98)	-	-
	'On scene'	0.18	(0.052, 0.31)	< 0.01	…that time to leaving role increases for employees who spend more time at the scene of incidents.
	'To hospital'	-0.68	(-1.10, -0.22)	< 0.005	…that time to leaving role decreases for employees who spend more time conveying patients.
	'Arrived at hospital to patient handover'	0.17	(-0.017, 0.36)	< 0.1	…that time to leaving role increases for employees who spend more time waiting at hospitals.
	'Patient handover to clear'	0.2	(-0.18, 0.58)	-	-
	Non JCT	0.097	(0.057, 0.14)	< 0.005	…that time to leaving role increases for employees who spend more time outside JCT tasks.
Incident Category (per shift worked)	Calls from people with life-threatening illnesses or injuries (Cat 1)	-0.33	(-0.64, -0.018)	< 0.05	…that time to leaving role decreases for employees who respond to more 'Category 1' incidents
	Emergency calls (Cat 2)	-0.32	(-0.63, -0.00)	< 0.05	…that time to leaving role decreases for employees who respond to more 'Category 2' incidents
	Urgent calls (Cat 3)	-0.068	(-0.42, 0.28)	-	-

*The AFT model is operating as a survival model in the implementation reported and hence a significant positive coefficient is indicative of an increased average survival time as the covariate increases.

†P-value limits have been drawn from 'An Introduction to Medical Statistics (Bland 2015)'[23].

‡Coefficients with p-value > 0.1 are represented by "-".

¥IMD: 3 was removed from the analysis feature space to avoid over-specification of the model and was selected for removal as the most frequently attended IMD, and hence giving the most power as a reference category.

αIMDs are ordered from IMD:1 (highest levels of deprivation) to IMD: 10 (lowest levels of deprivations).

Discussion

The objective of this study was to identify factors linked to staff retention/ turnover amongst the call handler and paramedic workforce. While there are several studies involving emergency service workforce (including ambulance, fire, and police services), there is paucity of evidence into factors impacting staff retention/ turnover among call handler and paramedic workforce within the UK. The complexities of retention, attrition, and related concepts involve numerous factors influencing employee well-being and motivation.

The NHS, as the largest public employer, boasts a diverse demographic representation. This study found that the impact of demographic characteristics on workforce retention varied. Specifically, there was evidence linking gender and nationality to retention rates within the first two years of employment among call handlers. However, this trend was not observed in the paramedic workforce. The role of nationality aligns with findings reported by Moscelli et al. [24], which highlighted that the impact of ethnicity on workforce retention was inconsistent across different clinical staff[24]. The role of gender, notably that female staff remain in entry level positions, reflect the concept of the 'sticky floor' [25] where women are less likely to move or pursue promotion or remain at the lower end of the pay scale perhaps due to fewer opportunities (if part time) or responsibilities that limit their mobility such as childcare or caring for older adults. Therefore, any effective strategy to alleviate NHS workforce pressures, whether through retaining current employees or recruiting new ones, must be tailored to consider the diverse characteristics of the workforce, rather than adopting a one-size-fits-all approach.

This study has found an association between employees that take short term sick or absence leave and a reduced risk of turnover in the paramedic workforce. An advantage for working for the NHS is that it provides paid sick leave for its employees, with the argument that paid sick leave reduces job instability associated with own or family member illness. The current study supports this argument, however it only accounts for short term sick leave. While extended sick leave might raise concerns about staff turnover, it is also plausible that a work environment that supports paid leave enables employees to attend to their own health needs or those of family members without risking their job security [26,27], hence are likely to stay longer with their current employer. More so, paid sick leave has previously been associated with job satisfaction in other professions such as nursing; job satisfaction linked with pay and benefits has also been found to correlate with intentions to remain within the EMS profession [28,29]. There is evidence to suggest that burnout and stress are prevalent within the ambulance service environment associated with declining mental health, with some studies reporting more than 40% of the staff experiencing burnout [15,30]. Burnout and stress may be the driving forces contributing to high sickness rates amongst the ambulance workforce compared to other professions within the UK NHS [31]. A workplace culture that supports employees to attend to their own health needs can make a difference in reduction of staff turnover thus increasing workforce stability.

Constant demands, lengthy and extended shifts cause fatigue and exhaustion, symptoms of burnout, a condition commonly reported at a higher level in emergency services compared to other professionals in similar roles [32]. Recent studies have shown burnout as a contributor for poor mental health which poses a threat to ambulance workforce retention. Burnout is a state of emotional, physical, and mental exhaustion caused by prolonged stress linked to unsupportive management practices, long hours and physical demands of the paramedic role[15]. While this study did not directly measure burnout and stress; time lost due to sickness, incident category and JCT have been considered as proxy measures. Therefore, the AFT models presented in this paper mirror findings from other studies that suggest the link

between ambulance staff burnout, stress and staff retention. For instance, paramedics attending higher numbers of the most stressful incidents (Category 1 or 2) show an increase in their turnover risk which could suggest staff burnout. Interestingly, spending time between incident responses, reported as 'non-JCT' hours, shows a marked effect on retention (each hour per shift spent 'not responding' increase the average employment time by approximately 10%, (95% CI: 6% to 15%) within the first two years of employment). This suggests that factoring time between calls, allowing staff time to decompress or debrief before attending to their next job is beneficial for staff retention. In complex work environments, such as the ambulance sector, debriefing can serve as a valuable resource, enhancing team processes, promoting collaborative learning, and contributing to staff well-being and resilience by mitigating burnout [33].

This study has several strengths. It repurposes routinely collected operational data from an ambulance NHS Trust, including call handler and paramedic data, to investigate retention factors at an individual level. Compared to existing literature, which focuses more on qualitative methods, this study benefits from the ease of replicating the analysis or translating it to other Trusts, as it utilises routinely collected data. The Trusts' existing business intelligence and system administration teams often have the necessary skills to extract and interpret the data, while a statistician or data scientist can readily transform and structure it. Assuming the Trusts' database systems remain static, such activities have an even lower barrier to replication at subsequent time points. This in-house activity has three key benefits: summarising chronic themes in the data, providing a mechanism to predict the ranking of attrition risks for individuals, and allowing qualitative studies to focus on acute individualistic factors. However, this study was limited to a single ambulance trust, which may have resulted in missing pressures on older workforce members and those working in more rural or isolated environments. By developing the program around routinely collected operational data sets, the process of transferring the analytical techniques, if not the findings, is relatively simple and could be used to inform workforce-centred retention strategies.

The analysis presented here has key limitations; the study focusses on a single ambulance Trust which serves an area of high population density and is purely observational in nature. These facets mean the results may not generalise to other settings, either if the findings are applied at other Trusts or if findings are acted on the patterns detected may be either purely correlational or are the result of a causal latent variable which was absent from the model. However, due to the focus on readily available nationally agreed operational data which will have, if not an identical data structure, an equivalent in other Trusts, the analytics can be readily mapped to new settings and utilised as data sources for follow on confirmational intervention studies. With respect to the data collection instruments, a strong limitation is the inclusion of 'non-JCT' time, which is a broad category with a significant contribution to the model. It is possible not all aspects of time spent outside the 'JCT' descriptions are of equal importance in driving retention, and further research in this area is vital.

[Word count -974]

Conclusion

This study demonstrate that as pressures mount on the paramedic workforce it is key for workforce planners to allow for time between incidents for paramedics to reflect and recuperate should they wish to avoid high levels of attrition and burnout. The findings would suggest that while an overabundance of sick leave might be of traditional concern, an absence of sick leave amongst paramedic employees might serve as a warning that areas of the workplace lack a culture of trust and self-care which could lead to staff attrition. In addition, his study demonstrates a methodology for the extraction of novel knowledge from routinely

collected operational data. Whilst the study findings highlight common drivers, it also points out specific predictors for retention among Ambulance NHS workforce, thus underscoring the importance of workforce centred retention strategies.

The focus of this study was within the initial two years of joining the Trust due to the business priorities of the partner Trust. Retaining new entries to the workforce is clearly key in high pressure environments where the initial emotional shock of the job can lead to rapid burnout and attrition, however, maintaining staff past this point should not be overlooked. While this work has focussed on analysis from the perspective of a new joiner to the Trust, an equivalent analysis aiming to address likely attrition rates and the most likely group to protect/ plan to replace given the current makeup of the workforce would be an invaluable tool for planning recruitment priorities.

Acknowledgements

We extend our profound gratitude to the lay members, research site staff, and project steering committee members for their invaluable time and contributions.

Author contribution

The study was conceptualised by RC, AD, MR, AL and SJ. Methodology designed by RC, AD, AE, MA, JM, MR, AL and SJ. Statistical analysis, R code development, data extraction and data visualisation were carried out by ZRS, RC, MB, MA and AE. Service user voice was supplied by GV at all stages of the study. Project administration was carried out by AD, CW, JM and SJ. Validation was done by MA. The original draft was done by RC, with review and editing by RC, AD, ZRS, MB, GV, JM, MR, AL, and SJ.

Funding

This study is funded by The Health Foundation under the project “NuRS and AmReS: nurse and ambulance workforce retention and safety” as part of the ‘Efficiency Research Programme (Round 3)’.

Competing interests

None

Patient consent for publication

Not required as only annonymised data was shared from NHS Trusts for analysis.

Ethical review

The project underwent original review by Birmingham City University’s Faculty Academic Ethics Committee (reference: Jones /4858 /R(C) /2019 /Nov /HELS FAEC) in November 2019. Health Research Authority approval was granted in February 2020 (IRAS ID: 301066). As part of HRA approval, NHS Research Ethics Committee (REC) opinion was not necessary, because the project required access to anonymised data only, and therefore is exempt from REC review. An amendment was made and approved in September 2020 to reflect a change in sponsor to Staffordshire University and the addition of a Covid-19 analysis.

Data sharing statement

The data that support the findings of this study are not publicly available due to privacy reasons. Data are however available from the authors upon reasonable request and with permission of University of Staffordshire.

References

(1) Kirk-Wade E, Harker R, Stiebahl S. NHS key statistics: England. House of Commons Library 2024 16 July.

(2) NHS. The NHS Long Term Plan. 2019.

(3) Leisman D, Wie B, Doerfler M, Bianculli A, Ward MF, Akerman M, et al. Association of fluid resuscitation initiation within 30 minutes of severe sepsis and septic shock recognition with reduced mortality and length of stay. Ann Emerg Med 2016;68(3):298–311.

(4) Bürger A, Wnent J, Bohn A, Jantzen T, Brenner S, Lefering R, et al. The effect of ambulance response time on survival following out-of-hospital cardiac arrest: an analysis from the German resuscitation registry. Deutsches Ärzteblatt International 2018;115 (33-34):541.

(5) Perkins GD, Jacobs IG, Nadkarni VM, Berg RA, Bhanji F, Biarent D, et al. Cardiac arrest and cardiopulmonary resuscitation outcome reports: update of the Utstein resuscitation registry templates for out-of-hospital cardiac arrest: a statement for healthcare professionals from a task force of the International liaison Committee on resuscitation (American heart association, European resuscitation Council, Australian and New Zealand Council on resuscitation, heart and stroke Foundation of Canada, InterAmerican heart Foundation, resuscitation Council of southern Africa, resuscitation Council of Asia); and the American heart association emergency cardiovascular care Committee and the Council on cardiopulmonary, critical care, perioperative and resuscitation. Circulation 2015;132(13):1286–1300.

(6) Rolewicz, L, Palmer B, Lobont C. The NHS workforce in numbers-Facts on staffing and staff shortages in England. 2024.

(7) The Nuffield Trust. Ambulance staff strikes: facts and figures on the ambulance workforce. 2022.

(8) Mahase E. NHS faces significant pressure as flu and covid cases rise. BMJ 2022 Dec 16;379:o3028.

(9) National Audit Office. NHS England Ambulance Services. 2017.

(10) Powell C, Fylan B, Lord K, Bell F, Breen L. A qualitative analysis of stressors affecting 999 ambulance call handlers' mental health and well-being. International Journal of Emergency Services 2022;12(2):231–242.

(11) First Responders Foundation. Recognizing the Unseen Heroes: Dispatchers and Their Vital Role. 2024.

(12) International Academics of Emergency Dispatch. AMERICA'S 911 WORKFORCE IS
IN CRISIS Results of a nationwide 911 staffing survey. 2023.

(13) Care Quality Commission. The health and care workforce. 2023.

(14) Wickham H, Averick M, Bryan J, Chang W, McGowan LD, François R, et al. Welcome to the Tidyverse. Journal of open-source software 2019;4(43):1686.

(15) Broström G. Event history analysis with R.: Chapman and Hall/CRC; 2021.

(16) Bland M. An introduction to medical statistics.: Oxford university press; 2015.

(17) Moscelli G, Nicodemo C, Sayli M, Mello M. Trends and determinants of clinical staff retention in the English NHS: a double retrospective cohort study. BMJ open 2024;14(4): e078072.

(18) Hill HD. Paid sick leave and job stability. Work Occup 2013;40(2):143–173.

(19) NICE. Workplace health: management practices. 2016.

(20) Chapman SA, Blau G, Pred R, Lopez AB. Correlates of intent to leave job and profession for emergency medical technicians and paramedics. Career development international 2009 Sep 18;14(5):487–503.

(21) Patterson PD, Probst JC, Leith KH, Corwin SJ, Powell MP. Recruitment and retention of emergency medical technicians: a qualitative study. J Allied Health 2005;34(3):153–162.

(22) Miller E. The prevalence of stress and burnout in UK emergency ambulance service workers and its impact on their mental health and well-being. British Paramedic Journal 2021;5(4):62–63.

(23) Beldon R, Garside J. Burnout in frontline ambulance staff. Journal of Paramedic Practice 2022;14(1):6–14.

(24) NHS Digital. NHS Sickness Absence Rates, January 2024. 2024; . Accessed 12/06/, 2024.

(25) Adams CJ, Hough H, Proeschold-Bell RJ, Yao J, Kolkin M. Clergy burnout: A comparison study with other helping professions. Pastoral Psychology 2017; 66:147–175.

(26) Chen J, Bamberger PA, Song Y, Vashdi DR. The Effects of Team Reflexivity on Psychological Well-Being in Manufacturing Teams. Journal of applied psychology 2018 Apr;103(4):443–462.

(27) Courtney JA, Francis AJ, Paxton SJ. Caring for the country: fatigue, sleep and mental health in Australian rural paramedic shift workers. J Community Health 2013; 38:178–186.

(28) Egan G. Time to address paramedic retention rates. 2017.

SI-1 Paramedicine Terminology

Table SI-1A. 'Job Cycle Time' (JCT) descriptions.

JCT term	Description
'Mobilisation'	The time spent between being assigned a new incident and beginning to travel to the incident.
'Running'	The time spent to travel to the site of an incident.
'On scene'	The time spent at the incident site.
'To hospital'	[If patient conveyed] The time spent transferring a patient from the incident to a hospital premises.
'Arrived at hospital to patient handover'	[If patient conveyed] The time spent waiting at hospital premises for the patient to be transferred to the hospitals care.
'Patient handover to clear'	[If patient conveyed] The time spent after the patient has been transferred to the hospitals care, e.g. completing medical notes and ensuring vehicle is prepared.
'Non-JCT Activity'	Activities undertaken on shift that are outside the bounds of the 'JCT'. Examples include time spent: • between dispatched incidents • on maintenance • in meetings • in training

SI-2 Demographic taxonomy tables

Summary of demographic taxonomies as found in the supplied data ('Original') as opposed to the aggregated terms used in analysis ('Transformed'), with frequencies based on head count.

Table SI-2A: Paramedic Gender distribution

Original	**Frequency**	**Percentage**
Male	798	47.7
Female	874	52.3
Total	1672	100.0

Table SI-2B: Paramedic Nationality distribution

Original	**Frequency**	**Percentage**	**Transformed**	**Frequency**	**Percentage**
British	795	47.5	British	795	47.5
Australian	641	38.3	Others	853	51.0
Irish	40	2.4			
Namibian	28	1.7			
New Zealander	31	1.9			
Nigerian	10	0.6			
South African	39	2.3			
*Others**	64	3.8			
Not Declared	24	1.4	Not Declared	24	1.4
Total	1672	100.0	Total	1672	100.0

Table SI-2C: Paramedic Distribution of marital status

Original	**Frequency**	**Percentage**	**Transformed**	**Frequency**	**Percentage**
Single	1334	79.8	Single	1334	79.8
Divorced	28	1.7	Divorced/Legally Separated/ Widowed	35	2.1
Legally Separated	6	0.4			
Widowed	1	0.1			
Married	171	10.2	Married/Civil Partnership	219	13.1
Civil Partnership	48	2.9			
Unknown	74	4.4	Not Declared	84	5.0
Missing	10	0.6			
Total	1672	100.0	Total	1672	100.0

Table SI-2D: Paramedic Pay scale distribution

Original	Frequency	Percentage	Transformed	Frequency	Percentage
XR05	1510	90.3	Band 5	1510	90.3
XR06	157	9.4	Band 6+	162	9.7
XR07	5	0.3			
Total	1672	100.0	Total	1672	100.0

Table SI-2E: Call handler Gender distribution

Gender	Frequency	Percentage
Male	267	30.7
Female	601	69.3
Total	868	100.0

Table SI-2F: Call handler Nationality distribution

Original	Frequency	Percentage	Transformed	Frequency	Percentage
British	763	87.9	British	763	87.9
Australian	11	1.3	Others	88	10.1
Irish	15	1.7			
Nigerian	10	1.2			
*Others**	52	6.0			
Not Declared	17	2.0	Not Declared	17	2.0
Total	868	100.0	Total	868	100.0

Table SI-2G: Call handler Distribution of marital status

Original	Frequency	Percentage	Transformed	Frequency	Percentage
Single	660	76.0	Single	660	76.0
Divorced	19	2.2	Divorced/Legally Separated/ Widowed	23	2.6
Legally Separated	3	0.3			
Widowed	1	0.1			
Married	112	12.9	Married/Civil Partnership	130	15.0
Civil Partnership	18	2.1			
Unknown	32	3.7	Not Declared	55	6.3
Missing	23	2.6			
Total	868	100.0	Total	868	100.0

Table SI-2H: Call handler Pay scale distribution

Original	Frequency	Percentage	Transformed	Frequency	Percentage

XN03	440	50.7	Band 3	440	50.7
XN04	428	49.3	Band 4	428	49.3
Total	869	100.0	Total	869	100.0

SI-3 Cox Proportional Hazard Assumption Testing

Performed using the 'cox.zph' function implemented in 'survival' which follows the diagnostics recommended by Grambsch and Therneau.

Table SI-3A. Cox PH diagnostic summaries for Paramedic data. A low p-value is evidence to reject the assumption of proportionality.

Variable		ChiSq	Df	p-value Interpretation
Age		0.70	1	-
Gender		0.01	1	-
Nationality		8.84	2	Moderate evidence (< 0.05)
Marital Status		14.41	3	Strong evidence (< 0.005)
Pay Scale		4.21	1	Moderate evidence (< 0.05)
Staff Absence Duration		1.29	1	-
Over time (hours)	Payment in lieu of break	17.28	1	Strong evidence (< 0.005)
	Planned	7.10	1	Good evidence (< 0.01)
	Unplanned	7.85	1	Good evidence (< 0.01)
Incidents (per Shift Worked)		7.12	1	Good evidence (< 0.01)
Incident by response location IMD (% of incidents attended)	IMD: 1	1.04	1	-
	IMD: 2	0.04	1	-
	IMD: 3 (excluded)			
	IMD: 4	0.15	1	-
	IMD: 5	2.10	1	-
	IMD: 6	6.64	1	Good evidence (< 0.01)
	IMD: 7	0.09	1	-
	IMD: 8	0.36	1	-
	IMD: 9	1.11	1	-
	IMD: 10	0.00	1	-
Job Cycle Time (Hours per Shift Worked)	"mobilisation"	5.86	1	Moderate evidence (< 0.05)
	"running"	5.15	1	Moderate evidence (< 0.05)
	"on scene"	6.57	1	Moderate evidence (< 0.05)
	"to hospital"	3.18	1	Weak evidence (< 0.1)
	"arrived at hospital to patient handover"	5.04	1	Moderate evidence (< 0.05)
	"patient hand over to clear"	5.25	1	Moderate evidence (< 0.05)
	Non JCT	9.19	1	Strong evidence (< 0.005)
Incident Category (per shift worked)	Calls from people with life-threatening illnesses or injuries (Cat 1)	0.28	1	-

	Emergency calls (Cat 2)	6.11	1	Moderate evidence (< 0.05)
	Urgent calls (Cat 3)	7.39	1	Good evidence (< 0.01)

Table SI-3B. Cox PH diagnostic summaries for Call handler data. A low p-value is evidence to reject the assumption of proportionality*.

Variable		**ChiSq**	**Df**	**p-value Interpretation**
Age		14.36	1	Strong evidence (< 0.005)
Gender		0.02	1	-
Nationality		0.48	2	-
Marital Status		2.06	3	-
Pay Scale		0.04	1	-
Staff Absence Duration		8.41	1	Strong evidence (< 0.005)
Over time (hours)	Planned	1.47	1	-

*P. Grambsch and T. Therneau (1994), Proportional hazards tests and diagnostics based on weighted residuals. *Biometrika,* **81**, 515-26.

SI-4 AFT Family decision metrics

Table SI-4. Summary of AIC and BIC values for Paramedic and Call handler AFT models with each distribution family. The families in bold are the optimal BIC, and hence the family selected for reporting.

Job Type	Family	AIC	BIC
Call handler	Weibull	5516	5606
	Gompertz	5541	5631
	Extreme value	**5513**	**5604**
	Log-logistic	5517	5607
	Log-normal	5530	5621
	Exponential	5539	5621
Paramedic	Weibull	4183	4472
	Gompertz	4402	4691
	Extreme value	4238	4527
	Log-logistic	**4110**	**4399**
	Log-normal	4380	4669
	Exponential	4425	4705

BMJ Open

AmReS - an observational retrospective time- to-event analysis of staff voluntary turnover in an English ambulance trust

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2024-098174.R1
Article Type:	Original research
Date Submitted by the Author:	21-Feb-2025
Complete List of Authors:	Cook, Robert; University of Staffordshire Shabuz, Zillur Rahman; Lancaster University Bennett, Matthew; London Ambulance Service NHS Trust East, Abigail; North West London Cancer Network Dube, Alisen; Staffordshire University Miller, Josh; West Midlands Ambulance Service NHS Foundation Trust Asaduzzman, Md; Staffordshire University, Department of Engineering Radford, Mark; NHS England Leary, Alison; London South Bank University, 412928 Jones, Sarahjane; Staffordshire University - Stafford Campus, School of Health and Social Care
Primary Subject Heading:	Health informatics
Secondary Subject Heading:	Emergency medicine, Health economics, Health services research
Keywords:	ACCIDENT & EMERGENCY MEDICINE, Burnout, Health Services, Health Workforce

I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our licence.

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which Creative Commons licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

AmReS - an observational retrospective time- to-event analysis of staff voluntary turnover in an English ambulance trust

Abstract

Objectives

The purpose of this study was to identify which, and to what extent, demographic and operational factors are indicative of likelihood for a new Call Handler or Paramedic to remain in-role within the first two years of employment at an Ambulance Trust using data held in the Trusts bespoke data warehouse.

Design

The study uses a retrospective observational cohort design using routinely collected data.

Setting

One Ambulance Trust focussed on a large, predominantly urban area in the UK.

Participants

The study used the data of all employees of the Trust that started employment as Call Handlers (869) or Paramedics (1,672) between the 1st of January 2018 to 31st July 2023.

Primary and secondary outcome measures

'Time to event' analysis of 'likelihood to remain in-post within the first two years of employment' as Call Handlers or Paramedics via Accelerated Failure Time (AFT) regression.

Results

Several factors showed a significant contribution to the likelihood of remaining in-post within an Ambulance NHS Trust. Among the findings, short term sick leave in the first two years of employment was associated with increased retention for Paramedics [0.040, 95%CI (0.030, 0.060)]. In addition, female Call Handlers were found to have increased retention [0.29, 95%CI (0.043, 0.54)], and Paramedic retention increased with time outside of 'Job Cycle Time' activities (i.e. activities other than responding to calls) [0.097, 95%CI (0.057, 0.14)].

Conclusions

This study presents a method for extracting new insights from routinely collected operational data, identifying common drivers and specific predictors for retention among the Ambulance NHS workforce. It emphasises the importance of workforce-centred retention strategies, highlighting the need for non-JCT time which in turn would allow paramedics to have time to reflect and recuperate to avoid burnout and attrition. The study also suggests that a lack of sick leave might indicate a lack of trust and self-care culture, potentially leading to paramedic staff attrition. Our approach to retention analytics provides a new mechanism for Trusts to monitor and respond to their attrition risks in a timely, proactive fashion.

Strengths and limitations of this study

Limitations:

- This was a single centre study, with an ambulance Trust focussed on a high population density urban area. However, the methodology will be transferrable to diverse settings.
- The study is an observational retrospective analysis, hence findings and patterns found in the data may be correlational not causational. Operational interventions taken from such findings need to be tracked to confirm the scale of the effect.

Strengths:

- The study has made use of real in-situ data reflective of the data and tasks as done. Hence, the replication of the work at other Trusts either as one-off insights or as part of their operational oversight is relatively resource inexpensive.
- The study makes use of routinely collected data so translation to different ambulance trusts is straightforward.
- The data continues to be collected, so the analytics can be deployed as a live intelligence tool.

Introduction

The National Health Service (NHS) stands as the largest employer in England, employing a workforce of over 1.3 million individuals[1, 2]. As of June 2024, there were over 100,000 job vacancies in the NHS [3] and staff shortages have been demonstrated to directly impact the quality and safety of care, patient experience, and staff work experience[4]. The increasing demand following the COVID-19 pandemic poses additional threats to staff retention, patient outcomes, and staff well-being[3, 5] and so workforce retention is a timely priority for the NHS, as outlined in the People Plan[6] and the NHS Long Term Workforce Plan[2].

Emergency medical services formed the frontline of the Covid-19 response and, particularly in England, are now faced with significant workforce shortages that affect their efficiency and effectiveness. Between 2021/22 and 2022/23 the average workforce vacancy rates for the ambulance sector increased from 3.6% to 6.6%[7], further exacerbated by reports that at least one in four paramedics have considered leaving their roles due to frustrations with inadequate patient services[8]. Those remaining in post face growing pressures to deliver a critical service where poor retention has already been linked to high levels of burnout, depersonalisation, heavy workloads, and feelings of being unsupported or regularly endangered[9-11].

Demands to compliment the current professional healthcare workforce are not novel. Health Education England (HEE) estimated that the NHS would require to recruit at least twice as many new paramedic trainees each year to meet future demand[12]. However, simply recruiting more staff risks leaving the underlying issues unresolved with the subsequent retention of staff potentially affected. Considered within the framework of Herzberg's motivator-hygiene theory of satisfaction[13], the environment into which a new hire arrives is key to the concept of workplace hygiene as mediated via co-worker relationships and work environment. Poor 'hygiene' leads to growing dissatisfaction within the workplace and hence any attempts to create satisfaction via 'motivator' mechanisms may go unrealised.

Herzberg's theory has been central to multiple studies of retention within healthcare, though few studies have focused on the EMS setting[14]. In the integrated urgent care (IUC) Workforce Blueprint[15] NHS England reflected on the findings of recent staff surveys, noting that while call handlers reported that they 'feel like they make a difference to patients and service users' the

common hygiene issues of work environment and support were present. Managers and policy makers are aware that over-work increases the prevalence of turnover, but what they don't have is reliable information as to when a staff member is overworking. There is no proactive mechanism to monitor the workforce for individuals at a heightened risk of attrition so they can address risks as they evolve, and hence we look to address this gap by studying attrition via an ambulance service's existing operational data.

Routinely collected data can be a valuable resource that complements current commonly used research methods that focus on staff feedback; healthcare providers can leverage readily available big data and specific analytical techniques to understand, monitor, and address issues related with workforce retention. Use of such data can provide a comprehensive view and insight into the contributory factors associated with staff turnover over time thus facilitate evidence-based development of retention strategies based on real time monitoring. Consequently, fostering a positive work environment that ensures a continuity of high-quality care. This study analyses operational data from a major English Ambulance Service to identify which, and to what extent, demographic and operational factors are indicative of likelihood for a new Call Handler or Paramedic to remain in-role within the first two years of employment at an Ambulance Trust.

Methods

This is a single centre retrospective observational study using anonymised routinely collected data from an Ambulance NHS Trust in England. The study period was set from the 1st January 2018 to 31st July 2023.

Data preparation

Seven data sets (see Table 1) were extracted from the Ambulance Trust's data warehouse using bespoke structured query language (SQL) scripts developed by the research team in collaboration with the ambulance trust's nominated business analysts. The business analysts were responsible for extracting the data and ensuring it was deidentified before sharing with the research team for analysis. 'Deidentification' was performed using an anonymization technique, replacing free text by a randomly generated alpha-numeric string which was then reused when the same free text reappeared and was outlined in the ethics application for the study.

Table -1: Summary of extracted data sets and variables

Dataset	**Description**	**File size‡**	**Variables of interest**
Employment records	Periods of employment for each member of staff. Each row represents one continuous period of employment.	2.1 MB N = 11,803	• Employee ID • Start/ end dates of 'employment' • Staff demographics.
Historical assignments	Time series of positions for each employee of the Trust. Each row represents one 'Assignment' (a period working in a given post and location) with periods of employment made up of multiple 'Assignments'.	12.1MB N = 104,852	• Employee ID • Start/ end dates of each 'Assignment' • Job title • Pay band • Indication if this was a period of active work or not (nonactive assignments including maternity leave and secondments)
Shifts	Time series of rostered and planned overtime shifts of individuals. Each row represents one shift of one individual.	191 MB N = 2,714,042	• Employee ID • Shift start/ end time • Assigned ambulance callsign (if applicable).
Incidents	Record of emergency service calls responded to by the ambulance service. Each row represents a call attended.	1.3 GB N = 11,382,236	• Responding ambulance callsign(s) • 'Job Cycle Times' (JCT)* • Conveyance† status • Index of Multiple deprivation (IMD) decile of response location.
Contacts	Record of all calls made to the ambulance service. Each row represents one call to the ambulance service.	548 MB N = 11,401,902	• Incident ID • Incident category
Overtime	Time series of work done beyond the rostered shifts. Each row is one period of overtime for one member of staff	186.5 MB N = 2,379,485	• Employee ID • Type of overtime (planned, unplanned, payments in lieu of breaks, etc.) • Time spent on overtime.
Staff Absence/ Sickness	Time series of short-term employee absences due to illness. Each row represents one period of sickness for one employee.	4 MB N = 63,125	• Employee ID • Start/ end data of absence.

*See SI-1 for descriptions of individual JCTs

†'Conveyance' refers to the transfer of a patient from the incident site to a hospital or equivalent location.

‡`N` refers to the number of rows of the data set.

Two separate datasets ('Call Handler' and 'Paramedic') were constructed from the historical assignment dataset using the job type variable. Using the employee identification number as assigned in Electronic Staff Record (ESR), the 'call handlers' and 'paramedics' historical assignment datasets were each aligned to the employment records, incidents, shift pattern, overtime, and staff absence/sickness. For analysis, each dataset by job type was subdivided into monthly units to create the time series structure required for the time-varying covariates in Accelerated Failure Time (AFT) and Cox Proportional Hazards (PH) analysis.

Prior to analysis the demographic taxonomies were aggregated, combining values with low representation in the data set (see SI-2 for the transformations and frequencies). The operational variables of interest (staff absence, time spent on each aspect of job cycle time (JCT), index of multiple deprivation (IMD) of incident location, and acuity category of incidents) were each corrected for an exposure to allow for their relative size. 'Time spent on each aspect of JCT' and 'incidents responded to by acuity category' were corrected for the number of shifts worked in that month. 'Time lost to absence' was corrected for the relative length of the month (length of month in days, unless assignment began or was terminated during the month). The 'jobs completed by IMD decile' were converted to 'percentage of incidents responded to within a given decile'. In the cases where no incidents were responded to in each month, e.g. during on boarding for newly qualified paramedics, IMD percentages were imputed via mean imputation (first by employee ID and then the data set average should an employee have never responded to an incident).

Inclusion criteria were judged against unique ESR numbers based on employment history. Data were included for those that were employed and working as a call handler or paramedic between the 1*st* of January 2018 and 31*st* July 2023 (inclusive of limits), exclusive of individuals that had moved down in pay bands to commence the post. The data set comprised all variables as described above for the first two years of employment within the specific role (call handler or paramedic) within the study period (i.e. an individual beginning a role on the 1*st of* July 2023 would have a censored observation after 31*st* July 2023). All data preparation was performed in R, making use of the 'tidyverse' framework[16]. Data was analyzed as it was recorded within the Trust database systems and the period for data extraction was dictated by the data available at the Trust.

Data Analysis

The analysis is interested in the effect of variables on time to event and hence data were analysed using time-varying covariates in 'Accelerated Failure Time' (AFT) regression (a type of survival analysis) following testing, and rejection of Cox Proportional Hazards (PH) regression (see SI-3 for Cox PH diagnostic tests). Usage of the Cox PH model where the proportional hazard assumption is not acceptable would have led to improper fitting of the model and incorrect inferences. AFT regression utilised the 'aftreg' function implemented in the 'eha: Event History Analysis' package[17]. Six distributions were considered as parameterisations of the AFT model ("Weibull", "Gompertz", "Extreme Value", "Log-logistic", "Log-normal", and "Exponential") with the optimal model selected using Bayesian Information Criteria (BIC) scores [see SI-4]. For this analysis, an event is defined as an employee quitting their job, being fired, or moved to a different role, and a nonevent is when an employee remained in their role either as a call handler or paramedic.

As the intention of this study is to characterize what can be learned from the available data, the sample size was not predetermined. To consider what sample size might be relevant to a properly powered study, a sample size of 796 individuals would be required to detect a 10% increase in odds for a step of one standard deviation in a non-binary covariate (assuming a 10% attrition rate, 5% significance level, and 80% power)[18].

The study obtained both university level and Health Research Authority (HRA) approval (IRAS ID: 301066).

Patient and Public Involvement and Engagement

Two lay representatives have been integral members of the research team, contributing to the project funding application, study design, delivery, and dissemination. Two further lay representatives have been members of the project's independent steering committee.

Results

Table 2 provides a summary of the Ambulance Trust data by job type (call handler and paramedic), percentages represent a proportion of the monthly data.

Call handler staff

Data for 868 call handlers were analysed, comprising a total of approximately 925 years of combined employment. The average age for call handlers was 31 years (standard deviation 9.4 years), 70.2% of the staff were recorded as female, 76.9% were single and 89.7% were declared as British nationals. In this study, 64.8% of call handlers were employed at 'Agenda for Change' (AfC) band 3 and on average each call handler worked 15 minutes extra as planned overtime per month. Time lost due to absence and sickness averaged 6.9% of each month (approximately 2.1 days). Due to the nature of their work, call handler data did not include Index of Multiple Deprivation (IMD), Job Cycle Time (JCT), and category of incidents per shift.

Paramedic staff

Data for 1,672 paramedics were analysed, comprising a total of approximately 2,567 years of combined employment. The average age of the paramedic workforce was 28 years (standard deviation 6.8 years), 52.2% of the staff were recorded as female, 80.3% were single and 47.2% declared as British nationals. In this study, 96.0% of paramedics were employed at band 5 and on average each worked 45.6 minutes extra as planned overtime and 12 minutes extra as unplanned overtime per month. Time lost due to absence and sickness amongst the paramedic staff averaged 3.9% of a month (approximately 1.2 days).

The paramedic staff responded to calls from a variety of locations representing different levels of deprivation as measured using the IMD; locations with IMD 2 and 3 recorded the highest percentage of incidents (18.0% and 20.0%, respectively), whereas locations with IMD 10 had the least percentage of incidents reported (2.1%).

During a shift, the paramedic spent most of their time actively responding to calls with this activity broken down into six 'Job Cycle Time' descriptions ('Mobilisation', 'Running', 'On scene', 'To hospital', 'Arrived at hospital to patient handover', and 'Patient handover to clear' with full definitions given in SI-1). Amongst these, on average most of their time was spent 'On Scene', i.e. with/ treating patients at the site of the incident, with the least time spent in 'Mobilisation'. The time spent on shift not responding to an incident (e.g. between incidents, attending meetings/training, or performing maintenance) is 'non-JCT time' which accounted for 3.2 hours of each shift on average.

Each call that is made to the ambulance service is triaged and assigned a 'categorisation' according to a nationally devised description. The greater the risk to patient life, the higher the categorisation, with Category 1 calls described as "Calls from people with life-threatening illnesses or injuries". Which calls receive an ambulance response, and hence become 'incidents', is decided by the Trust's dispatch team with priority given based on the

categorisation. On shift, the paramedics mostly experience Category 2 incidents ("Emergency calls", 3.2 incidents per shift on average) and would be expected to respond to one Category 1 incident ("life-threatening illnesses or injuries") for every 3 shifts worked (0.37 incidents per shift on average).

Table 2: Composition of the monthly data for Call Handler and Paramedic analyses. Each term reports 'mean (standard deviation)' unless otherwise stated.

Variable		**Monthly staff data**	
	Value	**Call handlers**	**Paramedics**
Staff demographics			
Age, years		31.0 (9.4)	28.0 (6.8)
Gender, %	Female	70.2%	52.2%
Nationality, %	British	89.7%	47.2%
	Not Declared	2.1%	1.4%
	Other	8.2%	51.4%
Marital Status, %	Divorced/ Legally Separated/Widowed	3.2%	1.9%
	Married/Civil Partnership	15.1%	13.2%
	Single	76.9%	80.3%
	Unknown	4.8%	4.6%
Staff pay scale			
Call handler, %	Band 3	64.8%	NA
	Band 4	35.2%	NA
Paramedic, %	Band 5	NA	96.0%
	Band 6+	NA	4.0%
Sickness/absence			
Staff Absence Duration (ratio of month)		0.069 (0.19)	0.039 (0.14)
Percentage of incidents attended in a month by Index of Multiple Deprivation (IMD) of incident location			
IMD: 1 (%)		NA	3.3 (4.2)
IMD: 2 (%)		NA	18.0 (10.0)
IMD: 3 (%)		NA	20.0 (10.0)
IMD: 4 (%)		NA	15.0 (7.7)
IMD: 5 (%)		NA	12.0 (7.1)
IMD: 6 (%)		NA	10.0 (6.8)
IMD: 7 (%)		NA	7.6 (6.1)
IMD: 8 (%)		NA	6.2 (5.5)
IMD: 9 (%)		NA	5.1 (5.9)
IMD: 10 (%)		NA	2.1 (3.8)
Job Cycle Time (JCT) -hours per shift worked			
'Mobilisation'		NA	0.079 (0.058)
'Running'		NA	0.62 (0.36)
'On scene'		NA	3.1 (1.70)
'To hospital'		NA	0.62 (0.37)
'Arrived at hospital to patient handover'		NA	0.82 (0.59)
'Patient handover to clear'		NA	0.63 (0.40)
Non JCT Time per Shift Worked		NA	3.20 (2.00)
Overtime (hours)			
Payment in lieu of break		NA	2.70 (3.10)

Planned		0.26 (2.3)	0.76 (2.20)
Unplanned		NA	0.20 (0.80)
Incident category per shift worked*			
Calls from people with life-threatening illnesses or injuries (Cat 1)		NA	0.37 (0.70)
Emergency calls (Cat 2)		NA	3.20 (1.90)
Urgent calls (Cat 3)		NA	1.20 (0.92)
Incidents (All categories) per Shift Worked		NA	5.10 (2.90)

*Calls of category 4 and above were removed from analysis due to rarity.

Ambulance workforce turnover

Factors affecting the ambulance workforce turnover were identified using the AFT regression models considering time-varying covariates with the BIC metric selecting the 'extreme value' and 'log-logistic' families for the Call Handler and Paramedic models respectively. The results of both analyses are reported in Tables 3 and 4 for Call Handlers and Paramedics respectively.

Factors impacting call handler turnover rates

Four factors were found to be associated with call handler workforce turnover: gender, nationality, pay scale, and average absence duration. There was strong evidence to suggest that call handlers employed at Band 4 were more likely to remain with their current employer longer (that is a reduced risk of turnover) compared to those employed at band 3 (0.61, CI: 0.33 to 0.89, p-value <0.005). A correlation between pay and retention was to be expected due to the pay progression structure of the Ambulance Trust; following their first-year employees move from Band 3 to Band 4 (with minimal exceptions) hence increased retention time may not be due to the higher banding, but instead the higher banding is an outcome of retention. There is evidence to suggest female call handlers were less likely to leave compared to their male counterparts (0.29, CI: 0.043 to 0.54; p-value <0.05). There was evidence to support a link between retention and call handler's nationality and absence duration (p-value <0.05); individuals who don't identify as 'British' have a higher risk of attrition and individuals with an increased level of sick leave have a reduced probability of remaining in the service.

Table 3. Summary of AFT* regression ('extreme value') for Job Type: Call handler.

Variable		**Estimate**	**95% CI**	**P-value †**	**Direction interpretation‡**
Age		-0.0079	(-0.021, 0.006)	-	-
Gender	Male (reference)	-	-	-	-
	Female	0.29	(0.043, 0.54)	< 0.05	...that time to leaving role increases if employee is female
Nationality	British (reference)	-	-	-	-
	Not Declared	0.26	(-0.8, 1.30)	-	-
	Other	-0.38	(-0.74, -0.025)	< 0.05	...that time to leaving role decreases if people do not identify as British
Marital Status	Single (reference)	-	-	-	-
	Divorced/ Legally Separated/Widowed	0.28	(-0.51, 1.10)	-	-
	Married/ Civil Partnership	0.00033	(-0.51, 1.1)	-	-
	Not Declared	0.21	(-0.38, 0.80)	-	-
Pay scale	Band 3 (reference)	-	-	-	-
	Band 4	0.61	(0.33, 0.89)	< 0.005	...that time to leaving role increases as pay increases
Staff Absence Duration (ratio of month)		-0.79	(-1.3, -0.3)	< 0.05	...that time to leaving role decreases as time lost to short term absences increases
Overtime: Planned (HRS)		0.16	(-0.065, 0.38)	-	-

*The AFT model is operating as a survival model in the implementation reported and hence a significant positive coefficient is indicative of an increased average survival time as the covariate increases.

†P-value limits have been drawn from 'An Introduction to Medical Statistics (Bland 2015)'[19].

‡Coefficients with p-value > 0.1 are represented by "-".

Factors impacting paramedic turnover rates

There was strong evidence to suggest that paramedic staff who worked more planned overtime or took sick leave were more likely to remain in service (p value < 0.005). Likelihood to leave the service was, for the most part, unaffected by the level of deprivation (as measured using IMD deciles) associated with the location of the incident except for the lower IMDs (locations with low levels of deprivation). The data suggests attending to incidents in least deprived areas (IMD 9 and 10) reduces turnover but attending incidents in the next lowest (IMD 8) bracket increases turnover. Responding to high calls from people with life-threatening and emergency illnesses or injuries results in high paramedic turnover. With the increase of time spent on driving patients to hospital there is a greater risk of attrition (-0.68, CI: -1.10 to -0.22; p-value < 0.005) whereas increased time spent at the scene of an incident, and between incidents (i.e. Non-JCT time) was linked to a reduced risk of attrition. There was evidence to suggest that paramedics employed at band 6 or above were more likely to leave compared to those employed at band 5 (-0.23, CI: -0.44 to -0.019, p-value <0.05). However, none of the paramedic staff demographics (age, gender, marital status, nationality) were found to be associated with staff turnover.

Table 4. Summary of AFT* regression ('log-logistic') for Job Type: Paramedic.

Variable		**Estimate**	**95% CI**	**P-value†**	**Direction interpretation‡**
Age		-0.0047	(-0.013, 0.0039)	-	-
Gender	Male (reference)				
	Female	0.061	(-0.038, 0.16)	-	-
Nationality	British (reference)				
	Not Declared	-0.21	(-0.54, 0.13)	-	-
	Other	0.018	(-0.084, 0.12)	-	-
Marital Status	Single (reference)				
	Divorced/ Legally Separated/ Widowed	0.14	(-0.24, 0.52)	-	-
	Married/ Civil Partnership	0.031	(-0.12, 0.18)	-	-
	Not Declared	-0.16	(-0.38, 0.05)	-	-
Pay Scale	Band 5 (reference)				
	Band 6+	-0.23	(-0.44, -0.019)	< 0.05	...that time to leaving role decreases as pay increases
Staff Absence Duration (ratio of month)		0.04	(0.03, 0.06)	< 0.005	...that time to leaving role increases as time lost to short term absences increases
Over time (hours)	Payment in lieu of breaks	0.28	(0.23, 0.34)	< 0.005	...that time to leaving role increases for employees who work through breaks
	Planned	0.25	(0.18, 0.32)	< 0.005	...that time to leaving role increases for employees who work planned overtime
	Unplanned	0.14	(-0.015, 0.3)	< 0.1	...that time to leaving role increases where employees work unplanned overtime
Incidents (per Shift Worked)		0.18	(-0.13, 0.5)	-	-
Percentage of incidents attended in a month by IMD of incident location$^{\alpha}$	IMD: 1(%)	0.0049	(-0.013, 0.023)	-	-
	IMD: 2 (%)	0.0042	(-0.0066, 0.015)	-	-
	IMD: 3 (%) (excluded)¥				
	IMD: 4 (%)	0.0083	(-0.0031, 0.02)	-	-
	IMD: 5 (%)	0.0006	(-0.01, 0.012)	-	-
	IMD: 6 (%)	-0.0037	(-0.015, 0.0072)	-	-
	IMD: 7 (%)	-0.0084	(-0.021, 0.004)	-	-
	IMD: 8 (%)	-0.028	(-0.038, -0.017)	< 0.005	...that time to leaving role decreases for employees who respond to more incidents at IMD:8 locales
	IMD: 9 (%)	0.014	(-0.00081, 0.03)	< 0.1	...that time to leaving role increases for employees who respond to more incidents at IMD:9 locales
	IMD: 10 (%)	0.034	(0.0079, 0.06)	< 0.05	...that time to leaving role increases for employees who

					respond to more incidents at IMD:10 locales
Job Cycle Time (Hours per Shift Worked)	'Mobilisation'	1.4	(-0.74, 3.6)	-	-
	'Running'	0.29	(-0.4, 0.98)	-	-
	'On scene'	0.18	(0.052, 0.31)	< 0.01	…that time to leaving role increases for employees who spend more time at the scene of incidents.
	'To hospital'	-0.68	(-1.10, -0.22)	< 0.005	…that time to leaving role decreases for employees who spend more time conveying patients.
	'Arrived at hospital to patient handover'	0.17	(-0.017, 0.36)	< 0.1	…that time to leaving role increases for employees who spend more time waiting at hospitals.
	'Patient handover to clear'	0.2	(-0.18, 0.58)	-	-
	Non JCT	0.097	(0.057, 0.14)	< 0.005	…that time to leaving role increases for employees who spend more time outside JCT tasks.
Incident Category (per shift worked)	Calls from people with life-threatening illnesses or injuries (Cat 1)	-0.33	(-0.64, -0.018)	< 0.05	…that time to leaving role decreases for employees who respond to more 'Category 1' incidents
	Emergency calls (Cat 2)	-0.32	(-0.63, -0.00)	< 0.05	…that time to leaving role decreases for employees who respond to more 'Category 2' incidents
	Urgent calls (Cat 3)	-0.068	(-0.42, 0.28)	-	-

*The AFT model is operating as a survival model in the implementation reported and hence a significant positive coefficient is indicative of an increased average survival time as the covariate increases.

†P-value limits have been drawn from 'An Introduction to Medical Statistics (Bland 2015)'[19].

‡Coefficients with p-value > 0.1 are represented by "-".

¥IMD: 3 was removed from the analysis feature space to avoid over-specification of the model and was selected for removal as the most frequently attended IMD, and hence giving the most power as a reference category.

αIMDs are ordered from IMD:1 (highest levels of deprivation) to IMD: 10 (lowest levels of deprivations).

Discussion

The objective of this study was to identify factors linked to staff retention/ turnover amongst the call handler and paramedic workforce. While there are several studies involving emergency service workforce (including ambulance, fire, and police services), there is paucity of evidence into factors impacting staff retention/ turnover among call handler and paramedic workforce within the UK. The complexities of retention, attrition, and related concepts involve numerous factors influencing employee well-being and motivation.

The NHS, as the largest public employer, boasts a diverse demographic representation. This study found that the impact of demographic characteristics on workforce retention varied. Specifically, there was evidence linking gender and nationality to retention rates within the first two years of employment among call handlers. However, this trend was not observed in the paramedic workforce. The role of nationality aligns with findings reported by Moscelli et al.[20], which highlighted that the impact of ethnicity on workforce retention was inconsistent across different clinical staff[20]. The role of gender, notably that female staff remain in entry level positions, reflect the concept of the 'sticky floor'[21] where women are less likely to move or pursue promotion or remain at the lower end of the pay scale perhaps due to fewer opportunities (if part time) or responsibilities that limit their mobility such as childcare or caring for older adults. Therefore, any effective strategy to alleviate NHS workforce pressures, whether through retaining current employees or recruiting new ones, must be tailored to consider the diverse characteristics of the workforce, rather than adopting a one-size-fits-all approach.

This study has found an association between employees that take short term sick or absence leave and a reduced risk of turnover in the paramedic workforce. An advantage for working for the NHS is that it provides paid sick leave for its employees, with the argument that paid sick leave reduces job instability associated with own or family member illness. The current study supports this argument, however it only accounts for short term sick leave. While extended sick leave might raise concerns about staff turnover, it is also plausible that a work environment that supports paid leave enables employees to attend to their own health needs or those of family members without risking their job security[22, 23], hence are likely to stay longer with their current employer. More so, paid sick leave has previously been associated with job satisfaction in other professions such as nursing; job satisfaction linked with pay and benefits has also been found to correlate with intentions to remain within the EMS profession[24, 25]. There is evidence to suggest that burnout and stress are prevalent within the ambulance service environment associated with declining mental health, with some studies reporting more than 40% of the staff experiencing burnout[11, 26]. Burnout and stress may be the driving forces contributing to high sickness rates amongst the ambulance workforce compared to other professions within the UK NHS[27]. A workplace culture that supports employees to attend to their own health needs can make a difference in reduction of staff turnover thus increasing workforce stability.

Constant demands, lengthy and extended shifts cause fatigue and exhaustion, symptoms of burnout, a condition commonly reported at a higher level in emergency services compared to other professionals in similar roles[28]. Recent studies have shown burnout as a contributor for poor mental health which poses a threat to ambulance workforce retention. Burnout is a state of emotional, physical, and mental exhaustion caused by prolonged stress linked to unsupportive management practices, long hours and physical demands of the paramedic role[11]. While this study did not directly measure burnout and stress; time lost due to sickness, incident category and JCT have been considered as proxy measures. Therefore, the AFT models presented in this paper mirror findings from other studies that suggest the link between

ambulance staff burnout, stress and staff retention. For instance, paramedics attending higher numbers of the most stressful incidents (Category 1 or 2) show an increase in their turnover risk which could suggest staff burnout. Interestingly, spending time between incident responses, reported as 'non-JCT' hours, shows a marked effect on retention (each hour per shift spent 'not responding' increase the average employment time by approximately 10%, (95% CI: 6% to 15%) within the first two years of employment). This suggests that factoring time between calls, allowing staff time to decompress or debrief before attending to their next job is beneficial for staff retention. In complex work environments, such as the ambulance sector, debriefing can serve as a valuable resource, enhancing team processes, promoting collaborative learning, and contributing to staff well-being and resilience by mitigating burnout [29].

An association between planned overtime variables and increased staff retention mirrors patterns from the wider staff satisfaction literature. Where overtime is voluntary and rewarded, as is the case for English paramedics, other studies have suggested a correlation with job satisfaction, and hence retention[30]. As the key mechanism here is that the overtime is voluntary, it would be improper to suggest that additional overtime would create retention. However, the uptake of voluntary overtime could be used as a proxy for satisfaction within the Trust for proactive workforce planning. A reduction in voluntary overtime would be suggestive of reduced satisfaction and the Trust may want to either intervene to mediate the root cause or increase its recruitment.

Within the wider literature on retention, it is common to consider the role of each variable within Herzberg's motivator-hygiene theory[13] in order to discriminate between the themes of workplace 'satisfaction' and 'dissatisfaction'. Within this context we can examine how each feature of the model contributes to retention. Arguably, the 'non-JCT' time represents a mediator for hygiene risks in the workplace (e.g. overwork) via both an implied limitation on work, and by creating space for mental recovery. Hence, in settings where dissatisfaction is developing (e.g. frozen salaries, policies lacking employee voice, or poor administration) theoretically greater non-JCT time could mitigate the dissatisfaction. The inverse would also be possible, and a Trust seeking to reduce non-JCT time while protecting staff retention levels should look to address workplace hygiene factors in tandem. We can consider the correlation between short term sick leave and retention not as a factor, but as a proxy for, a positive work environment, and by contrast a lack of short-term sick leave may serve as a marker for sub-groups of a Trust that lack a supportive managerial environment.

The model presented for paramedics is more complex, and as result more informative. This is not to say that call handlers could not benefit from an improved workplace, but rather that the data available for this study had greater limitations. Unfortunately, the workload of an individual call handler was not available in the current data reporting system operated at the Trust and so key variables around the acuity of their work, i.e. the equivalent of incident categorisation and attendance, could not be included in the model.

This study has several strengths. It repurposes routinely collected operational data from an ambulance NHS Trust, including call handler and paramedic data, to investigate retention factors at an individual level. Compared to existing literature, which focuses more on qualitative methods, this study benefits from the ease of replicating the analysis or translating it to other Trusts, as it utilises routinely collected data. The Trusts' existing business intelligence and system administration teams often have the necessary skills to extract and interpret the data, while a statistician or data scientist can readily transform and structure it. Assuming the Trusts' database systems remain static, such activities have an even lower barrier to replication at subsequent time points. This in-house activity has three key benefits:

summarising chronic themes in the data, providing a mechanism to predict the ranking of attrition risks for individuals, and allowing qualitative studies to focus on acute individualistic factors. However, this study was limited to a single ambulance trust, which may have resulted in missing pressures on older workforce members and those working in more rural or isolated environments. By developing the program around routinely collected operational data sets, the process of transferring the analytical techniques, if not the findings, is relatively simple and could be used to inform workforce-centred retention strategies.

The analysis presented here has key limitations; the study focusses on a single ambulance Trust which serves an area of high population density and is purely observational in nature. These facets mean the results may not generalise to other settings, either if the findings are applied at other Trusts or if findings are acted on the patterns detected may be either purely correlational or are the result of a causal latent variable which was absent from the model. However, due to the focus on readily available nationally agreed operational data which will have, if not an identical data structure, an equivalent in other Trusts, the analytics can be readily mapped to new settings and utilised as data sources for follow on confirmational intervention studies. With respect to the data collection instruments, a strong limitation is the inclusion of 'non-JCT' time, which is a broad category with a significant contribution to the model. It is possible not all aspects of time spent outside the 'JCT' descriptions are of equal importance in driving retention, and further research in this area is vital.

Conclusion

This study demonstrate that as pressures mount on the paramedic workforce it is key for workforce planners to allow for time between incidents for paramedics to reflect and recuperate should they wish to avoid high levels of attrition and burnout. The findings would suggest that while an overabundance of sick leave might be of traditional concern, an absence of sick leave amongst paramedic employees might serve as a warning that areas of the workplace lack a culture of trust and self-care which could lead to staff attrition. In addition, this study demonstrates a methodology for the extraction of novel knowledge from routinely collected operational data.

The transferability of the findings requires careful consideration. The underlying novel methodology to supplement our existing understanding of retention with data driven predictions is generalizable to any healthcare setting which has readily available operational data. Considering the specific signals observed, features may generalize should the target environment have the core employee protections (e.g. non-compulsory overtime with associated reward). Additionally, findings such as non-JCT and incident categorisation should be applied with nuance. Clearly a service needs to respond to the most intense incidents and operate as efficiently as possible, both to serve its population and to create the satisfaction of a hard job well done. While several of the lessons found here could transfer well to other high stress healthcare settings, with the accelerating pace of digital solutions in global healthcare a replication of the study to understand local drivers would often be more valuable. Whilst the study findings highlight common drivers, it also points out specific predictors for retention among Ambulance NHS workforce, thus underscoring the importance of workforce centred retention strategies.

The focus of this study was within the initial two years of joining the Trust due to the business priorities of the partner Trust. Retaining new entries to the workforce is clearly key in high pressure environments where the initial emotional shock of the job can lead to rapid burnout and attrition, however, maintaining staff past this point should not be overlooked. While this

study has taken steps to explore these factors for the under researched call handler group, the data available was strongly limited and future work is required to understand the impact of call acuity on staff satisfaction. In addition, this work has focussed on analysis from the perspective of a new joiner to the Trust, an equivalent analysis aiming to address likely attrition rates and the most likely group to protect/ plan to replace given the current makeup of the workforce would be an invaluable tool for planning recruitment priorities.

Acknowledgements

We extend our profound gratitude to the lay members, research site staff, and project steering committee members for their invaluable time and contributions.

Author contribution

The study was conceptualised by RC, AD, MR, AL and SJ. Methodology designed by RC, AD, AE, MA, JM, MR, AL and SJ. Statistical analysis, R code development, data extraction and data visualisation were carried out by ZRS, RC, MB, MA and AE. Service user voice was supplied by GV at all stages of the study. Project administration was carried out by AD, CW, JM and SJ. Validation was done by MA. RC acts as the guarantor for this study. The original draft was done by RC, with review and editing by RC, AD, ZRS, MB, GV, JM, MR, AL, and SJ.

Funding

This study is funded by The Health Foundation under the project “NuRS and AmReS: nurse and ambulance workforce retention and safety” as part of the ‘Efficiency Research Programme (Round 3)’.

Competing interests

None

Patient consent for publication

Not required as only annonymised data was shared from NHS Trusts for analysis.

Ethical review

The project underwent original review by Birmingham City University’s Faculty Academic Ethics Committee (reference: Jones /4858 /R(C) /2019 /Nov /HELS FAEC) in November 2019. Health Research Authority approval was granted in February 2020 (IRAS ID: 301066). As part of HRA approval, NHS Research Ethics Committee (REC) opinion was not necessary, because the project required access to anonymised data only, and therefore is exempt from REC review. An amendment was made and approved in September 2020 to reflect a change in sponsor to Staffordshire University and the addition of a Covid-19 analysis.

Data sharing statement

The data that support the findings of this study are not publicly available due to privacy reasons. Data are however available from the authors upon reasonable request and with permission of University of Staffordshire.

References

1. Sonja Stiebahl, Esme Kirk-Wade and Rachael Harker. NHS key statistics: England.

2. NHS. The NHS Long Term Plan.

3. Stiebahl S, Kirk-Wade E and Harker R. NHS Key statistics: England.

4. Care quality Commission. The state of the health care and adult social care in England 2022/23.

5. Mahase E. NHS faces significant pressure as flu and covid cases rise. BMJ 2022. DOI: 10.1136/bmj.o3028.

6. NHS England. We are the NHS: People Plan for 2020/21 - action for us all. Report no. 370.

7. NHS Digital. NHS Vacancy Statistics, England, April 2015 - September 2024, https://digital.nhs.uk/data-and-information/publications/statistical/nhs-vacancies-survey/april-2015---september-2024-experimental-statistics (2024, accessed 1st Dec 2024).

8. The Nuffield Trust. Ambulance staff strikes: facts and figures on the ambulance workforce.

9. Deakin M. NHS workforce shortages and staff burnout are taking a toll. BMJ 2022.

10. Blau G and Chapman SA. Why do emergency medical services (EMS) professionals leave EMS?. Prehosp Disaster Med 2016.

11. Beldon R and Garside J. Burnout in frontline ambulance staff. Journal of Paramedic Practice 2022.

12. National Audit Office. NHS England Ambulance Services .

13. Alshmemri M, Shahwan-Akl L and Maude P. Herzberg's two-factor theory. Life Science Journal 2017.

14. Peterson CE. *Effects of Herzberg's Hygiene Factors on Fire Department Paramedics*, ScholarWorks, 2019.

15. NHS England. Integrated Urgent Care (IUC) Workforce Blueprint, https://www.england.nhs.uk/urgent-emergency-care/nhs-111/integrated-urgent-care-nhs-111-workforce-blueprint/ (, accessed 12th January 2025).

16. Wickham H, Averick M, Bryan J, et al. Welcome to the Tidyverse. Journal of open source software 2019.

17. Broström G. *Event history analysis with R*: Chapman and Hall/CRC, 2021.

18. Hsieh FY and Lavori PW. Sample-Size Calculations for the Cox Proportional Hazards Regression Model with Nonbinary Covariates. Controlled clinical trials 2000. DOI: 10.1016/S0197-2456(00)00104-5.

19. Bland M. *An introduction to medical statistics*: Oxford university press, 2015.

20. Moscelli G, Nicodemo C, Sayli M, et al. Trends and determinants of clinical staff retention in the English NHS: a double retrospective cohort study. BMJ open 2024.

21. Williams CL. The Glass Escalator: Hidden Advantages for Men in the "Female" Professions. Social Problems 1992. DOI: 10.2307/3096961.

22. Hill HD. Paid sick leave and job stability. Work Occup 2013.

23. NICE. Workplace health: management practices.

24. Chapman SA, Blau G, Pred R, et al. Correlates of intent to leave job and profession for emergency medical technicians and paramedics. Career development international 2009. DOI: 10.1108/13620430910989861.

25. Patterson PD, Probst JC, Leith KH, et al. Recruitment and retention of emergency medical technicians: a qualitative study. J Allied Health 2005.

26. Miller E. The prevalence of stress and burnout in UK emergency ambulance service workers and its impact on their mental health and well-being. British Paramedic Journal 2021.

27. NHS Digital. NHS Sickness Absence Rates, January 2024 (2024, accessed 12/06 2024).

28. Adams CJ, Hough H, Proeschold-Bell RJ, et al. Clergy burnout: A comparison study with other helping professions. Pastoral Psychology 2017.

29. Chen J, Bamberger PA, Song Y, et al. The Effects of Team Reflexivity on Psychological Well-Being in Manufacturing Teams. Journal of applied psychology 2018. DOI: 10.1037/apl0000279.

30. Beckers DGJ, van der Linden D, Smulders PGW, et al. Voluntary or involuntary? Control over overtime and rewards for overtime in relation to fatigue and work satisfaction. Work & Stress 2008. DOI: 10.1080/02678370801984927.

SI-1 Paramedicine Terminology

Table SI-1A. 'Job Cycle Time' (JCT) descriptions.

JCT term	Description
'Mobilisation'	The time spent between being assigned a new incident and beginning to travel to the incident.
'Running'	The time spent to travel to the site of an incident.
'On scene'	The time spent at the incident site.
'To hospital'	[If patient conveyed] The time spent transferring a patient from the incident to a hospital premises.
'Arrived at hospital to patient handover'	[If patient conveyed] The time spent waiting at hospital premises for the patient to be transferred to the hospitals care.
'Patient handover to clear'	[If patient conveyed] The time spent after the patient has been transferred to the hospitals care, e.g. completing medical notes and ensuring vehicle is prepared.
'Non-JCT Activity'	Activities undertaken on shift that are outside the bounds of the 'JCT'. Examples include time spent: • between dispatched incidents • on maintenance • in meetings • in training

SI-2 Demographic taxonomy tables

Summary of demographic taxonomies as found in the supplied data ('Original') as opposed to the aggregated terms used in analysis ('Transformed'), with frequencies based on head count.

Table SI-2A: Paramedic Gender distribution

Original	Frequency	Percentage
Male	798	47.7
Female	874	52.3
Total	1672	100.0

Table SI-2B: Paramedic Nationality distribution

Original	Frequency	Percentage	Transformed	Frequency	Percentage
British	795	47.5	British	795	47.5
Australian	641	38.3	Others	853	51.0
Irish	40	2.4			
Namibian	28	1.7			
New Zealander	31	1.9			
Nigerian	10	0.6			
South African	39	2.3			
*Others**	64	3.8			
Not Declared	24	1.4	Not Declared	24	1.4
Total	1672	100.0	Total	1672	100.0

Table SI-2C: Paramedic Distribution of marital status

Original	Frequency	Percentage	Transformed	Frequency	Percentage
Single	1334	79.8	Single	1334	79.8
Divorced	28	1.7	Divorced/Legally Separated/ Widowed	35	2.1
Legally Separated	6	0.4			
Widowed	1	0.1			
Married	171	10.2	Married/Civil Partnership	219	13.1
Civil Partnership	48	2.9			
Unknown	74	4.4	Not Declared	84	5.0
Missing	10	0.6			
Total	1672	100.0	Total	1672	100.0

Table SI-2D: Paramedic Pay scale distribution

Original	Frequency	Percentage	Transformed	Frequency	Percentage
XR05	1510	90.3	Band 5	1510	90.3
XR06	157	9.4	Band 6+	162	9.7
XR07	5	0.3			
Total	1672	100.0	Total	1672	100.0

Table SI-2E: Call handler Gender distribution

Gender	Frequency	Percentage
Male	267	30.7
Female	601	69.3
Total	868	100.0

Table SI-2F: Call handler Nationality distribution

Original	Frequency	Percentage	Transformed	Frequency	Percentage
British	763	87.9	British	763	87.9
Australian	11	1.3	Others	88	10.1
Irish	15	1.7			
Nigerian	10	1.2			
*Others**	52	6.0			
Not Declared	17	2.0	Not Declared	17	2.0
Total	868	100.0	Total	868	100.0

Table SI-2G: Call handler Distribution of marital status

Original	Frequency	Percentage	Transformed	Frequency	Percentage
Single	660	76.0	Single	660	76.0
Divorced	19	2.2	Divorced/Legally Separated/ Widowed	23	2.6
Legally Separated	3	0.3			
Widowed	1	0.1			
Married	112	12.9	Married/Civil Partnership	130	15.0
Civil Partnership	18	2.1			
Unknown	32	3.7	Not Declared	55	6.3
Missing	23	2.6			
Total	868	100.0	Total	868	100.0

Table SI-2H: Call handler Pay scale distribution

Original	Frequency	Percentage	Transformed	Frequency	Percentage

XN03	440	50.7	Band 3	440	50.7
XN04	428	49.3	Band 4	428	49.3
Total	869	100.0	Total	869	100.0

SI-3 Cox Proportional Hazard Assumption Testing

Performed using the 'cox.zph' function implemented in 'survival' which follows the diagnostics recommended by Grambsch and Therneau.

Table SI-3A. Cox PH diagnostic summaries for Paramedic data. A low p-value is evidence to reject the assumption of proportionality.

Variable		ChiSq	Df	p-value Interpretation
Age		0.70	1	-
Gender		0.01	1	-
Nationality		8.84	2	Moderate evidence (< 0.05)
Marital Status		14.41	3	Strong evidence (< 0.005)
Pay Scale		4.21	1	Moderate evidence (< 0.05)
Staff Absence Duration		1.29	1	-
Over time (hours)	Payment in lieu of break	17.28	1	Strong evidence (< 0.005)
	Planned	7.10	1	Good evidence (< 0.01)
	Unplanned	7.85	1	Good evidence (< 0.01)
Incidents (per Shift Worked)		7.12	1	Good evidence (< 0.01)
Incident by response location IMD (% of incidents attended)	IMD: 1	1.04	1	-
	IMD: 2	0.04	1	-
	IMD: 3 (excluded)			
	IMD: 4	0.15	1	-
	IMD: 5	2.10	1	-
	IMD: 6	6.64	1	Good evidence (< 0.01)
	IMD: 7	0.09	1	-
	IMD: 8	0.36	1	-
	IMD: 9	1.11	1	-
	IMD: 10	0.00	1	-
Job Cycle Time (Hours per Shift Worked)	"mobilisation"	5.86	1	Moderate evidence (< 0.05)
	"running"	5.15	1	Moderate evidence (< 0.05)
	"on scene"	6.57	1	Moderate evidence (< 0.05)
	"to hospital"	3.18	1	Weak evidence (< 0.1)
	"arrived at hospital to patient handover"	5.04	1	Moderate evidence (< 0.05)
	"patient hand over to clear"	5.25	1	Moderate evidence (< 0.05)
	Non JCT	9.19	1	Strong evidence (< 0.005)
Incident Category (per shift worked)	Calls from people with life-threatening illnesses or injuries (Cat 1)	0.28	1	-

	Emergency calls (Cat 2)	6.11	1	Moderate evidence (< 0.05)
	Urgent calls (Cat 3)	7.39	1	Good evidence (< 0.01)

Table SI-3B. Cox PH diagnostic summaries for Call handler data. A low p-value is evidence to reject the assumption of proportionality*.

Variable		**ChiSq**	**Df**	**p-value Interpretation**
Age		14.36	1	Strong evidence (< 0.005)
Gender		0.02	1	-
Nationality		0.48	2	-
Marital Status		2.06	3	-
Pay Scale		0.04	1	-
Staff Absence Duration		8.41	1	Strong evidence (< 0.005)
Over time (hours)	Planned	1.47	1	-

*P. Grambsch and T. Therneau (1994), Proportional hazards tests and diagnostics based on weighted residuals. *Biometrika,* **81**, 515-26.

SI-4 AFT Family decision metrics

Table SI-4. Summary of AIC and BIC values for Paramedic and Call handler AFT models with each distribution family. The families in bold are the optimal BIC, and hence the family selected for reporting.

Job Type	Family	AIC	BIC
Call handler	Weibull	5516	5606
	Gompertz	5541	5631
	Extreme value	**5513**	**5604**
	Log-logistic	5517	5607
	Log-normal	5530	5621
	Exponential	5539	5621
Paramedic	Weibull	4183	4472
	Gompertz	4402	4691
	Extreme value	4238	4527
	Log-logistic	**4110**	**4399**
	Log-normal	4380	4669
	Exponential	4425	4705