THE UNIVERSITY *of* EDINBURGH

THE UNIVERSITY *of* EDINBURGH

Social contagion and environmental predictors of violent and aggressive behaviour

Jake Easto

Submitted in part fulfilment of the Doctorate in Clinical Psychology at the University of Edinburgh March 2022

Table of Contents

DClinPsychol Declaration of Own Work

Name: Jake Easto

Title of Work: Social contagion and environmental predictors of violent and aggressive behaviour

I confirm that this work is my own except where indicated, and that I have:

- Read and understood the Plagiarism Rules and Regulations
- Composed and undertaken the work myself
- Clearly referenced/listed all sources as appropriate
- Referenced and put in inverted commas any quoted text of more than three words (from books, web, etc.)
- Given the sources of all pictures, data etc. that are not my own
- Not made undue use of essay(s) of any other student(s), either past or present (or where used, this has been referenced appropriately)
- Not sought or used the help of any external professional agencies for the work (or where used, this has been referenced appropriately)
- Not submitted the work for any other degree or professional qualification except as specified

- Acknowledged in appropriate places any help that I have received from others (e.g. fellow students, technicians, statisticians, external sources)
- Complied with other plagiarism criteria specified in the Programme Handbook
- I understand that any false claim for this work will be penalised in accordance with the University regulations
- Received ethical approval from the School of Health in Social Science, University of Edinburgh

OR

- Received ethical approval from an approved external body and registered this application and confirmation of approval with the School of Health in Social Science's Ethical Committee

Signature ……Jake Easto…… **Date** ……01/03/2022……

Acknowledgments

I would like to thank my clinical and academic supervisors Prof. Gary Macpherson, Dr Suzanne O'Rourke and Dr Gordon Ross, for their support, guidance and input throughout the research process. I would also like to thank Dr Gordon Ross' colleagues in the department of mathematics Dr Daniel Paulin and Trinnhallen Brisley, for their support in helping me to develop Hawkes's process model and instructing me how to use it correctly. I would also like to give thanks to all my placement supervisors and the rest of my cohort for their support over the previous years.

I would especially like to thank my wife Chloe who has been an unending source of emotional and practical support throughout my life and especially over the last couple of years. Similarly, I would like to thank my parents and my friends for their love and support throughout this process.

List of abbreviations utilised

DPIA - Data Protection Impact Assessment

LARCD - Longitudinal Analysis of Routine Collected Data

NICE - National Institute of Clinical Excellence

PTSD – Post Traumatic Stress Disorder

PAA - Personal Attack Alarms

RMO – Registered Medical Officer

TSH – The State Hospital

V&A – Violence and/or Aggression

Research Portfolio Abstract

Introduction

Previous research investigating incidents of violence and aggression (V&A) within secure forensic settings have typically focused on individual factors of patients such as diagnosis and previous engagement in violent behaviour. The current thesis aims to complete an investigation of environmental effects which may influence rates of V&A within secure forensic mental health settings. A systematic review was undertaken to identify, synthesizes and evaluate the available research investigating environmental factors affecting rates of V&A within forensic mental health settings. Secondly an empirical study was completed which investigated the roles of temporal, meteorological and social contagion effects within a high security forensic hospital as they relate to rates of V&A.

Methods

A systemic search of relevant databases identified twenty-two studies meeting the pre-defined search criteria. The results of these studies were synthesised and discussed in the context of four groupings of effects: temporal & seasonal effects; meteorological effects; staff factors and ward characteristics. An assessment of the studies methodological quality was also completed.

The empirical paper was a retrospective cohort study which will followed an observational cross-sectional design. Routinely collected data about incidents of V&A were collatedcollected between the dates 26/06/2012 to the 30/09/2021. This data was combined with available meteorological data. Temporal & meteorological effects were investigated

using regression models~~.~~, while social contagion effects were investigated utilising a discreet Hawkes process.

Results

The results of the systematic review indicate that environmental effects are~~is~~ a growing area of research interest which suffers due to inconsistency in the methodological strength of some of the studies. However, there is evidence to support the inclusion of temporal effects, staff factors and ward characteristics into dynamic risk assessments. The need to consider temporal factors was further supported by the results of the empirical study which found a significant day of the week, and time of day effect. These results are discussed in the context of typical routines of the study hospital. There currently exists insufficient evidence to comment fully on the effect of meteorological conditions as they relate to rates of V&A. The application of the Hawkes process provided some tentative evidence to support the theory that incidents of V&A are spread in part by a social contagion effect.

Conclusion

The current thesis provides good evidence to support the use of the environmental factors within dynamic risk assessments, as there is clear evidence that the risk of V&A is not a constant ~~entity~~, but instead fluctuates and is influenced by a number of environmental factors. Secondly, it is possible that an environmental effect such as shift change overs, medication distribution or being made aware of previous acts of V&A may be leading to increases in V&A. These findings may be significant in planning future hospital routines and systems to reduce the possible build of environmental pressures.

Keywords: Violence; Aggression; Forensic; Secure; Environmental; Weather; Meteorological; Temporal; Seasonality: Social Contagion: Hawkes Process.

Lay Summary

Previous studies looking at how much violence occurs within forensic hospitals, have mostly looked at what are the personal characteristics of people who have become violent. ~~research looking at rates of violence and aggression in secure forensic hospitals have mainly focused on the personal characteristics of patients to predict if they are likely to become violent or aggressive.~~ The current study~~thesis~~ will instead look at different environmental effects such as the weather to see if they are important in predicting when incidents of violence might occur.~~ investigated how different environmental factors might also play an important role in predicting when incidents of violence and aggression might occur.~~

Initially we looked at all of the previously published studies that we could find looking at ~~available research that we could find which studied the role of~~ environmental effects linked to incidents of violence~~ and aggression~~, within forensic ~~inpatient~~ hospitals. We were able to identify four groups of effects~~ All of this information was combined together into four headings~~; temporal & seasonal effects; meteorological effects; staff factors and ward characteristics. We then ~~also~~ assessed the quality of each of the included studies using a standardised method, this is a common practice to ensure the studies meet a good scientific standard. Twenty-two studies were found and commented on in this way. The findings of these studies seem to suggest that more violence occurs in the summer, on weekdays and when staff shifts are changing over. There is also evidence to suggest that having more female and senior staff on shift may reduce the likelihood of violence ~~of~~ happening~~ and aggression occurring~~. Overall, there seems to be good evidence to suggest that environmental

effects~~factors~~ should be considered when assessing the risk of violence in forensic hospitals ~~completing risk assessments~~.

We also completed a research project in a ~~an in-patient~~ forensic hospital to investigate some of these environmental effects. We gathered information on all of the incidents of violence ~~and aggression~~ that occurred between 26/06/2012 to the 30/09/2021. Firstly the study investigated if the ~~We then investigated to see if the~~ month, day of the week or time of day influenced how often incidents of violence occurred.~~had a significant effect on the likelihood of an incident occurring.~~ Similarly, we investigated the effects that different weather conditions had on the rate of how often incidents of violence happened ~~and aggression~~. Finally, we investigated if incidents of violence ~~and aggression~~ seemed to "spread" by one incident making another in the near future more likely and if this was influenced by the hospitals alarm system. We found that the weather did not seem to effect the rates of violence ~~and aggression~~. However, we did find that violence was less likely to occur on the weekend and noted that violence was more likely to happen ~~there were two peaks of aggression in any one day occurring~~ in the morning and late afternoon. Finally, there was some evidence to suggest that incidents of violence might spread.~~is some tentative evidence to support the theory that incidents of violence and aggression might be spread in part by being made aware of previous incidents leading to increased stress responses in the patient~~.

Chapter 1 – systematic review

A systemic review of environmental factors affecting rates of violence within forensic mental health facilities

Jake Easto[1,2], Suzanne O'Rourke[1,2], Gary Macpherson[1,3], Marek Baran[1]

[1] The School of Health in Social Science, the University of Edinburgh.

[2] NHS The State Hospital

[3]Erasmus University of Rotterdam

Prepared for submission to the journal **Aggression and Violent behaviour** (impact factor – 4.382)

Word count = 8259

Abstract

Title

A systemic review of environmental factors affecting rates of violence within forensic mental health facilities.

Background

Violence and aggression (V&A) are consistent problems within forensic mental health facilities, leading to a reduced quality of life for both patients and staff. Typically risk assessments have focused on individual patient risk factors, with little focus paid to possible environmental risk factors for aggression.

Aims

To synthesize the available research evidence for environmental risk factors for V&A within forensic mental health settings. Secondly to assess the methodological quality of the identified papers. Finally, to make recommendations about future research in terms of focus and methodology.

Methods

A systematic review of the literature was conducted. The electronic databases PsycINFO, EMBASE, MEDLINE, SCOPUS, CINAHL and Cochrane were searched from inception to 09/07/2021. An assessment of the identified studies methodological quality was conducted before the findings were synthesized.

Results

Twenty-two studies met the inclusion ~~and exclusion~~ criteria and were included in this review. The identified studies were highly varied in their methodological quality. The included environmental effects could be separated into temporal & seasonal effects; meteorological effects; staff factors and ward characteristics.

Discussion

The current review has highlighted the need to consider environmental factors such as temporal factors when considering risk assessment for forensic in-patient hospitals. There is some tentative evidence to support increased violence during the summer, weekdays and during staff change overs. Similarly ward characteristics and staff make up such as gender ratios appear to be important in predicting increased levels of aggression. However, there is a need for higher quality research in this area.

Section 1: Introduction

It is well accepted that violence and aggression represents a significant and persistent problem within inpatient mental health services (Newbill et., 2010; Johnson, 2004; Schablon et al., 2018; Flannery et al., 2011; Odes et al., 2021). Staff ~~and other patients~~ are frequently the victim of verbal and physical aggression which is linked to increased levels of burnout, workplace fear and a reduction in workplace satisfaction (Elliott & Daley, 2013; Lanza, 1983; Needham et al., 2005). This can result in an atmosphere of fear which negatively ~~e~~affects patients and can lead to increased levels of stigmatization of mental health patients (Duxbury et al., 2015; Ramesh et al., 2018). It has also been found that rates of violence are higher in forensic services than in general psychiatry (Bowers et al., 2011). Therefore, there is a pressing need for good quality research investigating the causes of violence within

forensic mental health environments. It is hoped that a greater understanding of the underlying causes of V&A may help support interventions which mitigate its ~~c~~effects.

Research investigating V&A within forensic mental health services typically focuses on individual variables which are associated with increased levels of violence. This research has been highly influential and important in identifying potential risk factors within secure mental health services. Previous research in the area has identified a number of potential risk factors connected to increased levels of violent behaviour including: ~~has identified~~ a diagnosis of psychosis, age, traits of psychopathy, traumatic brain injury, adverse childhood incidents and a history of drug use ~~as important factors to consider in an assessment of an individual's risk of violence~~ (Brown, O'Rourke, & Schwannauer, 2019; Karatzias et al., 2019; Hogan & Ennis, 2010; Lindsey et al., 2004). However, the National Institute of Clinical Excellence (NICE) have highlighted the need to consider contextual factors in the management of V&A and this may be an area which is somewhat more neglected in research (NICE, 2005; Wright et al., 2014; Harmin, ~~H~~Lennaco & Olsen, 2009).

This trend is also seen in previously published systematic reviews, which have also typically focused on patient individual risk factors and behaviours (e.g., Greer et al., 2020; Papadopoulos et al., 2012; Lozzino et al., 2015). There have been some attempts to include environmental risk factors within systematic reviews such as Johnson (2004) and Harmin, Lennaco & Olsen (2009).~~), both of which included some environmental factors as part of their reviews.~~ However, neither review provided an in-depth analysis of potential environmental risk factors, only mentioning which effects were included in studies, they also included individual risk factors. Two other notable attempts include Spaducci et al, (2018) which investigated the effect of the smoking ban and MohammadiGorji et al, (2021) which looked at the effect of physical architecture on rates of violence in emergency rooms.

However, none of these reviews have taken an in depth and critical view of all possible environmental risk factors in the way the current review has.

The role of environmental risk factors can be conceptualised in a number of different ways, in one sense we can think about them as dynamic and changing risk factors, which if better understood may be able to inform and guide clinical decision making (Douglas & Skeem, 2005). They are also often attached to the concept of the therapeutic milieu, which describes the feel or atmosphere of treatment environments. It is a concept which primarily focuses on trying to describe the level of cooperation and trust which exists between clinicians and patients, but also pleasant and safe physical environments (Mahoney et al., 2009). It is also a concept which has come under fire at times for its lack of clarity and relevance in modern medicine (Redl, 1959; Thomas, Shattell & M~~m~~artin, 2002). Similarly many of the scales used to measure the therapeutic milieu have failed to keep pace with the changing face of hospital environments (Banks & Priebe, 2020).

There has perhaps been more focus on environmental risk factors within the qualitative research base. Two recent qualitative synthes~~e~~is and thematic analyses (Gudde et al., 2015; Staniszewska et al., 2019) investigated patient's experiences of V&A and what they believed were the most important contributing factors. These reviews provided stark findings noting that many patients found ward environments to feel busy, uncaring, stressful, and unsafe. The studies highlighted the need for meaningful activity, privacy, leisure time and supportive relationships with well trained staff (Gudde et al., 2015; Staniszewska et al., 2019). It should be noted however that the patients in contrast to the staff are more likely to see V&A as the result of being overwhelmed by environmental factors (Hinsby & Baker, 2004). These studies highlight the need for more focus on ward environments, the current review represents one of the first attempts to investigate and synthesise purely environmental effects on violence within forensic in-patient units.

There have been previous attempts to investigate the relationship between environmental factors and rates of V&A, often these studies will be completed with a public health agenda in mind. Previous studies have shown that environmental effects such as the weather may be influencing the symptomology of those with mental health disorders (McWilliams, Kinsella & O'Callaghan, 2013; Salib & Sharp, 2002). Specifically, Salib & Sharp (2002), found a significant correlation between humidity and psychiatric admissions. McWilliams, Kinsella & O'Callaghan~~n~~ (2013), in contrast were~~as~~ unable to identify any significant correlations between weather events and hospital admission for psychosis in Ireland. There is also a growing evidence base for the association of increased ambient temperatures and their link to increased violent crime, suicide and the worsening of mental health symptomology (Anderson et al., 2000; Field, 1992; Hansen et al., 2008; Thompson et al., 2018). Other studies have explored the relationship between access to green and blue spaces within urban environments and their effects on mental health (Dzhambov et al., 2018; Wood et al., 2017). However, all these studies highlight that the relationship between weather conditions and mental health is not well understood and requires further investigation. It also important to explore the behavioural processes by which these relationships are expressed, such as increased daylight and higher temperatures leading to more time spent socialising outside, which in turn leads to increased rates of violence and aggression.

In recent years there has been growing support for the use of the Safewards model (Bowers et al., 2014) within in-patient mental health setting. The primary aim of the model is to reduce the incidence of violence and the use of coercive interventions. This is achieved through the use of new interventions and environmental changes such as changes to décor and offering more choice of activities. The model highlights the need to develop good therapeutic relationships and encourages clear and consistent messaging. A recent systematic review

suggests that the Safewards model, when implemented correctly, may lead to reduced incidents of violence (Finch et al, 2021).

Ulrich, Bogren & Lundin~~,~~ produced a paper in 2012 in which they tried to pull together the available research to make suggestions about how new psychiatric facilities should be built and developed. This 10-year-old paper highlighted that the investigation of environmental effects was an underrepresented area of research. This paper developed a tentative model of how patients stress can be mitigated by environmental changes. The paper highlighted the importance of developing mental health facilities which have access to gardens, views of green spaces, single occupancy rooms and daylight exposure. The~~ is~~ paper ~~highlighted~~went on ~~to~~ empathise the need for good research focused on environmental predictors of V&A, in order to build quality new facilities.

The intended aims of this review are to~~:~~ synthesise the available research base of environmental risk factors for V&A within forensic mental health settings. Secondly to assess the methodological quality of the identified papers. Finally, to make recommendations about future research in terms of focus and methodology.

Section 2: Method

2.1 Review protocol

The present~~ed~~ review was completed following PRISMA Guidelines (Moher et al, 2009)~~, and a protocol of the review's design was submitted to PROSPERO before the review commenced~~. The review protocol and search strategy were developed from initial scoping searches in the topic area using Google Scholar.

Commented [EJ1]: I was certain I had registered with Prospero, but looking for it now on my account I cant find it and so have removed this sentence.

Commented [KJ2R1]: No problem, thanks Jake.

2.2 Search strategy

An initial search was completed by the lead author to ensure the viability of the review. A search using Google Scholar and PROSPERO ~~Prospero~~ was completed to ensure that a similar review had not been completed recently, no such reviews were identified. Secondly an initial scoping review was completed to help develop and refine search terms from identified articles.

The lead author then completed a search of electronic bibliographic databases including: PsycINFO, EMBASE, MEDLINE, SCOPUS, CINAHL and Cochrane. All searches took place between 09/07/2021 and 10/07/2021; t~~T~~he software, Covidence was used to store and manage all identified references. There were no restrictions placed on dates of publication. The search strategy was initially left broad to identify all relevant articles and made use of appropriate wild card functions and BOOLEAN operators. The reference lists for identified articles were also manually searched to ensure no possible relevant articles were excluded. The utilised search terms were:

- **Terms relating to mental health populations:** (psychiat* or mental* or forensic) and (hospital* or ward* or inpatient* or "in-patient"* or unit* or facilit*)
- **Terms relating to violence or aggression:** aggressi* or violen* or anger
- **Terms relating to environmental factors:** ecolog* or environ* or heat* or temperature* or routine* or tim* or staff or activit* or boredom

2.3 Study inclusion and exclusion criteria

2.3.1 Population

The review focused on forensic in-patient populations, this included both male and female patients. Both adult and juvenile populations were eligible for inclusion. However, the review excluded general inpatient, prison, and community mental health populations. Where a study included a mixture of forensic and non-forensic patients, the study was included.

2.3.2 Independent variable

The review's primary goal was to explore environmental variables which affected incidents of V&A. For a review to be included it must have at least one measure of environmental effect. An environmental effect is any measurable phenomenon present within the hospital, which is not an intended intervention or treatment, but can include normally occurring phenomenon which have been manipulated for the purposes of experimentation. Studies were not included if the environmental effect was unclear or unmeasurable.

2.*3.3 Outcome measure*

The review was interested in looking at rates of V&A, therefore only studies which provided a measurement of V&A were included. This included incidents of verbal aggression or self-harm (violence against the self). Studies which used a proxy measurement of V&A such as the use of coercive measures like restraint or seclusion were also eligible for inclusion.

2.3.4 Study design

The review only included quantitative research papers, which included cohort, cross sectional & longitudinal studies. Single case design studies and purely qualitative methodologies were excluded from the review. Non-English language papers were not included due to resource limitations.

2.3.5 Amendment of inclusion criteria

There were two specific changes to the inclusion and exclusion criteria which occurred during the screening phase of this review. Firstly, it was decided not to include studies which were evaluating the ~~s~~Safe ~~-~~wards model, due to the highly combined nature of environmental changes and interventions present within this model. A systematic review evaluating the effectiveness of the safe wards model was also recently published (Finch et al., 2021). Initially a broader search strategy was adopted due to concerns there would be an insufficient number of papers, however this proved to be untrue which allowed us to revert the focus back to forensic only populations. Thus, it was decided to reintroduce forensic populations as an inclusion criterion.

2.4 Study Selection

A total of **13462** papers were identified from the search, with **5281** duplicates being removed automatically by Covidence software, a further **7** were removed for being duplicates during the screening phase. Titles and abstracts were screened by the primary author against the identified inclusion and exclusion criteria, leading to **7659** articles being found to be irrelevant. The remaining **522** articles underwent a full text review against the inclusion and exclusion criteria previous described. This resulted in **22** studies being included in this review. A full break down of all identified papers and the reasons for exclusion can be seen in the PRISMA flow diagram in **fig.1**.

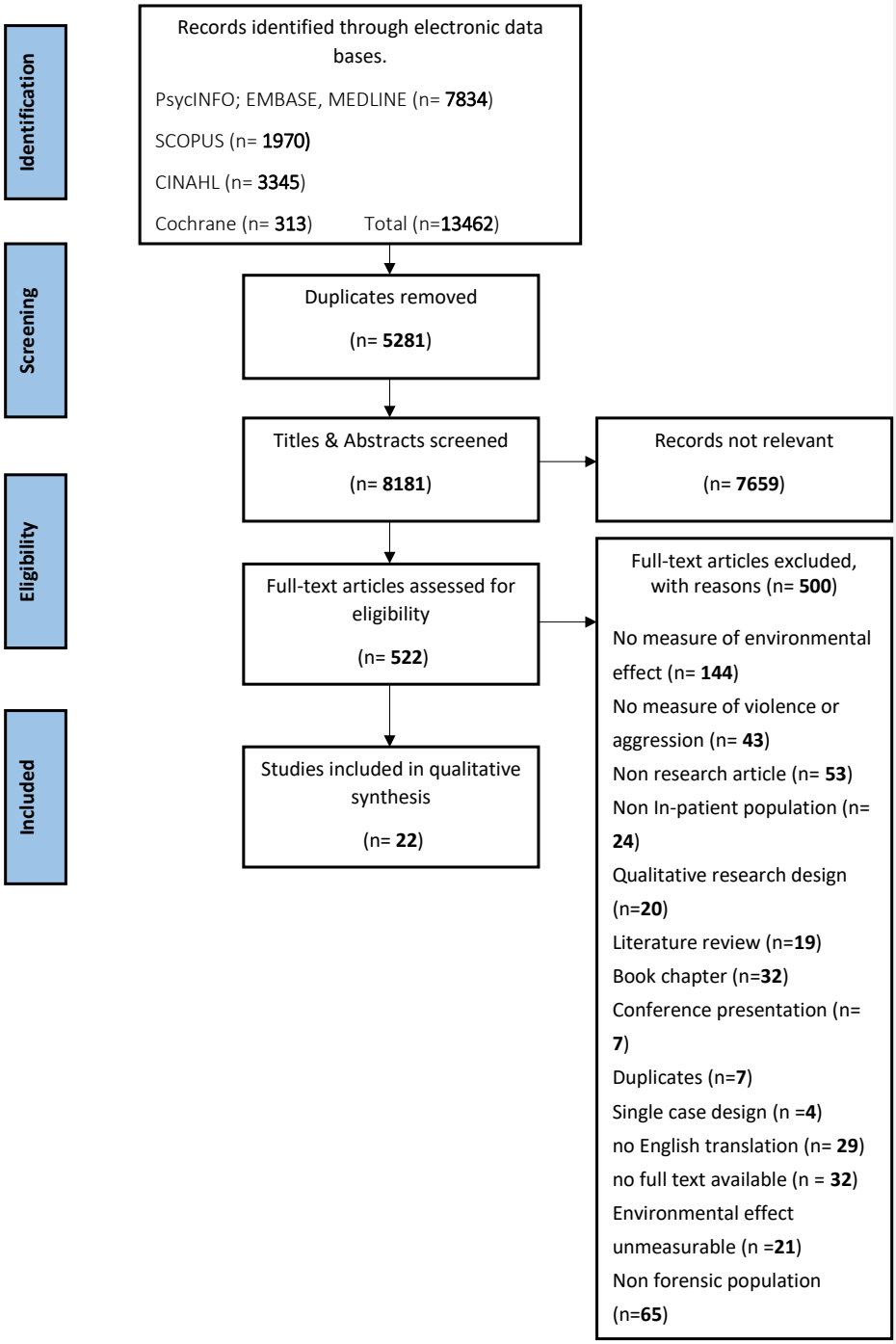


Fig 1. Prisma flow diagram of reviewed articles

2.5 Quality assessment

To better answer the research question each of the identified articles were assessed for their overall quality. We utilised the NICE – quality appraisal checklist for quantitative studies reporting correlations and associations (NICE, 2012). This assessment tool provided a framework to comment on the article's validity and reliability, looking at key areas of methodology such as sampling and the analysis strategy. Each criterion was scored on a three-point Likert scale, for its acceptability and risk of bias. The possible responses were "not applicable" (NA); "high risk of bias" (-); "acceptable" (+); "good" (++). To ease the comparison between articles each rating was also given a numerical score of 0, 1 or 2 respectively, meaning each article was scored out a possible maximum of 38. As not all of the questions were applicable for each study, each study was also given an overall percentage score, with non-applicable questions removed and the maximum score adjusted. The checklist questions can be seen in Appendix A. To minimise the potential for bias in the subjective nature of making decision around quality, a second researcher also completed a quality assessment using the same process. The results of the quality assessment for all papers can be seen in Appendix B. The Assessors agreed 81% of the time, disagreements were discussed, and final scores were agreed. The level of inter-rater reliability was assessed by Cohen's Kappa achieving a score of k = 0.67594, suggesting a moderate/substantial level of agreement.

2.6 Data extraction

A standardised pro-forma was utilised to extract key information on population, methodology and key findings. All relevant information from this process can be seen in table 1.

Section 3: Results

3.1 Study characteristics

A total of 22 studies met the identified inclusion ~~and exclusion~~ criteria, a summary of the studies characteristics and key findings can be seen in **table 1 & 2**. All the included studies apart from Kelly et al, (2015) utilised a methodology which conducted a longitudinal analysis of routinely collected data. This routinely collected data primarily came in the form of local incident reports. Kelly et al, (2015) instead relied on staff-reported estimations of the number of violent incidents as part of a staff questionnaire. All the studies included forensic mental health in-patient populations, however four studies (Lickiewicz et al., 2020; Paavola & Tiihonen, 2010; Ros et al., 2013; Haines et al., 2017) contained a mixed population of forensic and non-forensic in-patients. One study indicated they had an adolescent population (Hill et al., 2012), while a further 11 studies explicitly stated they utilised an exclusively adult population; the author is led to believe that the remaining 10 studies also utilised an adult population, based on the description of the facilities. In terms of gender, 12 of the included studies reported on mixed sex samples, with 4 reported on single sex samples; the remaining 6 did not report the gender of their sample. The included studies were conducted in 9 countries primarily in Europe, but also in the USA, Canada and Australia.

Table 1. Study demographic characteristics

Author & date.	Country and study length	Design	Population	Age	Forensic status	Quality rating (%)
Urheim, et al. (2020)	Norway 17 years	Longitudinal analysis of routine collected data (LARCD)	55 patients ~~adult~~ M&F Proportions not reported	Adult Mean age = 34.8 years	High secure forensic only	76%
Lickiewicz, et al. (2020)	Poland 2 years	LARCD	17974 patients Sex not reported.	Adult Age data not reported	Mixture of forensic & non forensic Proportion mix not reported	31%
Beck, et al. (2018)	USA 1 year	LARCD	22 patients ~~adult~~ M&F	Adult Age data not reported	Forensic only	60%
Haines, et al. (2017)	UK 6 months	LARCD& Cross sectional analysis of staff views	191 Staff	Adult	34 forensic and 26 non-forensic wards	53%

Formatted Table

			patients numbers not reported M&F	Age data not reported		
Kuivalainen, et al. (2017)	Finland 6 years	LARCD	707 patients ~~adult~~ Sex not reported	Adult Age data not reported	Forensic only	63%
Kelly, et al. (2015)	USA 1 month	Cross sectional design – staff survey	384 staff Patients M&F	Age data not reported	Forensic only	37%
Peuloa, Mela & Adelugba (2013)	Canada 4 years	LARCD	394 patients ~~Adult~~ (358)M & (26)F	Adult F mean age = 32.4 years M mean age = 35.1 years	Medium and High secure Forensic only	20%
Sullivan (2013)	UK 6 months	A-B Design LARCD	Not reported	Not reported	Forensic only	16%
Ros, et al. (2013)	Netherlands 4 months	LARCD& patient questionnaire	72 patients ~~Adult~~ Sex not reported	Adult Mean age = 36.7 years	Mixture of forensic & non forensic Proportion mix not reported	53%
Hill, et al. (2012)	UK 3 years	LARCD	37 patients ~~Adolescents~~ (28)M & (9)F	Adolescent Mean age = 16.9 years	Forensic only	40%
Paavola & Tiihonen (2010)	Finland 7 years	LARCD	385 patients ~~Adult~~ (324)M & (61)F	Adult Mean age = 34.6	Mixture of forensic & non forensic Proportion mix not reported	73%
Dafferen, Mayer & Martin (2006)	Australia 6 months	LARCD	Number of patients not reported M&F Proportions not reported	Adult Age data not reported	Forensic only	30%
Green & Robinson (2005)	UK 7 years	LARCD	69 patients ~~Adult~~ (33)M & (36)F	Adult Age data not reported	Forensic only	37%
Dafferen, Mayer & Martin (2004)	Australia 4 years	A – B design & LARCD	401 patients M&F Proportions not reported	Age data not reported	Forensic only	33%
Weizmann-henelius (2000)	Finland 4 years	LARCD	Total number not reported ~~Adult~~	Adult Mean age = 39.6	Forensic only	57%

Formatted: Left

			(90%)M & (10%)F			
Swinton, Hopkins & Swinton (1998)	UK 18 months	LARCD	80 patients F only	Adult Mean age = 33.1	Forensic only	70%~~)~~
Mason (1997)	UK	LARCD	Total number not reported Sex not reported ~~Not reported~~	Age data not reported	Forensic only	20%
Hunter & Love (1996)	USA 2 years	A - B Design & LARCD	~~Adult~~ Total number not reported M	Age data not reported	Forensic only	60%
Carmel, Decker & Yesavage (1991)	USA 56 months	LARCD	~~M~~	Age data not reported	Forensic only	33%
Carton (1991)	UK 2 months	LARCD & staff questionnaire	17 patients ~~Adult M&F~~M&F Proportions not reported	Age data not reported	Forensic only	20%
Barnard, et al. (1984)	USA 4 months	LARCD & collection of new data	198 patients M	Adult Age data not reported	Forensic only	28%
Rogers & Ciula (1980)	USA 18 months	LARCD	Not reported		Forensic only	50%

Formatted: Left

Table 2. Study effects and results characteristics

Author & date.	Environment effect	Aggression measure	Summary of results
Urheim, et al. (2020)	Staff factors & Ward characteristics • Patient turn over • Gender of Staff • Education of Staff	Incidents of aggression.	Lower rates aggression significantly correlated to more female staff, higher educated staff and higher rates of patient turn over.
Lickiewicz, et al. (2020)	Weather effects & Seasonal effects • Month	Proxy of aggression	Lower rates of coercive measure in summer (Jun, Jul, Aug)

Formatted Table

Formatted: List Paragraph, Left, Bulleted + Level: 1 + Aligned at: 0.63 cm + Indent at: 1.27 cm

Formatted: Font: (Default) Times New Roman, 10 pt

Formatted: List Paragraph, Left, Bulleted + Level: 1 + Aligned at: 0.63 cm + Indent at: 1.27 cm

Formatted: Font: (Default) Times New Roman, 10 pt

		(coercive measures)	Significant correlation between rates of coercive measures and temperature and low air pressure.
Beck, et al. (2018)	Temporal effects • Time of day	Incidents of aggression.	Incidents of aggression more likely to occur during day shift (8am to 8pm)
Haines, et al. (2017)	Ward characteristics (The ward features check list)	Incidents of aggression & Staff perception	Perceptions of safety higher on wards are significantly higher on wards which are brighter, have higher patient staff ratios and fewer green spaces.
Kuivalainen, et al. (2017)	Seasonal effects • Months • Seasons	Incidents of aggression. & Proxy of aggression (coercive measures)	Significantly lower levels of seclusion during winter No significant correlations between season or months for all incidents of violence
Kelly, et al. (2015)	Staff factors • Intra-staff conflict • Gender of staff • Staff experience	Staff survey of aggression and coercive measures	No significant correlation between years of experience of violence Males significantly more likely to be victim of violence Significant relationship between intra staff conflict and experience of violence
Peuloa, Mela & Adelugba (2013)	Seasonal effects & Temporal effects • Day of week • Season	Incidents of aggression	Lower rate of violence on weekend (no significance testing) Significantly higher rates of aggression in winter
Sullivan (2013)	Temporal effects • Time of day	Incidents of aggression	Peak of violence at 16:00-17:00, no significance testing
Ros, et al. (2013)	Ward characteristics (Prison Group Climate Inventory)	Incidents of aggression	Significant lower rates of aggression associated with scales of openness & atmosphere; support
Hill, et al. (2012)	Temporal effects • Time of day	Incidents of aggression	Peak between 16:00 – 17:00 & 21:00 & 22:00 – no significant testing
Paavola & Tiihonen (2010)	Seasonal effects • Seasons	Proxy of aggression (coercive measures)	Coercive measures higher in July, August, September, October & November when compared to January
Dafferen, Mayer & Martin (2006)	Staff factors • Gender	Incidents of aggression	No significant difference between between gender of staff and rates of aggression.
Green & Robinson (2005)	Temporal effects • Time of day • Day of week • Month	Incidents of aggression	No significance testing Rate of violence higher between 14:00-21:00; lower over weekends: higher in summer
Dafferen, Mayer & Martin (2004)	Temporal effects & Ward characteristics • Time of day • Old vs new hospital	Incidents of aggression	Incidents of aggression peak between 18-19:00 no significance testing No significant difference in total rates of aggression between the two hospitals.
Weizmann-henelius (2000)	Temporal effects & Seasonal effects • Time of day	Incidents of aggression	Significantly more incidents of violence in spring and summer compared to Autumn and winter. Significantly more incidents of violence during the day and nurses hand over time.
Swinton, Hopkins &	Temporal effects • Day of week • Time of day	Incidents of aggression	Incidents of self-harm peaked between 22:00-23:00, no significance testing.

Formatted: Font: (Default) Times New Roman, 10 pt
Formatted: List Paragraph, Left, Bulleted + Level: 1 + Aligned at: 0.63 cm + Indent at: 1.27 cm
Formatted: List Paragraph, Left, Bulleted + Level: 1 + Aligned at: 0.63 cm + Indent at: 1.27 cm
Formatted: Font: (Default) Times New Roman, 10 pt
Formatted: Font: (Default) Times New Roman, 10 pt
Formatted: List Paragraph, Left, Bulleted + Level: 1 + Aligned at: 0 cm + Indent at: 0.63 cm
Formatted: List Paragraph, Left, Bulleted + Level: 1 + Aligned at: 0 cm + Indent at: 0.63 cm
Formatted: Font: (Default) Times New Roman, 10 pt
Formatted: List Paragraph, Left, Bulleted + Level: 1 + Aligned at: 0 cm + Indent at: 0.63 cm
Formatted: Font: (Default) Times New Roman, 10 pt
Formatted: List Paragraph, Left, Bulleted + Level: 1 + Aligned at: 0 cm + Indent at: 0.63 cm
Formatted: Font: (Default) Times New Roman, 10 pt
Formatted: List Paragraph, Left, Bulleted + Level: 1 + Aligned at: 0 cm + Indent at: 0.63 cm
Formatted: Font: (Default) Times New Roman, 10 pt
Formatted: Font: (Default) Times New Roman, 10 pt
Formatted: List Paragraph, Left, Bulleted + Level: 1 + Aligned at: 0 cm + Indent at: 0.63 cm
Formatted: List Paragraph, Left, Bulleted + Level: 1 + Aligned at: 0 cm + Indent at: 0.63 cm
Formatted: Font: (Default) Times New Roman, 10 pt
Formatted: List Paragraph, Left, Bulleted + Level: 1 + Aligned at: 0 cm + Indent at: 0.63 cm
Formatted: Font: (Default) Times New Roman, 10 pt
Formatted: List Paragraph, Left, Bulleted + Level: 1 + Aligned at: 0 cm + Indent at: 0.63 cm
Formatted: Font: (Default) Times New Roman, 10 pt, Bold
Formatted: List Paragraph, Left, Bulleted + Level: 1 + Aligned at: 0 cm + Indent at: 0.63 cm
Formatted: Font: (Default) Times New Roman, 10 pt

Swinton (1998)		(self-harm only)	No significant difference between rates of self-harm between weekdays and weekends.
Mason (1997)	Seasonal effect	Proxy of aggression (coercive measures)	No significant correlation between rates of seclusion and lunar phases.
Hunter & Love (1996)	Ward characteristics • Change to ~~canteen~~ canteen environment and routine	Incidents of aggression	Significant reduction in violent incidents occurring during meal times.
Carmel, Decker & Yesavage (1991)	Ward characteristics • Psychiatrist staffing levels	Incidents of aggression	Significant positive correlation between rates of physical aggression and number of patients per psychiatrist
Carton, ~~Carton~~ (1991)	Temporal effects • Day of week	Incidents of aggression	Reduction in violent incident occurring over the weekend No significance testing
Barnard, et al. (1984)	Temporal effects • Time of day • Day of week	Incidents of aggression	Rates of aggression lower on weekend and at night, higher on Tuesday & Thursdays and just after breakfast No significance testing
Rogers & Ciula (1980)	Temporal effects & Ward characteristics • Time of day • Day of week • Availability of staff	Incidents of aggression & disruptive behaviour	No significant differences in time of day; day of week or availability of staff effects

Formatted: List Paragraph, Left, Bulleted + Level: 1 + Aligned at: 0 cm + Indent at: 0.63 cm

Formatted: Font: (Default) Times New Roman, 10 pt

Formatted: Font: (Default) Times New Roman, 10 pt

Formatted: List Paragraph, Left, Bulleted + Level: 1 + Aligned at: 0 cm + Indent at: 0.63 cm

Formatted: List Paragraph, Left, Bulleted + Level: 1 + Aligned at: 0 cm + Indent at: 0.63 cm

Formatted: Font: (Default) Times New Roman, 10 pt

Formatted: List Paragraph, Left, Bulleted + Level: 1 + Aligned at: 0 cm + Indent at: 0.63 cm

Formatted: Font: (Default) Times New Roman, 10 pt

Formatted: List Paragraph, Left, Bulleted + Level: 1 + Aligned at: 0 cm + Indent at: 0.63 cm

Formatted: Font: (Default) Times New Roman, 10 pt

3.2 Methodological review

A full breakdown of the quality assessment scores for each paper can be seen in Appendix B. Three of the included studies (Urheim et al., 2021; Paavola & Tiihonen, 2010; Swinton, Hopkins & Swinton, 1998) achieve a "good" standard of quality by scoring ≥ 70%. A further seven studies (Beck et al., 2018; Haines et al., 2017; Kuivalainen et al., 2017; Ros et al., 2013; Weizmann-Henelius, 2000; Hunter & Love, 1996; Rogers, Ciula & Cavanaugh, 1980) achieved an "adequate" standard of quality by scoring ≥ 50%. The remaining 12 studies all scored lower than 50%, indicating a number of issues relating to the validity and reliability of their methodologies.

One very consistent issue in most papers was a lack of a-priori or post-hoc power calculations, raising issues about reliability for some of the studies with lower sample sizes. For many of the papers with lower quality scores there were specific concerns about the validity of the paper's statistical conclusions. Four of the identified papers (Sullivan, 2013; Hill et al., 2012; Green & Robinson, 2005; Carton & Larkin, 1991) provided insufficient statistical analysis to justify their claims, in most cases only providing descriptive statistics. A further two studies (Barnard et al., 1984; Mason, 1997) provided very poor descriptions of their completed analyses, which would prohibit repetition of the study. Other studies (Peuloa, Mela & Adelugba 2013; Dafferen, Mayer & Martin, 2006; Dafferen, Mayer & Martin 2004) appear to have utilised multiple T-test without using Bonferroni-corrections increasing the likelihood of a type-1 error; however, it is possible these corrections were made but not explicitly stated in the text. Finally, Lickiewitz et al, (2020) completed an exploratory analysis utilising a number of different analysis strategies with different variables, but also reported on significance considered inappropriate for exploratory analyses (Gaus, Mayer & Muche., 2015). For the most part, description of the sample populations was consistently adequate, with a few examples of very good quality such as (Weizmann-Henelius, (2000). A couple of studies (Lickiewitz et al., 2020; Carton & Larkin, 1991) provided almost no demographic information about their sample which calls into to question the ecological validity of their findings.

3.3 Measures of violence and aggression

The primary outcome measure for all the studies included within this review was incidents of V&A. However, five (Lickiewitz et al., 2020; Kuivalainen et al., 2017; Kelly et al., 2017 Paavola & Tiihonen, 2010; Mason, 1997) of the included studies utilised the number of coercive measures (restraint or seclusion) either instead of, or in addition to actual incidents of aggression as their outcome measure. All studies except for Kelly et al, (2015) relied on

routinely collected data from the study locations such as reports following a violent incident. Kelly et al, (2015) instead utilised a staff survey method where participants were asked to estimate the number of incidents of aggression, they had experienced at work over the previous year, and how many coercive measures they had been involved in. The studies also differed in what constituted an aggressive incident, ten of the included studies explicitly stated that they counted incidents of verbal aggression. Similarly, nine of the studies also included incidents of self-harm in their analysis. Swinton, Hopkins & Swinton, (1998) was unique in the included studies as being the only paper which exclusively measured self-harm and no other type of violence. Two of the included papers (Hill et al., 2012; Rogers, Ciula & Cavanaugh, 1980) also reported on challenging behaviour, which describes situations such as anti-social behaviour or not complying with treatment. A small number of studies utilised standardised measures of aggression such as the staff observation aggression scale–revised (SOAS-R) (Nijman et al, 1999) and the overt aggression scale (OAS) (Yudofsky et al., 1986).

3.4 Findings overview

For the purposes of this review, we have defined an environmental effect as any measurable phenomenon present within a hospital, which is not an intended intervention or treatment. There was a range of different environmental effect covered in the included papers, for ease of comparison they are discussed below separated into the four subheadings: temporal & seasonal effects; meteorological effects; staff effects and ward characteristics. Only three (Sullivan, 2013; Dafferen, Mayer & Martin, 2004; Hunter & Love, 1996) of the included studies manipulated the environmental effects utilising an A-B research design.

3.4.1 Temporal & seasonal effects

A total of ten papers (Beck et al., 2018; Peuloa, Mela & Adelugba, 2013; Sullivan, 2013; Hill et al., 2012; Green & Robinson, 2005; Dafferen, Mayer & Martin, 2006; Weizmann-

Henelius, 2000; Swinton, Hopkins & Swinton, 1998; Barnard et al., 1984; Rogers, Ciula & Cavanaugh, 1980) commented on the effect of time of day on the rates of V&A. All of the included studies indicated that violent incidents were more common during the day (08:00 - 22:00), than at night (22:00-08:00). A small number of the included studies (Sullivan, 2013; Hill et al., 2012; Green & Robinson, 2005; Dafferen, Mayer & Martin, 2004) noted a peak of aggressive incidents occurring in the late afternoon 16:00 – 19:00. It was theorised that these peaks might be associated with some members of staff completing their shifts, or possibly due to hunger (Sullivan, 2013; Hill et al., 2012). Similarly, Weizmann-Henelius (2000) noted a significant increase in violence between 13:00-15:00 during the nursing hand over meeting. Other unit specific peaks included the 08:00-09:00 noted in Barnard et al, (1984), which corresponded with patient daily timetables being planned. Swinton, Hopkins & Swinton, (1998) noted a peak of incidents occurring at 21:30, however this difference is likely the result of self-harming behaviours occurring more often in private such as when patients are retiring to bed. It is unclear if violent incidents are more likely to occur during periods of unstructured activity, as the two papers (Peuloa, Mela & Adelugba 2013; Weizmann-Henelius 2000) which commented on this gave contradictory findings. These studies suggest that violent or aggressive incidents are more likely to occur during the day, with late afternoon (16:00 -19:00) and periods of staff change-over carrying increased risk.

Five of the included studies (Peuloa, Mela & Adelugba, 2013; Green & Robinson, 2005; Swinton, Hopkins & Swinton, 1998; Carton & Larkin, 1991; Barnard et al., 1984) investigated which days of the week were associated with increased levels of violence and aggression. All five of the studies noted a trend of decreased aggression occurring over the weekend (Saturday and/or Sunday). Some of the authors theorised these lower rates of aggression which occurred over the weekend were associated with a reduction in treatment orientated staff interactions and more relaxation time (Peuloa, Mela & Adelugba 2013;

Barnard et al., 1984). There was no clear consensus on increased risk for any one day of the week, most studies were able to identify individual ward features associated with days of increased violence such as, multidisciplinary team meeting days or days when benefits were paid (Peuloa, Mela & Adelugba, 2013; Barnard et al., 1984).

In terms of month/seasonal effects, six (L~~l~~ickiewicz et al., 2020; Beck et al., 2018; Peuloa, Mela & Adelugba 2013; Paavola & Tiihonen, 2010; Green & Robinson, 2005; Weizmann-Henelius 2000) of the identified studies commented on the relationship between month of the year and rates of violence. There is some evidence for increased levels of aggression occurring over the summer months, with three (Paavola & Tiihonen, 2010; Green & Robinson, 2005; Weizmann-Henelius 2000) papers finding this result. However, Lickiewicz et al, (2020) and Peuloa, Mela & Adelugba (2013) noted contradictory findings, showing reduced rates of coercive behaviours and incidents of violence in the summer months, and an increased rate during winter. Beck et al, (2018) investigated possible social contagion days, which are days with significantly more violence completed by separate patients, this study showed a peak of incidents occurring in October, however also noted that December had the fewest contagion days of any month. One~~Some~~ of the papers theorised that longer days might be associated with increased levels of violence (Weizmann-Henelius 2000), however at present there does not seem to be sufficient evidence to support a possible seasonal effect in the rates of violence and aggression. It should be noted that ~~all~~ six of the studies looking at seasonal effects were all conducted in Northern hemisphere countries (UK, Finland, Poland and Canada); therefore, there is a lack of information on countries which experience more extreme heat conditions in the summer such as Australia or countries in central or southern America.

3.4.2 Meteorological effects

Only two of the identified studies investigated the effects of weather and temperature on the rates of violence and aggression. Lickiewicz et al, (2020) completed an investigation in Poland on a range of different meteorological conditions and their effect on the rates of coercive measures. Specifically, the study included data on air temperature, air pressure, relative humidity, cloud cover, sunshine duration, wind speed and precipitation. The study investigated effect on all days with coercive incidents, and days with increased levels of coercive incidents (N<8). The results from the Spearman's ranked correlation analysis demonstrated a significant but weak correlation between days of increased coercive incidents and higher air mass, lower air pressure, higher mean and maximum air temperatures. The researchers then completed a stepwise regression followed by a multiple regression to investigate the cumulative effect of different meteorological elements. This application of the multiple regression model did not produce any significant results. The study also investigated a unique weather feature known as foehn wind, which is characterised by strong dry wind coming in a pulsing rhythm from the local mountain ranges. The study did not find a significant correlation for this weather event but did indicate that it seems to be associated with a particularly long string of days in which coercive incidents took place.

The second paper which explored meteorological effects was Mason, (1997) which looked at the effect of moon phases on the rates of seclusion. It should be noted that this paper's quality score was substantially lower than most of the other identified papers, in part due to its poorly described population and methodology. The study was unable to find any significant correlation between the phases of the moon and rates of seclusion.

3.4.3 Staff factors

Two studies (Urhiem et al., 2020; Kelly et al., 2015) focused on staff related factors which influenced rates of violence and aggression. Urhiem et al, (2020) was judged to be one of the

better-quality studies included in the current review. It assessed the impact of several institutional changes which were occurring at a high security forensic hospital in Norway, four of which met our criteria to be an environmental effect. The study found there was a strong and significant correlation between higher proportions of female staff and decreased incidents of violence (b = -5.49, p = 0.011). A similar if weaker effect was also found for the correlation between high proportion of more educated staff and decreased incidents of violence (b= -2.74, p = 0.034). Surprisingly higher rates of patient turnover were also significantly correlated with lower incidents of patient aggression. The final environmental effect of the availability of unescorted leave was found to have no significant correlation to incidents of violence.

Kelly et al, (2014) utilised an online staff survey to gather information from psychiatric staff. The survey asked participants to estimate their exposure to violence and aggression at work utilising a Likert scale. The online survey also collected demographic information and administered sub scales from the Psychiatric Nurses Stress Inventory (Sullivan, 1993), and the Perceived Stress Reactivity Scale (Schulz et al., 2005). The study found that male staff were significantly more likely to be the target of patient violence, and that there was no significant correlation between years of experience and the frequency of experiencing violence over the previous year. However, the main findings of the study were of a moderately significant association (r= 0.21, $p < 0.001$) between the experience of intra-staff conflict and the frequency of experiencing patient violence. A similar stronger effect (r=0.54, $p < 0.001$) was also found for experience of patient-staff conflict and frequency of experiencing patient violence. This study is hampered in some ways by its chosen methodology of estimating violent incidents through staff surveys which may lead to an in-built self-selection bias. However, the study highlights an interesting possible relationship between intra-staff conflict and rates of aggression on wards

Three more studies (Sullivan, 2013; Carmel, Tanke & Yesavage, 1991; Rogers, Ciula & Cavanaugh, 1980) looked specifically at staff availability and shift structure. Sullivan (2013) suggested that increased flexibility in terms of shift structure to ensure more staff were available through the day was associated with decreased incidents of aggression. However, this was not supported by Rogers and Ciula (1980), who found no significant correlation between availability of staff and rates of V&A. Finally, Carmel, Tanke & Yesavage (1991), found that higher proportions of psychiatrists and general practitioners per patient was associated with lower rates of violent incidents.

3.4.4 Ward characteristics

A further six studies (Urheim et al., 2020; Haines et al., 2017; Peuloa, Mela & Adelugba 2013; Ros et al., 2013; Dafferen, Mayer & Martin, 2004, Hunter & Love, 1996) focused on specific ward characteristics which were associated with different frequencies of V&A. Haines et al, (2017) utilised a unique methodology which combined incident reports and the results of the Wward Ffeatures Cehecklist, for 34 forensic and 26 non-forensic wards. After combining highly correlated ward features, the regression model produced interesting and slightly counterintuitive results. The study suggested that perceptions of safety from physical assault were higher on wards which had brighter light levels (OR = 1.53, p = 0.014); higher patient ratios and smaller living spaces (OR = 0.65, p = 0.007) and fewer green views from the ward (OR = 0.25, p =0.016). These findings could be considered unexpected quite counterintuitive, however may represent a disparity between higher security facilities which may have higher quality facilities and more staff compared to lower security facilities which have reduced risk of violence but also fewer resources.

Ros et al, (2013) utilised a combination of routinely collected data on violent incidents and a patient questionnaire. The patients were asked to complete the Prison Group Climate

Inventory-Short Form (PGCI-SF) which consists of 23 items scored on a Likert scale, this scale was completed at 3 time points this being at week 1, 4, & 11 of the study. The study utilised structural equation modelling to investigate the effect of different groupings of factors. The study found that lower rates of aggression were significantly associated with higher scores on the "atmosphere questions" at time point 1-2 (r= -0.241, p <0.05) and time point 2-3 (r= -0.24, p < 0.05). The 'atmosphere' questions covered items such as greater access to daylight, fresh air, and privacy, as well as greater trust of other patients. Similar findings were found for 'openness' at time point 1-2 (r= -0.256, p <0.05) and time point 2-3 (r= -0.236, p < 0.05). The 'openness' questions quantify how the patients judge the ward in terms of arbitrary rules, strictness and exerted control. Finally, 'support' which measured patients views of staff attentiveness, respect and trust was also significantly correlated with reduced incidents of violence (r=-0.256, p <0.05).

Two of the included studies which investigated ward characteristics utilised an A-B research design. Firstly, Hunter and Love (1996) found that introducing music and plastic cutlery, as well as increasing flexibility and alternative meaningful activity during mealtimes lead to a significant reduction in the violent incidents which occurred during mealtimes. Hunter and Love's (1996) findings should be considered closely as their methodology score was higher than most. Daffern, Mayer & Martin (2004) compared the rates of violence before and after the transfer of patients to a newly built hospital. Although interesting, it is hard to identify specific environmental effects in this study. The new hospital had increased leisure and recreational facilities, including outdoor spaces, patients also had increased privacy due to open access to their bedrooms throughout the day. However, after controlling for changes in the occupancy levels the study was unable to identify any significant changes in rates of V&A.

Peulua et al, (2013) reported that the majority (70%) of violent incidents they recorded occurred during unstructured time, however they did not complete any significance testing. Urheim et al, (2020) found that higher rates of patient turnover were associated with decreased incidents of violence (b=-0.05, *p*= 0.009).

Section 4: Discussion

4.1 Summary of findings

It is clear from this review that there currently exists a significant evidence base investigating environmental effects within in-patient mental health settings, and a growing research interest specifically focused on forensic environments. A total of 87 relevant papers were identified, with 22 focusing on forensic populations. However, there was a high degree of variance regarding the selected papers methodological quality, with a few of the papers having significant limitations regarding their chosen methodologies. Although highly subjective we have tried to quantify the quality of each of these papers regarding their methodological rigour and found that 12 of the included studies scored below the 50% mark. Consistent problems with these lower scoring papers included poorly described populations and methods, similarly many of studies provided only descriptive data with no indication if there were significant differences in variables they were measuring. The field could benefit from studies which utilise more sophisticated statistical techniques and studies which are less reliant on purely routinely collected data.

The most frequently examined type of research conducted in this area is the investigation of temporal and seasonal effects on rates of V&A. It is likely that this area is researched more than others because of the ease with which data can be collected from routinely collected sources such as incident reports which would typically have date and time stamps. From the included studies it appears the there is a clear reduction in violent incidents occurring at night

when patients would typically be resting or sleeping. There is some evidence of a possible increase in violent incidents occurring in the late afternoon and early evening, some papers suggest this might be occurring due to increasing hunger or changes in staffing levels (Sullivan, 2013; Hill et al., 2012). This would be consistent with previous research which has linked hunger with an increase in negative affect (MacCormack & Lindquist, 2019). It is likely that many temporal effects within units will be highly idiosyncratic in nature, however many papers gave no indication of local temporal structure which may exist within the unit such as mealtimes, or periods of relaxation. Future studies would benefit from discussing temporal effects in relation to their local established routines. Furthermore, many of the studies only presented descriptive statistics, future studies would benefit from using methodologies similar to those used in (Weizmann-Henelius, (2000) and (Rogers, Ciula & Cavanaugh, (1980) which treated time as a categorical variable and completed statistical analysis such as chi-squared goodness of fit tests upon it.

There appears to be a reduction in violent incidents occurring over the weekend, with most studies noting a reduction occurring on Saturday specifically. While unclear, it could be due to increased access to leisure time which was identified as important in the qualitative research (Gudde et al., 2015; Staniszewska et al., 2019). Like time-of-day effects, studies investigating the effect of day of the week should include information about institutional routines, as events such as family visits, team meeting or access to money or resources which may affect the rate of V&A. Looking at the studies included in the current review, although there is some evidence of a possible effect for increased rates of violence over the summer months, conflicting results limit our ability to say with more certainty. This may be an area which could benefit from further review with a less restrictive inclusion criteria, as a further 11 papers were identified which investigated temporal effects but did not include forensic patients. All the included studies took place in the northern hemisphere; including more data

from countries such as Australia would be beneficial in better understanding seasonal effects due to reversal of seasons and increased likelihood of experiencing more extreme weather conditions in their summer months.

There was only one study that looked at multiple meteorological phenomena and their effect on rate of violence and aggression (Lickiewicz et al., 2020). This study was fairly unique and possibly could have important consequences when considering dynamic risk assessments. If we accept that acts of aggression are caused in part by a build-up of environmental stress as suggested by Hinsby & Baker (2004), then weather events are likely adding to this build-up. This theory is supported by previous research investigating the effects of weather events on health outcomes (Thompson et al., 2018; Weilnhammer et al., 2021), and may become increasingly relevant as weather conditions such as temperature become more volatile as the result of climate change. It has been estimated that there will be a 257% increase in heat related deaths in the UK by the 2050s (Vardoulakis & Heaviside, 2012). Therefore this is an area which could benefit from increased high quality research focus. One of the main limitations of Lickiewicz et al, (2020), is the relatively small time period it covers, with only two years' worth of data, it is only measuring each season and the natural weather fluctuations which accompany it twice.

A total of five studies investigating~~ed~~ staff factors and their effect on rates of V&A were included in the current review. There is some evidence to suggest that higher proportions of female staff and higher educated staff might be connected to decreased incidents of violence, this may be an area which could benefit from increased investigation. It is possible that many patients may alter their social interactions with people based upon their sex or perceived rank within the hospital. These findings are slightly counter intuitive as previous research has shown that females are often more likely to be the victim of workplace aggression in the general population (Lanthier, Bielecky & Smith., 2018). These effects are further explored in

studies in general psychiatry in-patient units (Bizzarri et al., 2020; Bowers et al., 2013), as well as other effects such as the use of temporary staff (James et al., 1990) not captured in the current review. It may therefore be beneficial to complete a separate review of staff factors including all in-patient facilities. One particularly interesting finding by Kelly et al, (2014) was the association between intra staff conflict and staff – patient conflict, which may support the concept of a cooperative therapeutic milieu being important for maintaining safety (Mahoney et al., 2009).

Ros et al, (2013) utilised the Prison Group Climate Inventory-Short Form (PGCI-SF) which was able to capture patients' views on a number of environmental factors of interest such as access to daylight, feeling of safety and respect. These types of methodology are useful in capturing a cohesive view of a ward environment and could benefit from further study. The study is limited however by having to rely on self-report measures, which increase possible bias. Other similar scales include the Wward Ffeatures Cchecklist utilised by Haines et al, (2017) and the wWard Aatmosphere Sscale (Røssberg & Friis, 2013). Ros et al, (2013) found that increased access to daylight, privacy, fresh air and an atmosphere based on trust was associated with increased feeling of safety. Interestingly, some of the findings of Haines et al, (2017) do not make intuitive sense such as smaller, busier wards being associated with less violence, this may be a product of most violent patients being transferred to higher security facilities which had different physical characteristics. There were a number of studies which also utilised standardised measurements of environmental effect, which were identified but not included in this review due to not including forensic populations (Van der Schaaf et al., 2013; Ulrich et al., 2018; Moos & Schwartz, 1972; Christenfield et al., 1989); these studies highlighted the importance of patient privacy and space, as well as good organisation, but provided mixed results on the of role green spaces. Daffern, Mayer & Martin, (2004) also focused primarily on ward characteristics and their relation to incidents of

V&A but comparing incidents rates before and after the transfer of patients to a newly built hospital. This study is highly interesting but is hindered by the independent variable being very unclear; it is difficult to say for sure what may have been responsible for any changes in rates of V&A, due to lack of control over possibly influential factors.

Most of the studies utilised a methodology which included a longitudinal analysis of routinely collected data, primarily from incident reports. This methodology is useful in that it allows the collection of large amounts of data with comparatively fewer resources, and allows for 24-hour monitoring which would be difficult to replicate by using a researcher. However, there are problems of in-built biases in this methodology such as the under reporting of incidents, as noted in Ros et al, (2013) who found significantly lower rates of incidents recorded in incident reports when compared to staff and handover meetings. Given the complex nature of the populations being studied, it is harder to implement changes to usual treatments, and A-B-A research designs might be considered unethical. However, Hunter and Love (1996) represents one example of how experimenting with environmental effects can be done in a patient centred way, which is also in line the ethos of quality improvement research (Batalden & Davidoff, 2007).

4.2 Strengths and limitations

The current review was successful in identifying, appraising and combining~~combing~~ the current research base on environmental factors which influence rates of aggression within forensic in-patient services. The search criteria were intentionally left broad in order to capture as many types of environmental effects as possible, this is evident in the large number of studies which were screened. The current review has highlighted the need to consider environmental factors such as temporal factors when considering risk assessment for forensic

in-patient hospitals. The review also benefits from being the only one of its kind to investigate the environmental factors affecting rates of violence within forensic in-patient facilities.

However, the review also had several limitations which need to be considered when assessing its findings. Firstly, although a second researcher was utilised during the quality assessment stage, due to a shortage of resources, only one assessor was utilised during the paper screening stage. Relying on one assessor during the screening stage increases the risk of bias and the risk of relevant papers being omitted by error. Secondly, initial scoping searches lead to an under estimation of the number of relevant papers available. The large number of relevant papers allowed the review to take a more focused look at forensic populations which are likely to differ from general in-patient population in terms of rates of violence (Bowers et al., 2011). This decision however led to some specific environmental effects being omitted from the review such as the effect of staff uniforms (Lavender, 1987; Rinn, 1976), due to no studies investigating these effects within forensic populations being available. Similarly, there were a number of studies which focused on physical features of wards, which were not captured in great detail within this review.

Similarly, due to the diversity of methods utilised in the included papers, it was not possible to complete a meta-analysis. It was decided to include four studies (Lickiewicz et al., 2020; Paavola & Tiihonen, 2010; Ros et al., 2013; Haines et al., 2017) which contained a mixed population of forensic and non-forensic in-patients, which may limit the external validity of these studies when considering forensic populations. There is also a significant risk of cultural bias in the current review due to only including papers published in English. Finally, it was decided to use percentages for quality scores to support the reader, however it should be noted that the cut off scores for “good” and “adequate” are largely arbitrary.

4.3 Implications for future research and clinical practice

Future systematic reviews would benefit from focusing on more specific environmental effects. There currently exists a large enough research base to look at temporal, seasonal, staff and ward effects within separate systemic reviews when looking at all in-patient populations. The completion of separate reviews would allow greater accuracy in commenting on these effects. There currently exists a comparatively small number of studies investigating the effects of weather events on inpatient populations, and this is an area which could benefit from increased research focus. Similarly, there are currently very few studies using an experimental methodology investigating environmental effects within in-patient mental health facilities, with the notable exception of Hunter and Love (1996). It is likely that in the decades since this study took place, increased ethical standards of experimentation may reduce researchers' ability to manipulate patients living conditions in such a way. However small incremental changes to environmental phenomenon should be considered as part of quality improvement research projects, which in time could lead to several improvements to patient living standards. The findings of this study also lend further support to the argument that dynamic and changing factors should be consider when completing risk assessments (Douglas & Skeem, 2005; Greer et al., 2020). Furthermore, it may be important for individual in-patient units to investigate specific idiosyncratic risk factors which may exist within their usual routines.

4.4 Conclusions

In conclusion this was the first systematic review to investigate environmental risk factors associated with increased levels of aggression within forensic in-patient mental health facilities. The review highlights there is a growing research interest in this area, however the quality of such studies is inconsistent. There is some tentative evidence to suggest temporal

effects may be important in predicting when violence is likely to occur such as the summer, weekdays and during staff change overs. Similarly, it may be important to consider staff make up in regard to gender and seniority when considering safety planning. Through a better understanding of environmental factors associated with violence and the use of dynamic risk factors we may be able to better implement mitigating strategies ultimately protecting staff and patients and reducing the need to rely on coercive measures.

References

Anderson, C. A., Anderson, K. B., Dorr, N., DeNeve, K. M., & Flanagan, M. (2000). Temperature and aggression. In Advances in experimental social psychology (Vol. 32, pp. 63-133). Academic Press.

Banks, C., & Priebe, S. (2020). Scales for assessing the therapeutic milieu in psychiatric inpatient settings: A systematic review. General Hospital Psychiatry, 66, 44-50.

Batalden, P. B., & Davidoff, F. (2007). What is "quality improvement" and how can it transform healthcare?.BMJ Quality & Safety, 16(1), 2-3.

Bizzarri, J. V., Piacentino, D., Kotzalidis, G. D., Moser, S., Cappelletti, S., Weissenberger, G., ... & Conca, A. (2020). Aggression and violence toward healthcare workers in a psychiatric service in Italy: A retrospective questionnaire-based survey. The Journal of Nervous and Mental Disease, 208(4), 299-305.

Bowers, L., Alexander, J., Bilgin, H., Botha, M., Dack, C., James, K., ... & Stewart, D. (2014). Safewards: the empirical basis of the model and a critical appraisal. Journal of Psychiatric and Mental Health Nursing, 21(4), 354-364.

Brown, S., O'Rourke, S., & Schwannauer, M. (2019). Risk factors for inpatient violence and self-harm in forensic psychiatry: the role of head injury, schizophrenia and substance misuse. Brain Injury, 33(3), 313-321.

Bowers, L., Stewart, D., Papadopoulos, C., Dack, C., Ross, J., & Khanom, H. (2011). Inpatient Violence and Aggression: A Literature Review. report from the Conflict and Containment Reduction Research Programme, Kings College, London, available at: www. kcl. ac. uk/iop/depts/hspr/research/ciemh/mhn/projects/litreview/LitRevAgg. pdf.

Bowers, L., Stewart, D., Papadopoulos, C., & Iennaco, J. D. (2013). Correlation between levels of conflict and containment on acute psychiatric wards: The city-128 study. Psychiatric Services, 64(5), 423-430.

Christenfeld, R., Wagner, J., Pastva, W. G., & Acrish, W. P. (1989). How physical settings affect chronic mental patients. Psychiatric Quarterly, 60(3), 253-264.

Douglas, K. S., & Skeem, J. L. (2005). Violence risk assessment: getting specific about being dynamic. Psychology, Public Policy, and Law, 11(3), 347.

Dzhambov, A. M., Markevych, I., Hartig, T., Tilov, B., Arabadzhiev, Z., Stoyanov, D., ... & Dimitrova, D. D. (2018). Multiple pathways link urban green-and bluespace to mental health in young adults. Environmental research, 166, 223-233.

Elliott, K. A., & Daley, D. (2013). Stress, coping, and psychological well-being among forensic health care professionals. Legal and Criminological Psychology, 18(2), 187-204.

Field, S. (1992). The effect of temperature on crime. The British Journal of Criminology, 32(3), 340-351.

Finch, K., Lawrence, D., Williams, M. O., Thompson, A. R., & Hartwright, C. (2021). A Systematic Review of the Effectiveness of Safewards: Has Enthusiasm Exceeded Evidence?. Issues in Mental Health Nursing, 1-18.

Flannery, R. B., LeVitre, V., Rego, S., & Walker, A. P. (2011). Characteristics of staff victims of psychiatric patient assaults: 20-year analysis of the Assaulted Staff Action Program. Psychiatric Quarterly, 82(1), 11-21.

Greer, B., Taylor, R. W., Cella, M., Stott, R., & Wykes, T. (2020). The contribution of dynamic risk factors in predicting aggression: A systematic review including inpatient forensic and non-forensic mental health services. Aggression and Violent Behavior, 53, 101433.

Gudde, C. B., Olsø, T. M., Whittington, R., & Vatne, S. (2015). Service users' experiences and views of aggressive situations in mental health care: a systematic review and thematic synthesis of qualitative studies. Journal of Multidisciplinary Healthcare, 8, 449.

Hamrin, V., Iennaco, J., & Olsen, D. (2009). A review of ecological factors affecting inpatient psychiatric unit violence: implications for relational and unit cultural improvements. Issues in Mental Health Nursing, 30(4), 214-226.

Hansen, A., Bi, P., Nitschke, M., Ryan, P., Pisaniello, D., & Tucker, G. (2008). The effect of heat waves on mental health in a temperate Australian city. Environmental Health Perspectives, 116(10), 1369-1375.

Hinsby, K., & Baker, M. (2004). Patient and nurse accounts of violent incidents in a medium secure unit. Journal of Psychiatric and Mental Health Nursing, 11(3), 341-347.

Hogan, N., Ennis, L., & Assessment, F. (2010). Assessing risk for forensic psychiatric inpatient violence: A meta-analysis. Open Access Journal of Forensic Psychology, 2, 137-147.

James, D. V., Fineberg, N. A., Shah, A. K., & Priest, R. G. (1990). An increase in violence on an acute psychiatric ward: a study of associated factors. British Journal of Psychiatry, 156(6), 846-852.

Johnson, M. E. (2004). Violence on inpatient psychiatric units: State of the science. Journal of the American psychiatric nurses association, 10(3), 113-121.

Karatzias, T., Shevlin, M., Pitcairn, J., Thomson, L., Mahoney, A., & Hyland, P. (2019). Childhood adversity and psychosis in detained inpatients from medium to high secured units: results from the Scottish census survey. Child Abuse & Neglect, 96, 104094.

Lanthier, S., Bielecky, A., & Smith, P. M. (2018). Examining risk of workplace violence in Canada: a sex/gender-based analysis. *Annals of work exposures and health*, *62*(8), 1012-1020.

Lanza, M. L. (1983). The reactions of nursing staff to physical assault by a patient. Psychiatric Services, 34(1), 44-47.

Lavender, A. (1987). The effects of nurses changing from uniforms to everyday clothes on a psychiatric rehabilitation ward. British Journal of Medical Psychology, 60(2), 189-199.

Iozzino, L., Ferrari, C., Large, M., Nielssen, O., & De Girolamo, G. (2015). Prevalence and risk factors of violence by psychiatric acute inpatients: a systematic review and meta-analysis. PloS one, 10(6), e0128536.

MacCormack, J. K., & Lindquist, K. A. (2019). Feeling hangry? When hunger is conceptualized as emotion. Emotion, 19(2), 301.

Mahoney, J. S., Palyo, N., Napier, G., & Giordano, J. (2009). The therapeutic milieu reconceptualized for the 21st century. Archives of Psychiatric Nursing, 23(6), 423-429.

McWilliams, S., Kinsella, A., & O'Callaghan, E. (2013). The effects of daily weather variables on psychosis admissions to psychiatric hospitals. International Journal of Biometeorology, 57(4), 497-508.

MohammadiGorji, S., Bosch, S. J., Valipoor, S., & De Portu, G. (2021). Investigating the impact of healthcare environmental design on staff security: a systematic review. HERD: Health Environments Research and Design Journal, 14(1), 251-272.

Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., & Prisma Group. (2009). Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS medicine*, *6*(7), e1000097.

Moos, R., & Schwartz, J. (1972). Treatment environment and treatment outcome. Journal of Nervous and Mental Disease. Journal of Nervous and Mental Disease.

National Institute for Mental Health in England. (2005). Health Policy Implementation Guide: developing positive practice to support the safe therapeutic management of aggression and violence in mental health in-patient settings.

National Institute for Health and Care Excellence (2012). Retrieved from https://www.nice.org.uk/process/pmg4/chapter/appendix-g-quality-appraisal-checklist-quantitative-studies-reporting-correlations-and-associations

Needham, I., Abderhalden, C., Halfens, R. J., Dassen, T., Haug, H. J., & Fischer, J. E. (2005). The Impact of Patient Aggression on Carers Scale: instrument derivation and psychometric testing. Scandinavian Journal of Caring Sciences, 19(3), 296-300

Newbill, W. A., Marth, D., Coleman, J. C., Menditto, A. A., Carson, S. J., & Beck, N. C. (2010). Direct observational coding of staff who are the victims of assault. Psychological Services, 7(3), 177.

Nijman, H. L., Muris, P., Merckelbach, H. L., Palmstierna, T., Wistedt, B., Vos, A. M., ... & Allertz, W. (1999). The staff observation aggression scale–revised (SOAS-R). Aggressive Behavior: Official Journal of the International Society for Research on Aggression, 25(3), 197-209.

Odes, R., Chapman, S., Harrison, R., Ackerman, S., & Hong, O. (2021). Frequency of violence towards healthcare workers in the United States' inpatient psychiatric hospitals: A systematic review of literature. International Journal of Mental Health Nursing, 30(1), 27-46.

Papadopoulos, C., Ross, J., Stewart, D., Dack, C., James, K., & Bowers, L. (2012). The antecedents of violence and aggression within psychiatric in-patient settings. Acta Psychiatrica Scandinavica, 125(6), 425-439.

Ramesh, T., Igoumenou, A., Montes, M. V., & Fazel, S. (2018). Use of risk assessment instruments to predict violence in forensic psychiatric hospitals: a systematic review and meta-analysis. European Psychiatry, 52, 47-53.

Redl, F. (1959). The concept of a" therapeutic milieu.". American Journal of Orthopsychiatry, 29(4), 721.

Rinn, R. C. (1976). Effects of nursing apparel upon psychiatric inpatients' behavior. Perceptual and Motor Skills, 43(3), 939-945.

Røssberg, J. I., & Friis, S. (2003). A suggested revision of the Ward Atmosphere Scale. Acta Psychiatrica Scandinavica, 108(5), 374-380.

Salib, E., & Sharp, N. (2002). Relative humidity and affective disorders. International Journal of Psychiatry in Clinical Practice, 6(3), 147-153.

Schablon, A., Wendeler, D., Kozak, A., Nienhaus, A., & Steinke, S. (2018). Prevalence and consequences of aggression and violence towards nursing and care staff in Germany—A survey. International Journal of Environmental Research and Public Health, 15(6), 1274.

Schulz, P., Jansen, L. J., & Schlotz, W. (2005). Stress reactivity: Theoretical concept and measurement. Diagnostica, 51(3), 124-133.

Staniszewska, S., Mockford, C., Chadburn, G., Fenton, S. J., Bhui, K., Larkin, M., ... & Weich, S. (2019). Experiences of in-patient mental health services: systematic review. The British Journal of Psychiatry, 214(6), 329-338.

Sulilivan P.J. (1993). Occupational stress in psychiatric nursing. Journal of Advanced nursing, 18(4), 591-601.

Thomas, S. P., Shattell, M., & Martin, T. (2002). What's therapeutic about the therapeutic milieu?. Archives of Psychiatric Nursing, 16(3), 99-107.

Thompson, R., Hornigold, R., Page, L., & Waite, T. (2018). Associations between high ambient temperatures and heat waves with mental health outcomes: a systematic review. Public Health, 161, 171-191.

Ulrich, R. S., Bogren, L., & Lundin, S. (2012). Towards a design theory for reducing aggression in psychiatric facilities. In ARCH12 Conference: International Conference ARCH12 and Forum Vårdbyggnad Nordic Conference 2012. Chalmers Institute of Technology.

Ulrich, R. S., Bogren, L., Gardiner, S. K., & Lundin, S. (2018). Psychiatric ward design can reduce aggressive behavior. Journal of Environmental Psychology, 57, 53-66.

Van der Schaaf, P. S., Dusseldorp, E., Keuning, F. M., Janssen, W. A., & Noorthoorn, E. O. (2013). Impact of the physical environment of psychiatric wards on the use of seclusion. The British Journal of Psychiatry, 202(2), 142-149.

Vardoulakis, S., & Heaviside, C. (2012). Health effects of climate change in the UK 2012. London: Health Protection Agency, 10, 1600-0668.

Weilnhammer, V., Schmid, J., Mittermeier, I., Schreiber, F., Jiang, L., Pastuhovic, V., ... & Heinze, S. (2021). Extreme weather events in europe and their health consequences–A systematic review. International Journal of Hygiene and Environmental Health, 233, 113688.

Wood, L., Hooper, P., Foster, S., & Bull, F. (2017). Public green spaces and positive mental health–investigating the relationship between access, quantity and types of parks and mental wellbeing. Health & place, 48, 63-71.

Wright, K. M., Duxbury, J. A., Baker, A., & Crumpton, A. (2014). A qualitative study into the attitudes of patients and staff towards violence and aggression in a high security hospital. Journal of Psychiatric and Mental Health Nursing, 21(2), 184-188.

Yudofsky, S. C., Silver, J. M., Jackson, W., Endicott, J., & Williams, D. (1986). The Overt Aggression Scale for the objective rating of verbal and physical aggression. The American Journal of Psychiatry.

References of papers reviewed

Barnard, G. W., Robbins, L., Newman, G., & Carrera, F. (1984). A study of violence within a forensic treatment facility. Bulletin of the American Academy of Psychiatry and the Law, 12(4), 339-348.

Beck, N. C., Tubbesing, T., Lewey, J. H., Ji, P., Menditto, A. A., & Robbins, S. B. (2018). Contagion of violence and self-harm behaviors on a psychiatric ward. The Journal of Forensic Psychiatry and Psychology, 29(6), 989-1006.

Carmel, H., Tanke, E. D., & Yesavage, J. A. (1991). Physician staffing and patient violence. Journal of the American Academy of Psychiatry and the Law Online, 19(1), 49-51.

Carton, G., & Larkin, E. (1991). Reducing violence in a special hospital. Nursing standard (Royal College of Nursing (Great Britain): 1987), 5(17), 29-31.

Daffern, M., Mayer, M., & Martin, T. (2006). Staff gender ratio and aggression in a forensic psychiatric hospital. International Journal of Mental Health Nursing, 15(2), 93-99.

Daffern, M., Mayer, M. M., & Martin, T. (2004). Environment contributors to aggression in two forensic psychiatric hospitals. International Journal of Forensic Mental Health, 3(1), 105-114.

Green, B., & Robinson, L. (2005). Reducing violence in a forensic mental health unit: a seven-year study. Mental Health Practice, 9(4).

Haines, A., Brown, A., McCabe, R., Rogerson, M., & Whittington, R. (2017). Factors impacting perceived safety among staff working on mental health wards. BJPsych Open, 3(5), 204-211.

Hill, S. A., White, O., Lolley, J., Sidki-Gomez, A., & Williams, H. (2012). Incidents in an adolescent forensic secure inpatient service. Medicine, Science and the Law, 52(1), 27-31.

Hunter, M. E., & Love, C. C. (1996). Total quality management and the reduction of inpatient violence and costs in a forensic psychiatric hospital. Psychiatric Services (Washington, DC), 47(7), 751-754.

Kelly, E. L., Subica, A. M., Fulginiti, A., Brekke, J. S., & Novaco, R. W. (2015). A cross-sectional survey of factors related to inpatient assault of staff in a forensic psychiatric hospital. Journal of Advanced Nursing, 71(5), 1110-1122.

Kuivalainen, S., Vehviläinen-Julkunen, K., Louheranta, O., Putkonen, A., Repo-Tiihonen, E., & Tiihonen, J. (2017). Seasonal variation of hospital violence, seclusion and restraint in a forensic psychiatric hospital. International Journal of Law and Psychiatry, 52, 1-6.

Lickiewicz, J., Piotrowicz, K., Hughes, P. P., & Makara-Studzińska, M. (2020). Weather and Aggressive Behavior among Patients in Psychiatric Hospitals—An Exploratory Study. International Journal of Environmental Research and Public Health, 17(23), 9121.

Mason, T. (1997). Seclusion and the lunar cycles. Journal of Psychosocial Nursing & Mental Health Services, 35(6), 14-18

Paavola, P., & Tiihonen, J. (2010). Seasonal variation of seclusion incidents from violent and suicidal acts in forensic psychiatric patients. International Journal of Law and Psychiatry, 33(1), 27-34.

Peluola, A., Mela, M., & Adelugba, O. O. (2013). A review of violent incidents in a multilevel secure forensic psychiatric hospital: is there a seasonal variation?. Medicine, Science and the Law, 53(2), 72-79.

Rogers, R., Ciula, B., & Cavanaugh Jr, J. L. (1980). Aggressive and socially disruptive behavior among maximum security psychiatric patients. Psychological Reports, 46(1), 291-294.

Ros, N., Van der Helm, P., Wissink, I., Stams, G. J., & Schaftenaar, P. (2013). Institutional climate and aggression in a secure psychiatric setting. The Journal of Forensic Psychiatry & Psychology, 24(6), 713-727.

Sullivan, M., & Ghroum, P. (2013). Incident reporting to improve clinical practice in a medium-secure setting. Mental Health Practice, 16(7).

Swinton, M., Hopkins, R., & Swinton, J. (1998). Reports of self-injury in a maximum security hospital. Criminal Behaviour and Mental Health, 8(1), 7-16.

Urheim, R., Palmstierna, T., Rypdal, K., Gjestad, R., Senneseth, M., & Mykletun, A. (2020). Violence rate dropped during a shift to individualized patient-oriented care in a high security forensic psychiatric ward. BMC psychiatry, 20(1), 1-10.

Weizmann-Henelius, G. (2000). Violence in a Finnish forensic psychiatric hospital. Nordic Journal of Psychiatry, 54(4), 269-273.

Appendix A

National Institute for Clinical Excellence (NICE) – quality appraisal checklist for quantitative studies reporting correlations and associations (NICE, 2012).

Author

Date

Title

++ (2) = Good

+ (1) = Acceptable

- (0) = High risk of bias

N/A = Not Applicable/reported

Section 1: Population

- 1.1-Is the source population or source area well described?
- 1.2-Is the eligible population or area representative of the source population or area?
- 1.3-Do the selected participants or areas represent the eligible population or area?

Section 2: Method of selection of exposure (or comparison) group

- 2.1-Selection of exposure (and comparison) group. How was selection bias minimised?
- 2.2-Was the selection of explanatory variables based on a sound theoretical basis?
- 2.3-Was the contamination acceptably low?
- 2.4 How well were likely confounding factors identified and controlled?
- 2.5 Is the setting applicable to the UK?

Section 3: Outcomes

- 3.1 Were the outcome measures and procedures reliable?
- 3.2 Were the outcome measurements complete?

- 3.3 Were all the important outcomes assessed?
- 3.4 Was there a similar follow-up time in exposure and comparison groups?
- 3.5 Was follow-up time meaningful?

Section 4: Analyses

- 4.1 Was the study sufficiently powered to detect an intervention effect (if one exists)?
- 4.2 Were multiple explanatory variables considered in the analyses?
- 4.3 Were the analytical methods appropriate?
- 4.4 Was the precision of association given or calculable? Is association meaningful?

Section 5: Summary

- 5.1 Are the study results internally valid (i.e. unbiased)?
- 5.2 Are the findings generalisable to the source population (i.e. externally valid)?

Appendix B

~~Quality appraisal scores (page 1)~~

	1:1	1:2	1:3	2.1	2:2	2.3	2:4	2:5	3:1	3:2	3:3	3.4	3.5	4:1	4:2	4:3	4:4	5:1	5:2	total
Urheim, 2021	2	2	1	N/A	1	N/A	2	1	1	1	2	N/A	N/A	1	2	2	2	2	1	23 (76%)
Lickiewicz 2020	0	0	0	1	1	N/A	0	1	1	2	0	N/A	N/A	0	1	1	1	1	0	10 (31%)
Beck 2018	1	1	1	N/A	2	N/A	1	1	2	1	2	N/A	N/A	0	1	1	1	2	1	18 (60%)
Haines 2017	1	1	0	N/A	1	N/A	1	2	1	1	2	N/A	N/A	0	2	1	2	1	0	16 (53%)
Kuivalainen 2017	1	1	2	2	2	N/A	0	1	1	2	2	N/A	N/A	0	0	2	2	1	1	20 (63%)
Kelly 2015	1	1	1	N/A	1	N/A	1	1	0	0	1	N/A	N/A	0	1	2	1	0	0	11 (37%)
Peluola 2013	0	1	0	N/A	2	N/A	0	1	1	1	2	N/A	N/A	0	0	0	0	0	0	6 (20%)
Sullivan 2013	0	1	0	N/A	1	N/A	0	2	1	1	1	N/A	N/A	0	0	0	0	0	0	5 (16%)
Ros 2013	1	1	1	N/A	1	N/A	1	1	0	1	1	N/A	1	0	2	2	2	1	1	17 (53%)
Hill 2012	1	1	1	N/A	2	N/A	0	2	1	1	2	N/A	N/A	0	0	0	0	0	1	12 (40%)
Paavola 2010	2	2	2	N/A	1	N/A	1	1	1	2	1	N/A	N/A	0	1	2	2	2	2	22 (73%)

Formatted: Font: Not Bold

~~Quality appraisal scores (page 2)~~

	1:1	1:2	1:3	2.1	2:2	2.3	2:4	2:5	3:1	3:2	3:3	3.4	3.5	4:1	4:2	4:3	4:4	5:1	5:2	total
Daffern 2006	0	1	0	N/A	2	N/A	1	1	1	1	1	N/A	N/A	0	1	0	0	0	0	9 (30%)
Green 2005	2	1	2	N/A	0	N/A	0	2	1	1	1	N/A	N/A	0	1	0	0	0	0	11 (37%)
Daffern 2004	1	1	1	N/A	1	N/A	1	1	1	1	1	N/A	N/A	0	0	0	1	0	0	10 (33%)
Weizmann-Henelius 2000	2	2	2	N/A	1	N/A	1	1	1	0	1	N/A	N/A	0	1	1	1	1	2	17 (57%)
Swinton 1998	1	2	1	N/A	2	N/A	1	2	1	1	2	N/A	N/A	0	2	1	2	2	1	21 (70%)
Mason 1997	0	1	1	N/A	1	N/A	0	1	0	1	0	N/A	N/A	0	0	0	1	0	0	6 (20%)
Hunter 1996	1	2	1	N/A	2	N/A	1	1	1	1	1	N/A	2	0	0	2	1	1	1	18 (60%)
Carmel 1991	1	1	1	N/A	0	N/A	0	1	1	0	1	N/A	N/A	0	0	1	1	1	1	10 (33%)
Carton 1991	0	0	0	N/A	0	N/A	0	2	1	1	1	N/A	N/A	0	1	0	0	0	0	6 (20%)
Barnard 1984	2	2	1	0	0	N/A	0	1	1	1	1	N/A	N/A	0	0	0	0	0	0	9 (28%)
Rogers 1980	1	2	1	N/A	0	N/A	0	1	1	2	2	N/A	N/A	0	1	2	0	1	1	15 (50%)

	1.1	1.2	1.3	2.1	2.2	2.3	2.4	2.5	3.1	3.2	3.3	3.4	3.5	4.1	4.2	4.3	4.4	5.1	5.2	total
Urheim, 2021	2	2	1	N/A	1	N/A	2	1	1	1	2	N/A	N/A	1	2	2	2	2	1	23 (76%)
Lickiewicz 2020	0	0	0	1	1	N/A	0	1	1	2	0	N/A	N/A	0	1	1	1	1	0	10 (31%)
Beck 2018	1	1	1	N/A	2	N/A	1	1	2	1	2	N/A	N/A	0	1	1	1	2	1	18 (60%)
Haines 2017	1	1	0	N/A	1	N/A	1	2	1	1	2	N/A	N/A	0	2	1	2	1	0	16 (53%)
Kuivalainen 2017	1	1	2	2	2	N/A	0	1	1	2	2	N/A	N/A	0	0	2	2	1	1	20 (63%)
Kelly 2015	1	1	1	N/A	1	N/A	1	1	0	0	1	N/A	N/A	0	1	2	1	0	0	11 (37%)
Peluola 2013	0	1	0	N/A	2	N/A	0	1	1	1	2	N/A	N/A	0	0	0	0	0	0	6 (20%)
Sullivan 2013	0	1	0	N/A	1	N/A	0	2	1	1	1	N/A	N/A	0	0	0	0	0	0	5 (16%)
Ros 2013	1	1	1	N/A	1	N/A	1	1	0	1	1	N/A	1	0	2	2	2	1	1	17 (53%)
Hill 2012	1	1	1	N/A	2	N/A	0	2	1	1	2	N/A	N/A	0	0	0	0	0	1	12 (40%)
Paavola 2010	2	2	2	N/A	1	N/A	1	1	1	2	1	N/A	N/A	0	1	2	2	2	2	22 (73%)
	1.1	1.2	1.3	2.1	2.2	2.3	2.4	2.5	3.1	3.2	3.3	3.4	3.5	4.1	4.2	4.3	4.4	5.1	5.2	total

Daffern 2006	0	1	0	N/A	2	N/A	1	1	1	1	1	N/A	N/A	0	1	0	0	0	0	9 (30%)
Green 2005	2	1	2	N/A	0	N/A	0	2	1	1	1	N/A	N/A	0	1	0	0	0	0	11 (37%)
Daffern 2004	1	1	1	N/A	1	N/A	1	1	1	1	1	N/A	N/A	0	0	0	1	0	0	10 (33%)
Weizmann-Henelius 2000	2	2	2	N/A	1	N/A	1	1	1	0	1	N/A	N/A	0	1	1	1	1	2	17 (57%)
Swinton 1998	1	2	1	N/A	2	N/A	1	2	1	1	2	N/A	N/A	0	2	1	2	2	1	21 (70%)
Mason 1997	0	1	1	N/A	1	N/A	0	1	0	1	0	N/A	N/A	0	0	0	1	0	0	6 (20%)
Hunter 1996	1	2	1	N/A	2	N/A	1	1	1	1	1	N/A	2	0	0	2	1	1	1	18 (60%)
Carmel 1991	1	1	1	N/A	0	N/A	0	1	1	0	1	N/A	N/A	0	0	1	1	1	1	10 (33%)
Carton 1991	0	0	0	N/A	0	N/A	0	2	1	1	1	N/A	N/A	0	1	0	0	0	0	6 (20%)
Barnard 1984	2	2	1	0	0	N/A	0	1	1	1	1	N/A	N/A	0	0	0	0	0	0	9 (28%)
Rogers 1980	1	2	1	N/A	0	N/A	0	1	1	2	2	N/A	N/A	0	1	2	0	1	1	15 (50%)

Chapter 2 – Empirical paper

Social contagion and other environmental predictors of increased violence within a high security forensic hospital.

Jake Easto[1,2], Suzanne O'Rourke[1,2], Gary Macpherson[2,4], Gordon Ross[3], Daniel Paulin[3] &Trinnhallen Brisley[3]

[1] The School of Health in Social Science, the University of Edinburgh.

[2] NHS The State Hospital

[3] The School of Mathematics, the University of Edinburgh

[4] Erasmus University of Rotterdam

Prepared for submission to the journal **Aggression and Violent behaviour** (impact factor – 4.382)

Word Count = 10450

Abstract

Background

Violence and aggression (V&A) are enduring problems within secure mental health facilities. There is a growing interest in the role that environmental factors may play in mediating the effects of V&A. There is also some suggestion from quantitative research that a social contagion effect may also be influencing rates of V&A.

Aim

The current study investigated potentially influential environmental correlates of V&A within a secure forensic mental health facility. These included social contagion effects, temporal effects and meteorological effects.

Design

The current study is a retrospective cohort study which followed an observational cross-sectional design. The study utilised longitudinal routinely collected data from a national high secure forensic mental health facility combined with available meteorological data.

Methods

All incident reports between 26/06/2012 & 30/09/2021 were collated and combined with available meteorological data. A discrete Hawkes process was utilised to investigate potential self-exciting effects which may exist within the data. Temporal effects and meteorological effects were examined utilising regressions models.

Results

The current study found initial support for the theory that incidents of V&A are spread through a process of social contagion, finding higher excitation rates in situations where patients would be aware of incidents of V&A. The study also found a significant day of the week, and time of day effect. These results are discussed in the context of typical routines of the study hospital. There currently exists insufficient evidence to comment fully on the effect of meteorological conditions as they relate to rates of V&A.

Discussion

The findings of the current study support the theory that social contagion and other environmental effects can influence rates of V&A within secure forensic mental health environments. It is hoped through the better understanding of these potentially important

effects that more dynamic and flexible risk management strategies can be implemented for the benefit of both patients and staff.

Section 1: Introduction

There is a substantial and well-established research base demonstrating that V&A are consistent ~~present~~ difficulties within in-patient mental health settings, especially so in forensic mental health facilities (Bowers et al., 2011; Newbill et., 2010; Flannery et al., 2011; Odes et al., 2021). This atmosphere of aggression is associated with a wide variety of negative outcomes for both patients and members of staff (Elliott & Daley, 2013; Lanza, 1983; Needham et al., 2005; Duxbury et al., 2015; Ramesh et al., 2018). It is unsurprising therefore that there is a growing body of research investigating possible causes and correlations of V&A within such facilities, typically this research has focused on individual variables or specific patient characteristics. It should be noted that research in this area has been highly useful (e.g. Brown, O'Rourke, & Schwannauer, 2019; Karatzias et al., 2019;

Hogan & Ennis, 2010; Witt, Van Dorn & Frazel., 2013), and has supported the creation of gold standard tools such as the HCR-20.

However, many researchers and the National Institute for Clinical Excellence (NICE) have highlighted the need to include ecological factors within risk assessments (e.g., Johnson 2004; Harmin, Lennaco & Olsen 2009; NICE, 2005; Wright et al., 2014). There currently exists a significant and growing research base utilising both quantitative and qualitative approaches. Studies utilising qualitative methods have typically completed interviews exploring the views of patients and staff as to why they believe violence occurs in secure mental health settings. It was noted by some studies that there was a discrepancy between the views of staff and patients, specifically that patients were more likely to view acts of V&A occurring because of overwhelming environmental pressures as opposed to underlying mental health disorders (Hinsby & Baker, 2004, Fish & Culshaw, 2005, Pulsford et al., 2013). The literature in this area went on to highlight a number of environmental effects which patients and in some cases staff, believed contributed to an increased rate of V&A, these included a lack of personal space and meaningful activities (Meehan, McIntosh & Bergen, 2006; Gudde et al., 2015). Specific hospital routines such as the dispensation of medication and food were also highlighted as adding to increased environmental stress (Wright et al., 2014; Barno, Ward &~~,~~ Casey, 2015).

Looking beyond the hospital environment there is some evidence to suggest that other environmental effects such as higher ambient temperatures are associated with a deterioration in psychiatric symptoms, as well as an increase in violence and self-harm within community settings (Thompson et al., 2018; Basu et al., 2018). Lickiewicz et al, (2020) found a weak but significant correlation between temperature, air pressure, humidity and wind speed and rates of coercive interventions within a forensic in-patient population. As mentioned previously

meteorological conditions represent an understudied area of potential environmental effect that could be linked to rates of V&A.

Qualitative research has also highlighted that patients within secure forensic environments often experienced pervasive feelings of tension and fear about their fellow patients "you never know when it's going to happen, you're on guard all day" (Meehan, McIntosh & Bergen, 2006) This theme of fear of fellow patients was found in a number of other qualitative studies (Gudde et al., 2015; Pulsford et al., 2013; Livingston, Nijdam-Jones & Brink, 2012); It was reported in one study that patients found staff interventions such as restraint and sedation highly reminiscent of previous experiences of abuse (Fish & Culshaw, 2005). The findings of these qualitative papers suggest that patients are often experiencing hypervigilance and are scanning their environments for danger including the threats posed by their fellow patients. Previous research has also highlighted that forensic mental health patients have high rates of early childhood abuse and are at an increased risk of physical assault (Beck et al., 2008; Karatzias et al., 2019). Early experiences of abuse are linked to changes in the limbic systems, resulting in increased experiences of hypervigilance and hyperarousal (Weiss, 2007). It may therefore be useful to think about the described feeling of tension, in terms of Ethlers and Clarks (2000) model of PTSD. Patients within secure forensic mental health environments might experience an acute stress reaction in response to a perceived threat in their environment, which may be influenced by a previous traumatic experience or beliefs about the danger associated with other patients. Patients, members of staff or environmental stimuli may act as a trigger for these anxiety responses.

Previous qualitative research therefore suggests that the high rates of V&A seen within secure mental health settings, might be explained in part by a build-up of environmental pressures, caused in part by the perceived threat of other patients and possibly staff reactions to incidents (Hinsby & Baker, 2004; Meehan, McIntosh & Bergen, 2006; Wright et al.,

2014). This interaction could be understood within the context of social contagion theory, which posits that behaviours and emotional states can spread within a social network like an infectious disease (Bastiampillai, Allison & Chan, 2013; Hill et al., 2010). There has been relatively little exploration of possible social contagion effects regarding V&A within secure mental health settings. The main study of note in this field is Beck et al, (2018), which investigated the temporal architecture of incidents of V&A, over a one-year period within a 16-bed forensic in-patient ward. The study was able to demonstrate that incidents of V&A were occurring at a non-random rate and tended to cluster around temporal points, which it suggested was evidence of possible contagion effects. However, the methods employed by the researchers did not allow them to investigate if one incident of aggression affected the likelihood of a second, limiting their ability to comment on potential contagion effects.

There is a more established research base exploring the role of social contagion effects within the suicide and self-harming behaviours literature, in particular in regard to young people and adolescents (Zenere, 2009; Joiner, 1999; Mercy et al., 2001; Taiminen et al., 1998; Niedzwiedz et al., 2014). Given that we can categorise self-harming behaviour as violence directed towards the self, this research base can provide support for the theory of social contagion. The identified studies utilised a range of methodologies which differed greatly in their complexity and rigor but were at times hindered by a poor definition of terms to describe contagion effects. However, there is a growing evidence base to suggest the existence of localised suicide clusters amongst adolescents (Joiner, 1999; Niedzwiedz et al., 2014). A systemic review completed by Niedzwiedz et al., (2014), highlighted the need to focus on mapping the potential spatial and temporal relationships that may be influencing suicide clusters. These findings provide some support for the theory that emotionally driven behaviours such as self-harm or suicide might be influenced by potential social contagion effects. There has also been some research conducted investigating the role of social

contagion effects as it relates to adolescent's engagement in 'deviant' behaviours including violence (Dishon & Dodge, 2005). This research provides further evidence that emotional states or behaviour patterns may be influenced by engagement within social networks.

As mentioned previously there have been relatively few attempts to investigate social contagion effects within forensic in-patient populations, Beck et al, (2018) was only able to comment on this effect in a limited way due to the methodologies implemented. Another option would have been to utilise Social Network Analysis, which has been used to investigate the "spread" of several phenomena including smoking, drug use, depression and divorce (Christakis & Fowler, 2013). These methods can investigate and estimate the likelihoods of behaviours based upon a person's engagement with their social network (Christakis & Fowler, 2013). Another method of investigating potential social contagion effects would be to use the Hawkes process, also sometimes known as self-exciting spatial temporal processing (Reinhart, 2018). This specific statistical method was initially developed to model the aftershocks of earthquakes, however in recent years has it also been used to model a number of social effects such as financial transactions, terrorist attacks, property crime and gang violence (Reinhart, 2018; Mohler et al., 2011). The Hawkes process benefits from being able to comment on the effect that previous events have on the likelihood of future events occurring. Therefore, the Hawkes process may be a good option to investigate potential social contagion effects of violence which might be occurring within forensic mental health facilities.

Given the negative impact that acts of V&A can have on both patients and members of staff, there is a pressing need for good quality research which can explore possible social contagion effects and other environmental predictors of violence and aggression. A better understanding of these effects might lead to more flexible and dynamic risk assessments and interventions being implemented within secure forensic settings.

Section 2: Aims and hypotheses

The aim of the current study was to investigate potentially influential environmental correlates of V&A within a secure forensic mental health facility. The environmental effects of interest have been drawn from previous quantitative and qualitative research. The effects can be best understood in two parts, these being social contagion effects and then other environmental effects (temporal & meteorological).

Firstly, we were interested in exploring any potential social contagion effects which might be occurring within our sample. To explore this, we investigated if previous incidents of V&A influenced the probability of future events occurring, and to what extent this effect was influenced by the hospital's alarm system. A finding that demonstrates incidents of V&A are

not occurring independently of each other, would provide some tentative evidence towards the theory that incidents of V&A may in part be predicted by social contagion theory. The first part of the study will take the form of an exploratory analysis.

Q1 – Does the rate of V&A appear to be influenced by a social contagion effect?

We aimed to explore if our current sample demonstrates a self-exciting effect which is influenced by the geographical separation of the patients and the effect of the alarm system.

Secondly, we investigated the temporal architecture of incidents of V&A and the effects of meteorological conditions. The temporal data was then compared to and understood in the context of well-established institutional routines around medication distribution, mealtimes, and activities. Meteorological effects were investigated including the role of length of day (minutes); temperature (degrees Celsius); precipitation (millimetres); sea level pressure (hectopascals) and wind speed (kilometres per hour).

Q2 - What temporal effects are important in predicting increased rates of violence and aggression.

Hypothesis 1 - There will be an increase in V&A behaviour in the late afternoon & early evening.

Null Hypothesis 1– The rate of V&A will be evenly distributed over time.

Hypothesis 2 – There will be a decrease in V&A incidents over the weekend

Null Hypothesis 2– There will be no significant difference in the rates of V&A across the different days of the week.

Hypothesis 3 – There will be an increase in rates of V&A during the summer months.

Null Hypothesis 3- There will be no significant difference in the rates of V&A across the year

Q3 - What meteorological effects are important in predicting increased rates of V&A.

Hypothesis 4 – There will be an increased rate of V&A with higher temperatures.

Null Hypothesis 4 – Average ambient temperature will not significantly predict rates of V&A

Hypothesis 5 – There will be an increase in rates of V&A with higher precipitation

Null Hypothesis 5 – Level of precipitation will not significantly predict rates of V&A

Hypothesis 6 – The minutes of day light will significantly influence rates of V&A.

Null Hypothesis 6 – The minutes of day light will not significantly predict rates of V&A.

Hypothesis 7 - There will be an increase in rates of V&A with higher wind speeds.

Null Hypothesis 7 – The average daily wind speed will not significantly predict rates of V&A.

Section 3: Method

3.1 Ethical considerations and approval

Ethical approval was sought and granted by NHS North of Scotland research ethics committee and University of Edinburgh research ethics and integrity board. There have been no significant deviations from the submitted protocol and the study has adhered to the agreed data protection impact assessment (DPIA).

3.2 Design

The current study is a retrospective cohort study which ~~will~~ follows an observational cross-sectional design. The study will utilise~~d~~ longitudinal routinely collected data combined with publically available meteorological data. Data was collected form 26/06/2012, because this was when the hospital redeveloped its campus and associated security systems.

3.3 Setting

NHS The State Hospital (TSH) is an NHS high security forensic hospital in the village of Carstairs, Lanark, Scotland, the longitudinal and lateral coordinates of which are 55.7°N 3.69°W, 209m. The hospital consists of 4 units, each of which consist of 3 wards and a central hub. Each ward consists of 12 bedrooms with an en-suite bathroom, a shared living space, therapy rooms and a modified safe room. Each hub also has a number of shared leisure and therapeutic facilities, patients also have access to a multipurpose activity centre used for a number of vocational and therapeutic activities. The movement of patients within TSH is strictly controlled. Every member of staff within the hospital perimeter is required to carry a personal attack alarm (PAA), staff are able to activate the alarm if they require additional staff to handle an incident of V&A. When a PAA is activated, there is an audible sound heard internally throughout the hospital, which makes staff and patients aware of an ongoing incident and its location. There is also a rapid redeployment of staff within hubs and the deployment of a specific response team. This means that patients and members of staff are likely to be aware of an incident occurring which required a PAA activation. This alarm is louder in the unit in which the incident is taking place.

A total 144 patients can be accommodated within the facility; however, the total number of patients being treated there at any one time is variable. All patients being treated within the TSH are detained under the Mental Health (Scotland) Act 2015 or Criminal Procedure (Scotland) Act (1995) due to being assessed to have a mental disorder and pose a risk of harm

to themselves or others. Patients will enter the hospital either directly from court or may be transferred from prison or another mental health facility.

3.4 Patient demographics

A total of 446 patients were treated in the State Hospital during the study period (26/06/2012 to the 30/09/2021), of these 180 were transferred from prison, 119 were transferred from hospital and 147 were transferred from court. All of the patients treated in the hospital during the study period were male. The majority of the patients (n= 320) admitted to the hospital had a primary diagnosis of schizophrenia, schizotypal or delusional disorder (F20-F29), as identified by the international classification of diseases (11th revision) (World Health Organization, 2018). The next four largest groupings of primary diagnosis were 47 mental and behavioural disorders due to psychoactive substance use (F10-F19); 34 disorders of adult personality and behaviour (F60-F69); 30 intellectual disability (F70-F79) and 15 patients with a mood disorder (F30-F39). Of these 446 patients treated within the facility during the study period, a total of 433 completed an act of V&A which met the inclusion and exclusion criteria to be included in the current data sample.

All patients currently being treated at the hospital are handed a privacy notice upon arrival informing them that their routinely collected data may be used for research purposes, and the process to opt out of this, which can be seen in Appendix B. Patients can exercise their right to object to their personal data being used in research by contacting their RMO, a member of their clinical team or the data protection officer. The process of utilising routinely collected data was covered in the projects data protection impact assessment and was reviewed by all relevant ethics boards, a copy of the notice can be seen in appendix B.

3.5 Data collection and coding

Within the TSH incidents of V&A are recorded by staff using Datix software, where the use of dropdown boxes and comment boxes, information such as the date, time, patient involved, type of incident, an estimation of severity, a note if the PAA was activated and a short description of the event are recorded. All incident report entries are held and managed by the Risk Department within the hospital. A request was made to access all incident report entries from 26/06/2012 to the 30/09/2021. A total of 9752 incident reports were collected and then screened against the inclusion ~~and exclusion~~ criteria listed below.

Commented [KJ3]: Sorry Jake, I think I was overzealous here, this reads fine, you can keep this in.

Inclusion

- Clear indication of date and time of incident
- Clear indication of which patient(s) were involved in the incident
- Clear description of location
- An act of physical aggression against a person
- An act of physical aggression against an object
- An act of verbal aggression or threating behaviour
- An act of self-harm
- An act of sexualised behaviour with a clear target.

Exclusion

- Accidental property damage
- Masturbation and exposure behaviour when deemed to be completed in a non-threatening way
- Urination in public areas
- Inappropriate sexual conversation between patients when non-threatening and overheard by staff
- Incidents occurring in the visitor centre

- Duplicates.

After screening the incident reports a total of 7383 were included in the present study. It was decided not include incidents which occurred in the visitor's centre as there was only 4 such incidents, and on each occasion the aggressor was a visiting family member. The available data set was then coded and anonymised utilising a local encrypted workstation.

Available meteorological data for all of the incident dates was collected from a combination of -https://www.timeanddate.com/ and https://www.meteoblue.com. Information on the length of day, (maximum, minimum & average) temperature, average air pressure, average precipitation and average wind speed was attached to each date.

3.6 Analysis strategy

Analyses was completed in two main stages, firstly we explored the role of social contagion effects, secondly, we investigated other environmental factors. The three identified research questions and their associated analysis strategy are listed below.

Q1 – Does the rate of V&A appear to be influenced by a social contagion effect?-

*To investigate the role of social contagion on the rates of V&A in the hospital, a discreet Hawkes process model was run on a sub section of the available data set. The Hawkes process is a form of a stochastic process, which is able to investigate self-exciting effects. Self-excitation is the process by which a previous incident of V&A would temporarily increase the probability of another incident of V&A occurring in the future. This probability of another event occurring is often referred to as the intensity, the fact that the process is self-exciting means that every incident increases the intensity (probability of another incident) which leads to more events in a crescendo like effect. The Hawkes process investigates these effects by separating incidents into background events, which is the random rate of events we

would expect without the influence of previous events and offspring events which represent a temporary increase in the intensity.

The following equation was used to model the discrete Hawkes process for our current sample. The discrete Hawkes model assumes the number of incidents which occurs within the discrete time period follows a Poisson random variable rate. The parameters of the model were estimated by computing the log-likelihood of the parameters and found maximum likelihood estimate.

$$\tilde{\lambda}_t^m = \mu^{(m)} + \sum_{l=1}^{m} \sum_{i:t_i<t} \left(K_{lm} + A_m^l \mathbb{1}(alarm_{ti} = TRUE) \right) y_{ti}^l \, g(t - t_i)$$

This equation models the rates of V&A in our sample, time was treated as a discrete variable and separated in 5 minute intervals. Aa breakdown of this model can be seen below:

Commented [KJ4]: The formatting has gone strange here, can you fix?

- $\tilde{\lambda}_t^m$ is the rate of incidents of V&A in ward (m) at time (t).
- $\mu^{(m)}$ is the baseline rate of events in ward (m).
- K_{lm} is the average rate of offspring events in ward (m) created by an incident in ward (l).
- y_{ti}^l is the number of events that happened in ward (l) during the time interval $[t_i, t_i + 1]$
- Conditioned on the events that happened before t_i (i.e the interval $[0, t_i]$), the discrete time Hawkes model assumes that y_t^l is distributed as a Poisson random variable with rate $\tilde{\lambda}_t^l$.
- $A_m^l \mathbb{1}(alarm_{t_i} = TRUE)$ is the effect of the variable of the alarm being sounded in ward (l) on the rate of offspring events in ward (m) $\mathbb{1}$ denotes the indicator function, meaning if the alarm sounded at a time point it is coded as a 1 opposed to 0.

- $g(t - t_i)$ is the rate of decay, describing the amount of reduction over time of the excitation effects. We chose this to correspond to a geometric distribution, i.e.

$$g(t\text{-}t_i ; \beta) = \beta\ (1\text{-}\ \beta)\text{^}\{t\text{-}t_{i\text{-}1}\}$$

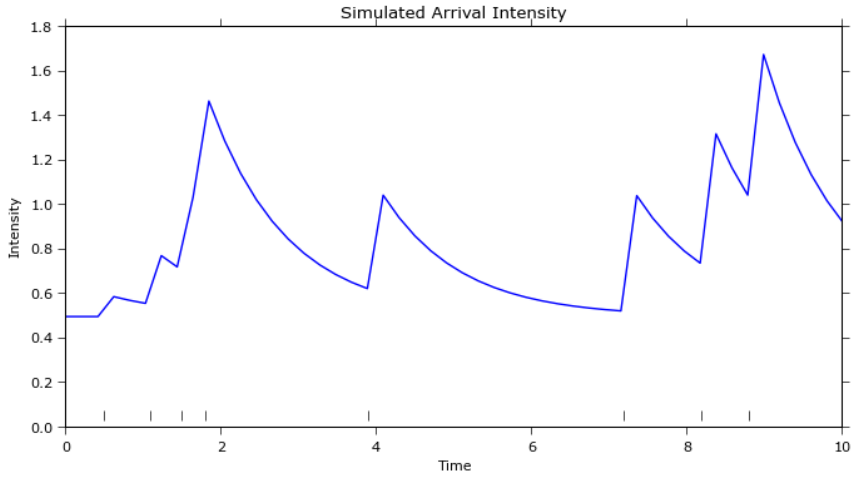
Here β is a parameter that controls the rate of decay, to be estimated from the data.

The parameters of the model were estimated using a log likelihood function for a Poisson ~~passion~~ distribution. This is a process of investigating what is the likelihood of finding the current rate of events at any one-time point within a -Poisson~~passion~~ distribution. The log likelihood function can be maximised to find the parameters that best explain the observed data. The following equation was used to obtain the log-likelihood function

$$logL(\theta|\tau) = \sum_{t=1}^{TMax} \sum_{m=1}^{M} (Y_t^m \log(\lambda_t^m) - \lambda_t^m)$$

An example of the Hawkes process can be seen illustrated in *Image 1* (Heusser, 2013). In this simulated graph we can see the intensity on the y-axis which is a measure of the probability that an event will occur, it begins at around 0.5 representing the baseline (μ), each event which occurs seen on the x-axis, leads to a temporary increase in intensity (K) before decaying. Depending on the model there may also be a limit to how long one incident can affect the level of intensity. The rate of the decay β can be seen in the graph in the gradual decline in intensity after event returning towards the base rate (μ).

Image 1. Simulated Hawkes process (Heusser, 2013)



In our current model the intensity~~,~~ describes the probability of an incident of V&A occurring. We utilised a discreet Hawkes process where time is treated as a discreet value and is divided into 5-minute sections, and for computational purposes we assume that the impact that one incident of V&A can haves~~s~~ on the probability of future events dies out after 4 weeks. Using the Hawkes process, therefore we were able to estimate the average increase in probability (intensity) of an incident of V&A occurring, after a previous incident occurred both with and without the effect of the PAA. This increase in probability is realised on three levels of effect based upon the layout of the hospital. Level 1 describes the effect an incident would have on the same ward. Level 2 describes the effect an incident would have on a ward within the same unit. Level 3 describes the effect an incident would have on the rest of the hospital. Demonstrated in matrix 1.

Matrix 1.

	Ward 2	**Ward 3**	**Ward 10**
Ward 2	Level 1	Level 2	Level 3

Ward 3	Level 2	Level 1	Level 3
Ward 10	Level 3	Level 3	Level 1

Utilising this model, we were able to estimate the average offspring excitation rate (K) and the average alarm specific offspring excitation rate (A). Given that patients will be aware of events occurring at level 1 but will only be aware of events occurring at level 3 if the alarm has sounded, we were able to explore possible social contagion effects. If rates of offspring events (k) are higher in level 1 than they are in level 2 & level 3 then this might provide some support for the explanation that the rates of excitation are being influenced in part by a social contagion effect. Similarly, if we note that the effect of the alarm (A) is higher than average offspring excitation rate (K) in levels 2 and/or 3 this would suggest the alarm is leading to further excitation in areas which would otherwise be unaware of the event, allowing for exploration of the possible effect of social contagion.

Formatted: Font: (Default) Times New Roman

To explore this model a subset of the total sample representing three (ward 2, ward 3 & ward 10) of the 12 wards were selected. These wards were selected as they were thought to be a good representation of the whole hospital and were able to demonstrate all three levels of effect. Similarly, due to potential effect of COVID-19 distancing measures, no incidents~~indents~~ recorded after 01/03/2020 were included. A total of 1763 incidents of V&A occurred in the selected wards over the study period.

***** The Discrete Hawkes process model was developed and implemented in collaboration with my academic supervisor Dr Gordon Ross and his colleagues Daniel Paulin & Trinnhallen Brisley

Q2 - What temporal effects are important in predicting increased rates of V&A?~~.~~

~~Thirdly, t~~Temporal effects on V & A were also investigated. We completed linear regressions investigating daily rates of aggression compared to days of the week, month of the year and seasons. As each of the variables were categorical with more than two categories, we could not simply assign them a numerical value such as 1-7 as one day of the week such as Friday is of no more value than another, we had to use dummy variables (indicator variables). Dummy coding allows us to represent different values such as days of the week as binary information. However, we cannot use all the categories at the same time as this would lead to multicollinearity and break the model, instead we must identify a baseline category which acts as a control, which is omitted and against which all the other variables are measured (Field, Miles & Field., 2012). The regression coefficient (beta, B) therefore measures the strength of the difference between the variable and the baseline category. The omitted measure was chosen to be the one with lowest number of incidents meaning that Sunday was omitted from days of the week, December from months and winter from seasons. These methods are consistent with those utilised in Paavola & Tiihonen, (2010).

In order to investigate the effects of time of day we completed a binary logistic regression with dummy variables. In this logistic regression time of day was treated as a categorical variable and the outcome variable was a binary yes or no if an event occurred. The omitted time period was 00:00 – 02:00 as this had the lowest number of incidents.

.

Q3 - What meteorological effects are important in predicting increased rates of V&A~~.~~?

The final stage of the analysis investigated the effects of temperature (min, max & mean), length of day, air pressure, precipitation, and wind speed, against daily incidents of V&A. We utilised two-dimensional scatter plots, Pearson correlations and a multiple regression to

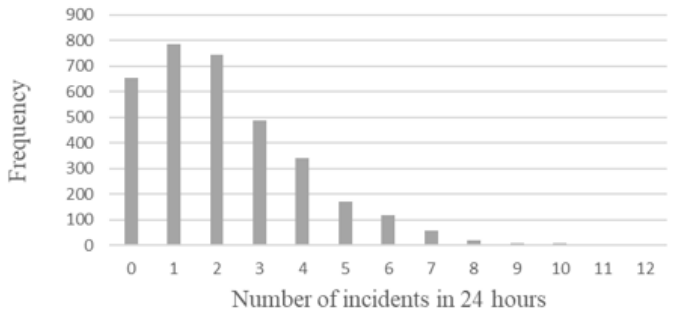
investigate these potential relationships. The intercorrelation of the weather effects was also investigated.

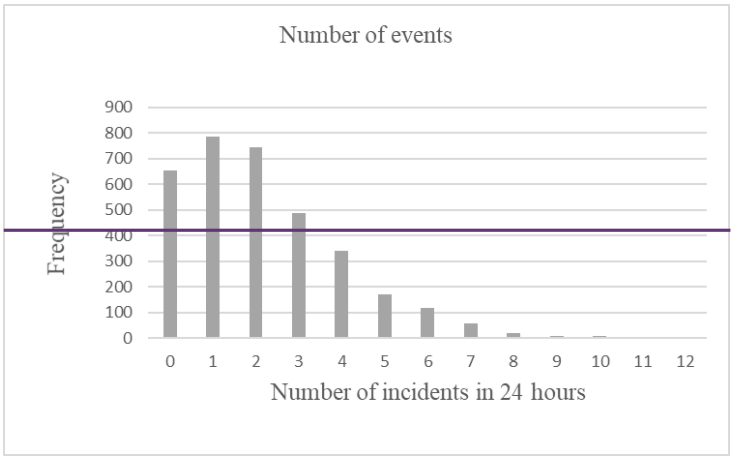
All statistical analysis ~~will be~~was completed utilising the statistical programme R.

3.7 Statistical assumptions

The necessary four assumptions for utilising parametric tests are that your identified sample should be normally distributed, use interval data, should have homogeny of variance and be independent. If we look at the histogram of number of incidents within a 24-hour period in fig 1. we can see that the distribution of events seems mostly normally distributed with a long tail.

Fig 1. Number of events





The mean number of events within a 24-hour period is 2.170 with a standard deviation of 1.856. The z -scores for skewness = 0.084 and for kurtosis are 0.168, indicated our sample is skewed due to too many low scores, meaning some of the higher scores are likely outliers. A follow up Shaprio-Wilks test found that our sample was significantly different to a normal distribution W = 0.896, $p < 0.001$. This finding is likely due to the large sample used and then the influence of the large tail in the data. A visual inspection of the histogram would suggest a normal distribution, and due to the central limit theorem, we would assume a sample as large as the one currently being used would be normally distributed. We can accept that all other assumptions have been met, however we should be cautious when considering our results and their relevance to the wider population of forensic in-patients.

3.8 Power calculations

The First stage of our analysis will be utilizing a Hawkes point processing model to test if our data is self-exciting. The use of this type of analysis to study social phenomena such as crime, violence or trends in social media is still relatively new, and thus there is a lack of clarity as to the minimum data set required to complete this type of analysis. One previous study

utilizing the method to model crime data, suggested a minimum of 1000 data points are needed for the model to work accurately (Mohler et al., 2011). This would suggest that we would need a minimum of 1000 individual incidents of V&A, in order to be sufficiently powered to utilize this statistical method.

G*Power (Faul, Erdfelder & Buchner, 2009) was also utilised to estimate the required sample size for completing a multiple regression. The a priori calculation utilized a Power (1-β error probability) of 0.95, an α error probability of 0.05, we estimated a low effect size f^2 of 0.02 based on the previous study by Lickiewicz et al, (2020) and accounted for 6 variables to be included. This resulted in estimated sample size of 1050 days of data. All the a priori sample size calculations were satisfied by the collected sample.

Section 4: Results

4.1 Descriptive data.

A total of 7383 incidents of V&A which met the inclusion ~~and exclusion~~ criteria occurred during the study period. The percentage of each type of incident can be seen in table 1. In those incidents in which there was a specific target of aggression, staff were targeted 73% of the time, with other patients making up the other 27% of targets. Staff activated their PAA in response to 16% of recorded incidents. The total number of incidents of violence and aggression for any day ranged from 0 to 12, with a mean of 2.170 and standard deviation of 1.856.

Table 1. T~~t~~ype of incident

Type of incident	Number recorded	Percentage (%)	Percentage (%) of PAA activations
Assault	772	10.5%	37.4%
Attempted Assault	575	7.8%	28.4%
Property Damage	45	0.6%	1.6%
Self-harming Behaviour	1007	13.7%	0.8%
Sexualised Behaviour	35	0.5%	0.8%
Threatening Behaviour	2827	38.3%	26%
Verbal Aggression	2122	28.7%	5%

4.2 Social contagion effects

Utilising the above described discrete Hawkes process and completing a maximum likelihood estimation we were able to estimate the following parameters which best describe the current data. The base rates (μ) for each of the three wards were μ1 (ward 2) = 0.000454678, μ2 (ward 3) =0.000154969, μ3 (ward 10) = 0.000333353. This represents the average rates of incidents we would expect to occur without the influence of~~or~~ previous events. The rate of decay β = 0.00094780. We also estimated K_{lm} and A^{l}_{m} at the three different levels of effect. Level 1 representing effect on the same ward, level 2 representing effect on a different ward in the same hub and level 3 representing effect on a different ward in a different hub. K is the average rate of offspring events occurring due to a previous incident. A is the additional

effect of the alarm being sounded on the rate of offspring events. This average rate of offspring events is referred to as excitation, the higher the rate of excitation the more incidents we would expect to see.

Table 2 of Hawkes process excitation rates

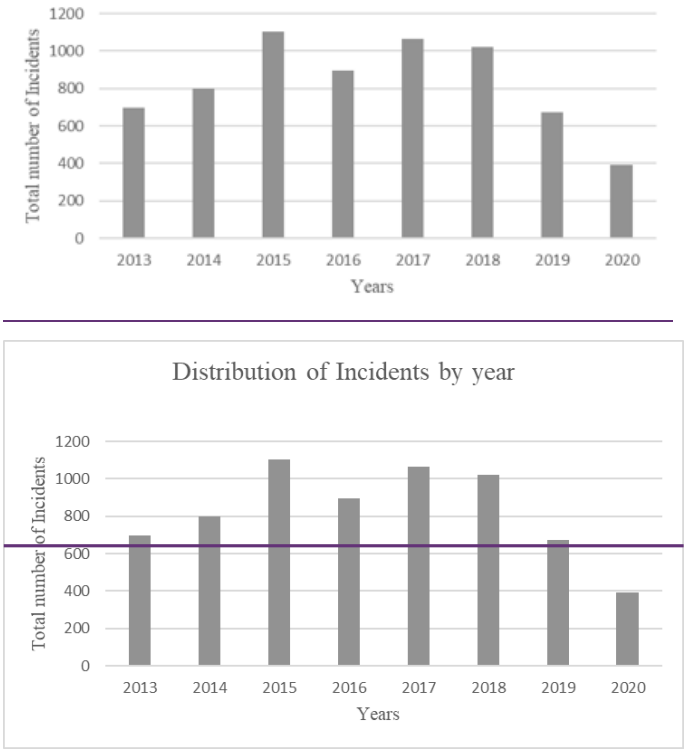
	(k)	**(A)**
Level 1	0.4508	<0.000001
Level 2	<0.000001	0.0028
Level 3	<0.000001	<0.000001

These results suggest that the average rate of excitation is strongest at level 1 and weakest at level 3. The results also indicate that most of the excitation occurring at level 2 is coming from the effect of the alarm having been activated. The current model suggests that for every incident of V&A that occurs but does not lead to the activation of PAA, there is an increased in probability (intensity) of another incident V&A to occur on average at level 1, with a negligible additional increase in the rate of excitation coming from the effect of the alarm being activated at level 1. At level 2 we can see that the majority of excitation is coming from incidents of V&A which have led to a PAA being activated.

4.3 Temporal effects

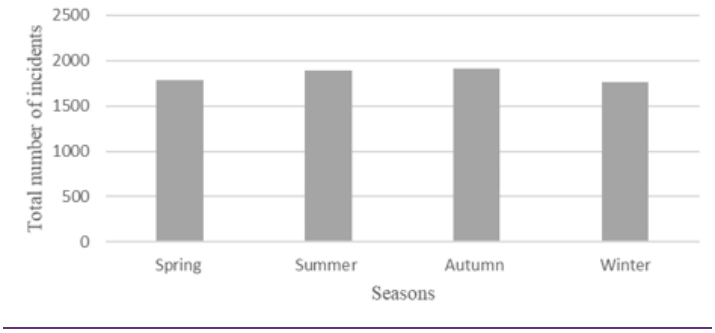
The distribution of incidents of violence and aggression by time can be seen in figures 2, 3, 4, 5 & 6.

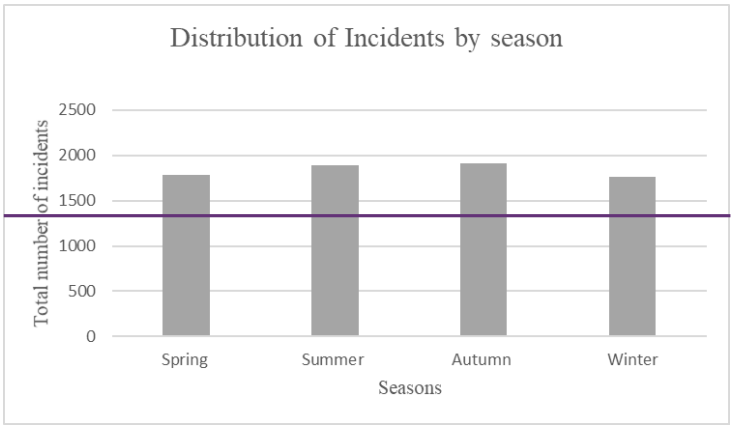
Fig.2 Distribution of Incidents by year



Firstly, when looking at the distribution of incidents by year, there is a noticeable drop of incidents in 2020 compared to the years previously. It is likely this is the result of Covid-19 restrictions which were put into place in Scotland on the 23/03/2020. The new restrictions lead to a substantial change in the routines of many patients, which may have affected the likelihood of incidents of V&A occurring.

Fig 3. Total incidents of V&A by Season





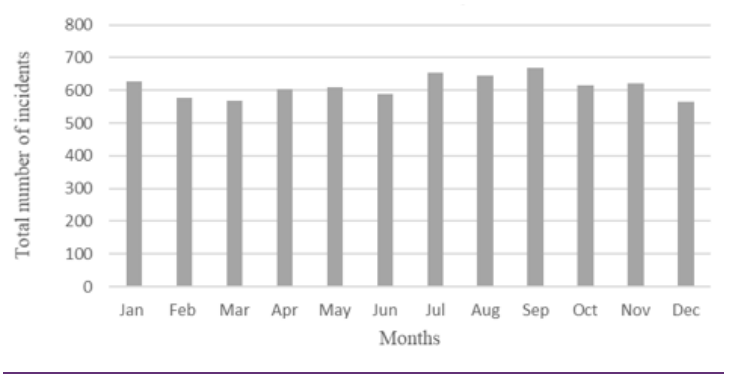
Looking at figure 3, we can see that most incidents of V&A occurred in Autumn, to investigate this possible relationship further we completed a linear regression with a categorical predictor variable and dummy season variables. However, the change of season did not explain a significant amount of the variance in rates of V&A (*F* (3,3380) = 0.837, *p* = 0.473. R^2 = 0.0007, R^2adjusted = -0.0001). Each of the categorical variable regression coefficients when compared against winter can be seen in table 3.

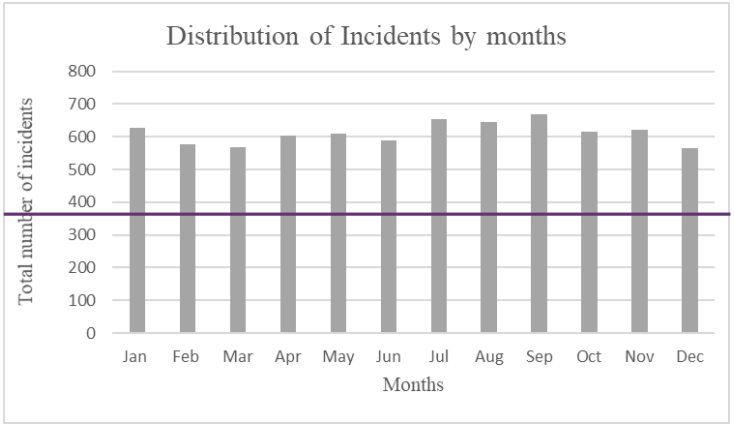
Table3. Regression coefficients for season vs Winter

Season	**B**	**B SE**	**P**

Spring vs Winter	-0.025	0.092	0.784
Summer vs Winter	-0.068	0.090	0.452
Autumn vs Winter	0.070	0.091	0.442

Fig 4. Total incidents of V&A by month



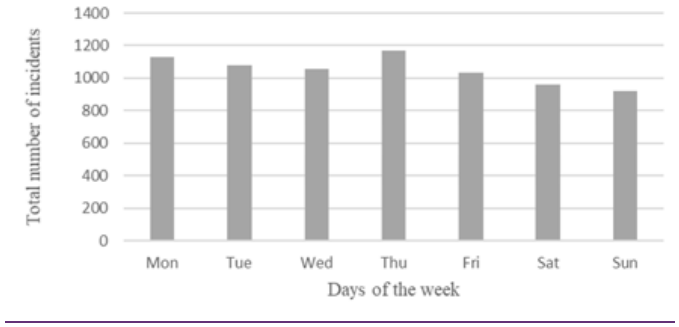


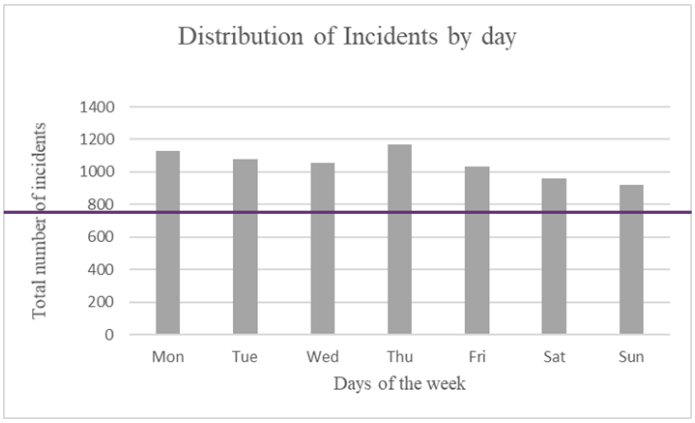
When looking at the distribution of incidents by month we can see there was a peak of incidents occurring in September and dip of incidents occurring in December. Similarly, we utilised a linear regression treating months of the year as a categorical variable and utilising dummy variables. Separating out seasons into individual months was also insignificant. F (11,3372) = 0.688, p = 0.751. R2 = 0.0022, R2adjusted = -0.0010. Each of the categorical variables regression coefficients when compared against December can be seen in table 4. Looking at the results of the linear regression for both seasons and months, we can conclude that there is currently not enough evidence to reject null hypotheses 3. Therefore, month of the year does not appear to be a useful predictor of rates of aggression within the hospital.

Table 4. Regression coefficients for month vs December

Month	**B**	**B SE**	**P**
Jan vs Dec	0.038	0.158	0.812
Feb vs Dec	-0.205	0.155	0.185
Mar vs Dec	-0.092	0.155	0.554
Apr vs Dec	0.003	0.156	0.983
May vs Dec	-0.194	0.155	0.209
Jun vs Dec	-0.124	0.150	0.412
Jul vs Dec	0.014	0.154	0.929
Aug vs Dec	-0.146	0.150	0.331
Sep vs Dec	-0.022	0.155	0.636
Oct vs Dec	0.074	0.156	0.636
Nov vs Dec	-0.044	0.155	0.778

Fig 5. Total incidents of V&A by day of the week





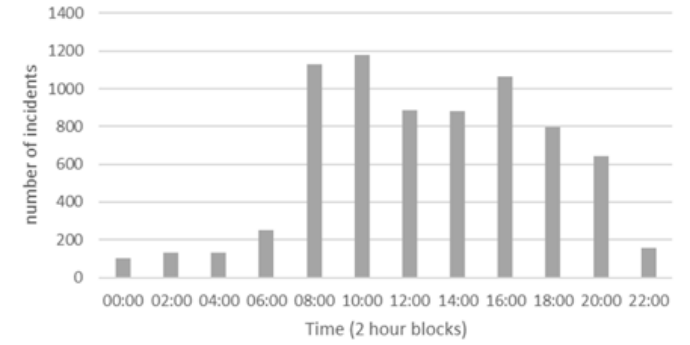
Looking at the distribution of incidents of violence and aggression by day of the week, there does appear to be a slight reduction in events over the weekend with Sunday having lowest number of incidents and a peak of events occurring on a Thursday. To investigate this relationship, we again utilised a linear regression treating days of the week as a categorical variable and utilising dummy variables. The regression model was significant, suggesting day of the week explained a significant amount of the variance in V&A. $F(6,3377) = 4.483$, $p < 0.001$. $R2 = 0.008$, $R2adjusted = 0.006$. Each of the categorical variables regression coefficients when compared against Sunday can be seen in table 5. Although significant we

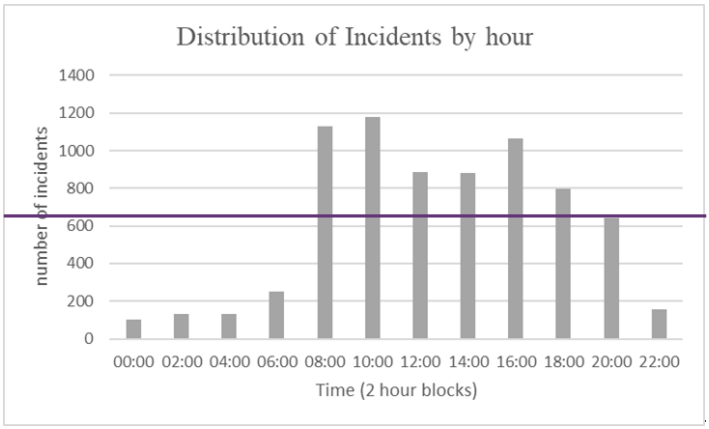
can see from the value adjusted R^2 that very little of the variance in rates of V&A is predicted by the model. We can see from the table that the effect of Thursday was significant (p = 0.023), and Tuesday was borderline no significant (p= 0.052). These results mean we are justified in rejecting Null Hypothesis 2; however, these results need to be considered in the context of TSH routines in order to better understand them.

Table 5. Regression coefficients for day of week vs Winter

Day	**B**	**B SE**	**P**
Mon vs Sun	0.160	0.119	0.179
Tue vs Sun	0.231	0.119	0.052
Wed vs Sun	0.045	0.119	0.702
Thu vs Sun	-0.271	0.119	0.023
Fri vs Sun	-0.035	0.119	0.770
Sat vs Sun	-0.188	0.119	0.114

Fig 6. *Total incidents of V&A by hour of day (2-hour blocks)*





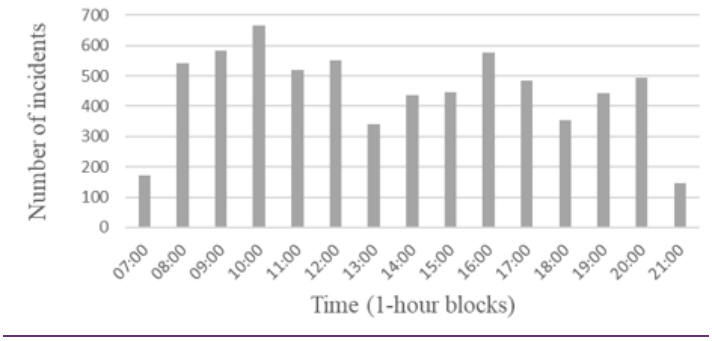
When looking at figure 6, we can see there is a clear difference in the distribution of incidents of V&A. To investigate the role of time of day on rates of violence and aggression, we completed a binary logistic regression where time of day was a categorical variable, and the outcome variable was a binary 1/0 for if an incident occurred or not. Like before we utilised dummy variables as part of this analysis. The logistic regression model was significant, X^2 (11) = 4126, $p < 0.001$. The model explained 10.5% of the variance (Hosmer and Lemeshow R2). Each of the categorical variables' regression coefficients and odds ratios (with 95% CI) when compared against 00:00 – 02:00 can be seen in table 6. The results of the logistic regression allow us to reject null hypothesis 1. The results clearly show an effect for time of

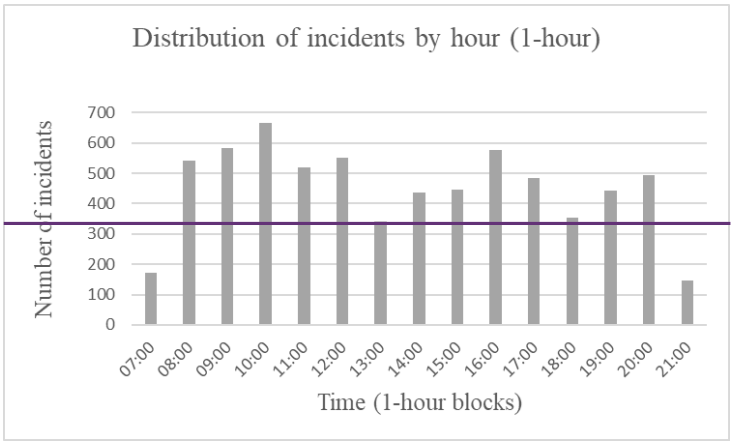
day with incidents far more likely to occur during the day as opposed to at night. There also seems to be two peaks of incidents occurring during the day, one at the beginning of day 08:00 to 12:00 and a second occurring in the late afternoon 16:00 -18:00. All of these results should be considered in respect to the typical routine of TSH which can be seen in table 8. When interpreting a logistic regression we can utilise odds ratios as a substitute for effect sizes, from this we can see peaks in the strength of the relationship occurring at 08:00, 10:00 & 16:00.

Table 6. Regression coefficients for Time (2-hour block) vs 00:00

Time	B	B SE	P	Lower	Odds Ratio	Upper
02:00	0.264	0.134	<0.05	1.003	1.302	1.695
04:00	0.258	0.134	0.054	0.996	1.294	1.685
06:00	0.941	0.120	<0.001	2.034	2.562	3.251
08:00	2.656	0.106	<0.001	11.625	14.244	17.640
10:00	2.703	0.106	<0.001	12.190	14.930	18.484
12:00	2.342	0.107	<0.001	8.481	10.412	12.921
14:00	2.345	0.107	<0.001	8.492	10.428	12.940
16:00	2.573	0.107	<0.001	10.691	13.105	16.237
18:00	2.224	0.108	<0.001	7.521	9.246	11.483
20:00	1.965	0.109	<0.001	5.790	7.137	8.886
22:00	0.438	0.129	<0.001	1.204	1.549	1.999

Fig 7. *Total incidents of V&A by hour of day (1-hour blocks)*





Given that there appears to be clear night and day effect in the data, a secondary analysis using the same methodology was completed looking at the hours between 07:00 & 21:00, separating time into one-hour blocks. The baseline category for this logistic regression model was 21:00 as this had the lowest number of incidents. The logistic regression model was significant, $X^2(14) = 814$, $p < 0.001$. However this second model only explained 2% of the variance (Hosmer and Lemeshow R2), much lower thant the first. Each of the categorical variables' regression coefficients and odds ratios (with 95% CI) when compared against 21:00-22:00 can be seen in table 7. There appears to be two peaks of incidents of V&A occurring at 10:00 and at 16:00, with two troughs occurring at 13:00 and 18:00. These

findings should be viewed in conjunction with the typical daily routine which exists within the TSH, which can be seen in table ~~7~~8.

Table 7. Regression coefficients for Time (1-hour block) vs 21:00

Time	B	B SE	P	Lower	Odds Ratio	Upper
07:00	0.173	0.115	0.132	0.950	1.189	1.490
08:00	1.404	0.096	<0.001	3.380	4.071	4.933
09:00	1.495	0.096	<0.001	3.707	4.459	5.397
10:00	1.634	0.095	<0.001	4.267	5.122	6.186
11:00	1.353	0.097	<0.001	3.208	3.867	4.690
12:00	1.417	0.096	<0.001	3.425	4.125	4.997
13:00	0.888	0.102	<0.001	1.995	2.430	2.974
14:00	1.162	0.099	<0.001	2.640	3.195	3.887
15:00	1.190	0.098	<0.001	2.718	3.287	3.998
16:00	1.456	0.095	<0.001	3.598	4.329	5.241
17:00	1.280	0.098	<0.001	2.980	3.598	4.368
18:00	0.928	0.101	<0.001	2.079	2.530	3.093
19:00	1.173	0.099	<0.001	2.671	3.231	3.931
20:00	1.303	0.097	<0.001	3.049	3.679	4.466

Table 8. Typical TSH daily timetable

Time period	Mealtimes	Medication	Staff Shift changes	Clinical work & placements being completed	Patients secured in their room
00:00					x

02:00					x
04:00					x
06:00					x
07:00			x		x
08:00	x	x	x		
09:00				x	
10:00				x	
11:00				x	
12:00	x	x		x	
13:00				x	
14:00			x	x	
15:00				x	
16:00			x	x	
17:00	x	x			
18:00					
19:00					
20:00	x	x	x		
21:00					x
22:00					x

4.3 Meteorological effects

In the final stage of analysis, we were interested in investigating which meteorological effects were important in predicting rates of V&A. Initially we produced 2-dimensional scatter plots for each variable which showed very weak/borderline correlations between each of the variables and rates of V&A. This can be seen clearly in the produced Pearson's correlation coefficient displayed in table 9.

Table 9. Pearson's correlation between meteorological effect and daily rate of V&A

Variable	**B**	**T – value**	**DF**	**P**	**95 % CI**
Length of day	-0.010	-0.010	3382	0.559	-0.044/0.024
Temperature mean	0.009	0.009	3382	0.6092	-0.025/0.042
Temperature min	0.007	0.007	3382	0.6744	-0.026/0.041
Temperature max	0.008	0.008	3382	0.6327	-0.026/0.042
Air pressure	-0.007	-0.007	3382	0.6671	-0.041/0.026
Precipitation	0.016	0.016	3382	0.342	-0.017/ 0.050

Wind speed	-0.008	-0.008	3382	0.6494	-0.042/ 0.026

None of the identified meteorological variables were statistically significant. To further investigate the role of meteorological effects we also completed a multiple regression to investigate the joint influence of the variables on rates of V&A. We utilised a hierarchical multiple linear regression and chose the load order of variables based on previous research (Lickiewicz et al., 2020) while trying to maximise the correlation with incidents of violence and minimise the inter correlation of variables. The rate of intercorrelation can be seen in table 10 and the multiple regression models can be seen in table 11. For obvious reasons temperature mean, min & max were highly correlated and so only one was chosen for each model. The multiple regression models were found to be not significant $p > 0.05$, therefore we do not currently have enough evidence to reject null hypotheses 4, 5, 6 & 7.

Table 10. Intercorrelation coefficients for meteorological effects

	Length of day	**Temp mean**	**Temp min**	**Temp max**	**Pressure**	**Precipitation**	**Wind speed**
Length of day	1.000	0.695	0.554	0.721	0.196	-0.009	-0.309
Temp mean	0.695	1.000	0.933	0.967	0.161	0.007	-0.275
Temp min	0.554	0.933	1.000	0.834	0.043	0.097	-0.156
Temp max	0.721	0.967	0.834	1.000	0.251	-0.069	-0.354
Pressure	0.196	0.161	0.043	0.251	1.000	-0.368	-0.413
Precipitation	-0.009	0.007	0.097	-0.069	-0.368	1.000	0.175
Wind speed	-0.309	-0.275	-0.156	-0.354	-0.413	0.175	1.000

Table 11. Hierarchical multiple linear regression model

	R2	B	SE B	P
Model 1	0.001			0.631
Intercept		3.215	3.037	0.290
Precipitation		0.009	0.010	0.376
Length of day		-0.0002	0.0002	0.169
Temperature mean		0.011	0.009	0.234
Wind speed		-0.003	0.004	0.427
Pressure		-0.0008	0.003	0.772
Model 2	0.001			0.757
Intercept		3.073	3.038	0.312
Temperature min		0.007	0.009	0.441
Pressure		-0.0007	0.002	0.810
Precipitation		0.008	0.010	0.397
Length of day		-0.0002	0.0002	0.283
Wind speed		-0.003	0.004	0.377
Model 3	0.001			0.598
Intercept		3.441	3.046	0.259
Pressure		-0.001	0.003	0.708
Temperature max		0.011	0.009	0.201
Wind speed		-0.002	0.004	0.488
Precipitation		0.010	0.010	0.335
Length of day		-0.0003	0.0002	0.148

Section 5: Discussion

5.1 Social contagion effects

Firstly, as we can see from both the chi-square and logistic regression, incidents of V&A do not appear to be occurring at a truly random rate. The results of the Hawkes process describe the temporary increase in probability that an incident of V&A will occur following a previous incident of V&A. We investigated this effect at three levels: within ward effects, within unit effects and within hospital effects, as well as looking at the variable of whether the PAA was activated or not. The results indicate that the intensity was highest at level 1 and lowest at level 3 and there was some evidence of alarm specific excitation occurring at level 2. These

findings suggest that there will be more incidents of V&A in same ward following a previous incident, and if the alarm sounded there may also be an increase in wards within the same unit. One possible reason for this pattern of excitation might be that witnessing an incident of V&A lead to an increased level of stress amongst patients and staff, which in turn will lead to an increased probability of an incident of V&A occurring. This process is similar to the pervasive atmosphere of stress and anxiety described in the qualitative literature ~~(~~(Meehan, McIntosh & Bergen, 2006; Gudde et al., 2015; Pulsford et al., 2013; Livingston, Nijdam-Jones & Brink, 2012). It may also be possible that this effect is caused by other patients taking advantage of any current disruption within a ward. Similarly the results could represent highly distressed individuals who are causing a disproportionate amo unt~~ng~~ of V&A.

The results of Hawkes process provide some tentative support for the theory that rates of V&A within secure forensic setting may be influenced in part by a social contagion effect. This is evident by the level of excitation without a PAA activation alarm found to be highest at level 1 (patients witnessing incident first-hand) and lower at Level 2 & Level 3 (patient very unlikely to have knowledge of the event ~~due~~). Similarly, the only way patients at level 2 are likely to be aware of an incident of V&A occurring will be if it led to the activation of the PAA, therefore providing further evidence that the level of excitation measured by the model appears to be driven by a social contagion effect. However, this increase in excitation was not seen at level 3, this could be because patients at level 2 would be more aware of the redistribution of staff. However, this is only one interpretation of how the self-exciting effect seen might be expressed, further investigation with more complex models may be able to explore this mechanism further.

The results of the Hawkes process could be suggestive of the theory that incidents of V&A can be spread through a social contagion effect. However, to the best of our knowledge this is

the first application of the Hawkes process to explore this effect, therefore the results should be interpreted with caution, and further hypothesis driven testing should be completed. From these exploratory findings it would seem logical to investigate the effect on the whole hospital population and to perform further analysis to investigate the fit of more complex models.

5.2 Temporal effects

The current study was able to investigate temporal effects and their relation to incidents of V&A. Firstly, although not significant we can see a peak of incidents occurring in late summer into early autumn, these finding are similar to those of Paavola & Tiihonen, (2010), Green & Robinson, (2005), and Weizmann-Henelius (2000). There were some key differences in methodology however, Green & Robinson, (2005) did not complete any significance testing, while Weizmann-Henelius utilised a chi square goodness of fit test and Paavola & Tiihonen, (2010) used a methodology similar to our own. The current study's regression model for seasons and months of the year produced adjusted R2 values of -0.0010 and 0.006 respectively, meaning that the results are not only non-significant but also explained very little of the variance. This is very different from Paavola & Tiihonen, (2010) which found a significant adjusted R2 value of 0.65. The main difference between the two studies was that Paavola & Tiihonen, (2010) only looked at rates of coercive interventions as opposed to looking at all incidents of V&A. These findings are in line with the tentative evidence of increases in violent and suicidal behaviour during the summer which are seen in the community (Michael & Zumpe., 1983; Morken & Linaker., 2000; Yang et al., 2019). The possible mechanism of these effects within forensic hospital could be changes to staff due to increased annual leave, associated meteorological effects, or possibly increased opportunities to mix with other patients.

We were also able to investigate the role of day of week on rates of V&A and found a significant effect indicating a reduced rate of violence occurring on a Sunday. The current regression model is significant however, looking at the adjusted R2 value of 0.006, we can see that only a small amount of the variance (0.6%) is being explained by this predictor. These findings are similar to those of previous studies which have identified a drop in rates of aggression over the weekend period (Peuloa, Mela & Adelugba, 2013; Green & Robinson, 2005; Swinton, Hopkins & Swinton, 1998; Carton & Larkin, 1991; Barnard et al., 1984). There seems to be clear evidence of a weekend effect in rates of V&A. This reduction in rates of aggression could be associated with less structured time, reduced clinical input or increased likelihood of family visits. The mechanism of reduced violence over weekends is an area which could benefit from further research focus to identify the mechanism by which this effect is expressed.

Finally, we examined the relationship between time of day and rates of violence and aggression which was shown to be significant. The first model looking at the whole explained around 10.5% of variance, however the second only looking at hours when patients are typically awake explained only 2 % of the variance by Hosmer and Lemeshow R2 value. These findings need to be considered in the context of the well-established routines which occur within TSH which can been seen in table ~~7~~8.

Firstly, like other research in this area there is a clear effect for incidents of violence occurring more frequently during the day than at night, this is almost certainly explained by most patients being asleep and secured in their rooms between 22:00 and 08:00.There seems to be two key peaks during the day these being in the early morning 10:00-11:00 and at the end of the day 16:00 -17:00. These time periods largely represent the beginning and end of clinical input and hospital placements. There is a steep increase in the number of events which begins at 08:00 and increases to a peak at 10:00, which represents a particularly busy

time within the hospital in which medication is distributed, meals are served, staff shifts change over, and daily sessions and placements are organised and commenced all of which have previously been identified as potentially stress inducing stimuli (Wright et al., 2014; Barno, Ward, Casey, 2015; Barnard et al., 1984; Peuloa, Mela & Adelugba 2013; Weizmann-Henelius 2000). The second spike occurring between 16:00-17:00 is like that seen in previous studies (Sullivan, 2013; Hill et al., 2012), and also represents a period of change within the day as placements and clinical work completed by allied health professionals comes to a close. There also appear to be two distinct troughs in the incidents of V&A occurring at 13:00 & 18:00 which is directly after the dispensation of medication and meals. This could represent the effects of medication or perhaps a reduction in violence due to elevated blood sugar levels following a meal.

5.3 Meteorological effects

The cCurrent study intended to investigate the effects of different meteorological conditions (temperature, pressure, precipitation, length of day and wind speed) on rates of violence and aggression within TSH. The methodology of the current study was fairly robust compared to the only other study investigating a similar population (Lickiewicz et al., 2020), boasting a longer research period (more yearly cycles). However, we were unable to find a significant relationship between any of the meteorological effects and rates of V&A. One of the major differences between the current study and that of Lickiewicz et al, (2020), was that our study included all incidents which met our inclusion ~~and exclusion~~ criteria, while the later study focused solely on rates of physical coercion. In this way Lickiewicz et al, (2020) are looking at more serious incidents of V&A and their relationship to meteorological conditions. The fact that incidents of verbal aggression and threatening behaviour made up 67% of our total incidents may have hidden any potential effects. It would have perhaps been more beneficial

to look only at more serious incidents of V&A such as assault, attempted assault and self-harm.

The lack of a significant relationship is somewhat surprising given the relatively large amount of research which has demonstrated a relationship between meteorological conditions, especially temperature, and the worsening of mental health conditions, increased hospital admissions and suicide mortality (Bolton et al., 2018; Liu et al., 2021; Thompson et al., 2018; Weilnhammer et al., 2021; Wang et al., 2018). It may be that this relationship is less pronounced within hospital environments than it is in the community. There are a number of possible reasons for this, firstly TSH is a modern hospital, where the patients' movements and access to outdoor spaces is highly controlled therefore they may simply have less exposure to changing meteorological conditions. Secondly the study was completed in Scotland which does not experience the very large increases in temperature which has the most evidence for influencing metal health symptoms. Thirdly it might be that in this highly controlled environment the mechanisms by which people's health and behaviour declines in the community such as increased alcohol consumption in warmer weather is mitigated. Finally, it may be that in a concentrated environment such as a forensic hospital, that individual factors such as diagnosis and previous involvement in violent crime are stronger predictors, thus diluting any environmental effects. Given that there is relatively little research investigating meteorological effects on forensic in-patient populations, the area would benefit from further research focus, particularly given that many researchers are predicting that this effect may become stronger as weather conditions become more extreme as the result of climate change (Obradovich et al., 2018; Liu et al., 2021).

5.4 Clinical utility

Firstly, the current study has provided a template for other inpatient units to investigate their own individual temporal structure of V&A. Secondly there appears to be some evidence to support the theory that a build-up of environmental pressures as described in the qualitative literature is leading to increased rates of V&A at specific times. This is evident in reduced levels of violence occurring over the weekend and busier periods on the wards leading to increased levels of V&A. It may therefore be beneficial to try and reduce the concentration of potential stressors at any one time, this could include separating medications and mealtimes, as well operating more flexible staff shift patterns. It may also be beneficial for clinical work not to be concentrated between 9-5, Monday to Friday again implementing a more flexible structure. However, we should note none of the temporal factors investigated explain a large degree of the variance and so further study where these routines are investigated and manipulated would be beneficial.

The results of the Hawkes process have provided some support for the theory that incidents of V&A might be spread through a process of social contagion. This result should be considered carefully but may support the use of more dynamic risk assessment tools which are able to consider the destabilising effect that witnessing or being made aware of an incident of V&A might have on other patients within the hospital. The PAA system within the hospital is a vital tool to ensure the safety of both staff and patients, however the results of the current study suggest that it may also have a stress inducing effect on patients in different wards within the same unit. It may therefore be useful for future research project to explore ways in which to reduce the negative impact that the alarm systems might have on patients.

5.5 Recommendations for future research

The current research project was developed in part by reviewing previous qualitative research in the area. It may therefore be useful to complete a follow up qualitative research project focused on exploring staff and patient's beliefs about increased incidents during the times identified by the current study. The current study relied on routinely collected data and established hospital routines to investigate possible environmental effects linked to V&A. Future research studies could investigate potential relationships in greater detail using social network analysis methodologies (Butts, 2008), which would require direct observations of patients within the wards to map their interactions and the effect of environmental; this methodology would be similar to that seen in functional analysis often used in intellectual disability services. To our knowledge this is the first application of the Hawkes process to investigate V&A within a secure forensic environment therefore the methodology would benefit from further study and repetition to better understand its ecological validity. In particular it would be beneficial to complete the Hawkes process on the whole hospital population, to include potentially important factors such as day of the week effects and to validate the model using goodness of fit tests.

5.6 Strengths and limitations of current study

The current study benefits from utilising a novel statistical approach to investigate social contagion effects, which allows for more accurate discussion of this theory than previous studies. The large sample size provided a high level of power, which means we should have been able to detect even very small effects. However, a few limitations should be considered when considering the findings of the current study. Firstly, the present study has relied on routinely collected data increasing the risk of inbuilt biases, inconsistency, and possibly missing data. Previous studies have demonstrated that there are significantly lower rates of incidents recorded than may have happened (Ros et al., 2013). A number of other studies in this area only included incidents of physical assault or incidents which required staff control

or restraint, which could be considered more extreme incidents of V&A. The decision was made to include all incidents of V&A to give the best indication of the temporal architecture of violence, however this may have had a blanketing effect, as all incidents were weighted equally. It may have been more advantageous to only look at more serious incidents, or only these which activated the alarm, or to have introduced an artificial weighting based upon severity. Thirdly, given that we found a significant weekend effect it may be beneficial in future analysis only to look at weekdays when assessing which routines might be associated with increased levels of V&A. Fourthly, from inspecting the scatter plots the correlation between weather data and incidents of V&A was very weak and pushed the assumption of linearity to its limit, it may have been advantageous to consider other analysis strategies.

The Hawkes process was used in the current study to explore potential social contagion effects within a forensic in-patient environment. These initially exploratory findings should be interpreted with care however for several reasons. Firstly, the aim was to develop hypothesis about potential reasons for the level and pattern of excitation seen in our current sample, as such no significance testing, or validation of the model was completed. Secondly the results of the discrete Hawkes process need to be interpreted with care as the process is likely to pick up on unmeasured fluctuations in the data, meaning there is a risk of significant unmeasured mediating effects being present. Similarly, the Hawkes process model developed makes a number of assumptions about the hospital and the population such as treating all wards equally which may be missing out important individual factors such as some patients being diagnosed with autism spectrum disorder or intellectual disabilities which might make them more sensitive to loud noises such as the alarm system. We also treated all incidents of V&A as equal, however it is likely that more serious events such as assaults are likely to lead to more excitation at level 1 than events such as verbal aggression. The use of only three wards increases the risk of misinterpretation due to the effects of V&A occurring in wards

not captured in the current model, it would likely be highly beneficial to complete this analysis again in the future including all available data. A number of potentially important variables were also not included in model such as day of the week effects. Finally, it was decided to use a 4-week memory in the Hawkes process meaning that incidents of V&A affected the likelihood of future events for a period of 4 weeks. This might be an unrealistic amount of time for an incident to affect future events but was chosen as a compromise between ensuring the model had enough data points to run accurately and what would be a realistic length of effect.

5.7 Conclusion

The current study has been highly successful in exploring and further developing the existing research base surrounding environmental stimuli which may be affecting rates of V&A within secure forensic settings. The results of this study further add to the evidence that risk is not a static entity but is dynamic and influenced by a number of environmental stimuli as well as individual characteristics. The use of more dynamic risk assessments and increasing flexibility of certain hospital routines may help reduce patients' experience of environmental stress. Through better understanding of environmental stressors, it is hoped that staff may be able to implement mitigating factors overall reducing the rates of violence and coercive interventions which would have beneficial effects for both patients and staff. The current study has demonstrated a self-exciting effect within the sample which may ~~be~~ suggest that incidents of V&A might spread both at a ward and unit level. The exact mechanism of how this spread occurs though required further study and investigation.

References

Bastiampillai, T., Allison, S., & Chan, S. (2013). Is depression contagious? The importance of social networks and the implications of contagion theory. Australian & New Zealand Journal of Psychiatry, 47(4), 299-303.

Basu, R., Gavin, L., Pearson, D., Ebisu, K., & Malig, B. (2018). Examining the association between apparent temperature and mental health-related emergency room visits in California. American Journal of Epidemiology, 187(4), 726-735.

Beck, N. C., Tubbesing, T., Lewey, J. H., Ji, P., Menditto, A. A., & Robbins, S. B. (2018). Contagion of violence and self-harm behaviors on a psychiatric ward. The Journal of Forensic Psychiatry & Psychology, 29(6), 989-1006.

Barnard, G. W., Robbins, L., Newman, G., & Carrera, F. (1984). A study of violence within a forensic treatment facility. Bulletin of the American Academy of Psychiatry and the Law, 12(4), 339-348.

Barnao, M., Ward, T., & Casey, S. (2015). Looking beyond the illness: Forensic service users' perceptions of rehabilitation. Journal of Interpersonal Violence, 30(6), 1025-1045.

Bolton, M. J., Ault, L. K., Greenberg, D. M., & Baron-Cohen, S. (2018). Exploring the Human Side of Meteorology: A Brief Report on the Psychology of Meteorologists. Journal of Operational Meteorology, 6(3).

Bowers, L., Alexander, J., Bilgin, H., Botha, M., Dack, C., James, K., ... & Stewart, D. (2014). Safewards: the empirical basis of the model and a critical appraisal. Journal of Psychiatric and Mental Health Nursing, 21(4), 354-364.

Brown, S., O'Rourke, S., & Schwannauer, M. (2019). Risk factors for inpatient violence and self-harm in forensic psychiatry: the role of head injury, schizophrenia and substance misuse. Brain Injury, 33(3), 313-321.

Butts, C. T. (2008). Social network analysis: A methodological introduction. Asian Journal of Social Psychology, 11(1), 13-41.

Carton, G., & Larkin, E. (1991). Reducing violence in a special hospital. Nursing Standard (Royal College of Nursing (Great Britain): 1987), 5(17), 29-31.

Chen, H., Cohen, P., & Chen, S. (2010). ¿ Hoy biga is a biga odds ratio. Interpretan the magnitudes of odds ratios in epidemiological studies. Común Sta Simula Computa, 39, 860-864.

Christakis, N. A., & Fowler, J. H. (2013). Social contagion theory: examining dynamic social networks and human behavior. Statistics in Medicine, 32(4), 556-577.

Dishion, T. J., & Dodge, K. A. (2005). Peer contagion in interventions for children and adolescents: Moving towards an understanding of the ecology and dynamics of change. Journal of Abnormal Child Psychology, 33(3), 395-400.

Duxbury, J. A. (2015). The E ileen S kellern Lecture 2014: physical restraint: in defence of the indefensible?. Journal of Psychiatric and Mental Health Nursing, 22(2), 92-101.

Ehlers, A., & Clark, D. M. (2000). A cognitive model of posttraumatic stress disorder. Behaviour Research and Therapy, 38(4), 319-345.

Elliott, K. A., & Daley, D. (2013). Stress, coping, and psychological well-being among forensic health care professionals. Legal and Criminological Psychology, 18(2), 187-204.

Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. Behavior Research Methods, 39, 175-191.

Field, A., Miles, J., & Field, Z. (2012). Discovering statistics using R. Sage Publications.

Fish, R., & Culshaw, E. (2005). The last resort? Staff and client perspectives on physical intervention. Journal of Intellectual Disabilities, 9(2), 93-107.

Flannery, R. B., LeVitre, V., Rego, S., & Walker, A. P. (2011). Characteristics of staff victims of psychiatric patient assaults: 20-year analysis of the Assaulted Staff Action Program. Psychiatric Quarterly, 82(1), 11-21.

Green, B., & Robinson, L. (2005). Reducing violence in a forensic mental health unit: a seven-year study. Mental Health Practice, 9(4).

Gudde, C. B., Olsø, T. M., Whittington, R., & Vatne, S. (2015). Service users' experiences and views of aggressive situations in mental health care: a systematic review and thematic synthesis of qualitative studies. Journal of Multidisciplinary Healthcare, 8, 449.

Hamrin, V., Iennaco, J., & Olsen, D. (2009). A review of ecological factors affecting inpatient psychiatric unit violence: implications for relational and unit cultural improvements. Issues in Mental Health Nursing, 30(4), 214-226.

Heusser, J. (2013). Simulated Arrival Intensity Graph. www.github.com. (https://jheusser.github.io/images/fake_intensity.png).

Hill, A. L., Rand, D. G., Nowak, M. A., & Christakis, N. A. (2010). Emotions as infectious diseases in a large social network: the SISa model. Proceedings of the Royal Society B: Biological Sciences, 277(1701), 3827-3835.

Hinsby, K., & Baker, M. (2004). Patient and nurse accounts of violent incidents in a medium secure unit. Journal of Psychiatric and Mental Health Nursing, 11(3), 341-347.

Hogan, N., Ennis, L., & Assessment, F. (2010). Assessing risk for forensic psychiatric inpatient violence: A meta-analysis. Open Access Journal of Forensic Psychology, 2, 137-147.

Johnson, M. E. (2004). Violence on inpatient psychiatric units: State of the science. Journal of the American Psychiatric Nurses Association, 10(3), 113-121.

Joiner Jr, T. E. (1999). The clustering and contagion of suicide. Current Directions in Psychological Science, 8(3), 89-92.

Karatzias, T., Shevlin, M., Pitcairn, J., Thomson, L., Mahoney, A., & Hyland, P. (2019). Childhood adversity and psychosis in detained inpatients from medium to high secured units: results from the Scottish census survey. Child Abuse & Neglect, 96, 104094.

Lanza, M. L. (1983). The reactions of nursing staff to physical assault by a patient. Psychiatric Services, 34(1), 44-47.

Liu, J., Varghese, B. M., Hansen, A., Xiang, J., Zhang, Y., Dear, K., ... & Bi, P. (2021). Is there an association between hot weather and poor mental health outcomes? A systematic review and meta-analysis. Environment International, 153, 106533.

Livingston, J. D., Nijdam-Jones, A., & Brink, J. (2012). A tale of two cultures: Examining patient-centered care in a forensic mental health hospital. Journal of Forensic Psychiatry and Psychology, 23(3), 345-360.

Meehan, T., McIntosh, W., & Bergen, H. (2006). Aggressive behaviour in the high-secure forensic setting: the perceptions of patients. Journal of Psychiatric and Mental Health Nursing, 13(1), 19-25.

Mercy, J. A., Kresnow, M. J., O'Carroll, P. W., Lee, R. K., Powell, K. E., Potter, L. B., ... & Bayer, T. L. (2001). Is suicide contagious? A study of the relation between exposure to the suicidal behavior of others and nearly lethal suicide attempts. American Journal of Epidemiology, 154(2), 120-127.

Michael, R. P., & Zumpe, D. (1983). Sexual violence in the United States and the role of season. The American Journal of Psychiatry

Mohler, G. O., Short, M. B., Brantingham, P. J., Schoenberg, F. P., & Tita, G. E. (2011). Self-exciting point process modeling of crime. Journal of the American Statistical Association, 106(493), 100-108.

Morken, G., & Linaker, O. M. (2000). Seasonal variation of violence in Norway. American Journal of Psychiatry, 157(10), 1674-1678.

National Institute for Mental Health in England. (2005). Health Policy Implementation Guide: developing positive practice to support the safe therapeutic management of aggression and violence in mental health in-patient settings.

Needham, I., Abderhalden, C., Halfens, R. J., Dassen, T., Haug, H. J., & Fischer, J. E. (2005). The Impact of Patient Aggression on Carers Scale: instrument derivation and psychometric testing. Scandinavian Journal of Caring Sciences, 19(3), 296-300

Newbill, W. A., Marth, D., Coleman, J. C., Menditto, A. A., Carson, S. J., & Beck, N. C. (2010). Direct observational coding of staff who are the victims of assault. Psychological Services, 7(3), 177.

Niedzwiedz, C., Haw, C., Hawton, K., & Platt, S. (2014). The definition and epidemiology of clusters of suicidal behavior: a systematic review. Suicide and Life-Threatening Behavior, 44(5), 569-581.

Obradovich, N., Migliorini, R., Paulus, M. P., & Rahwan, I. (2018). Empirical evidence of mental health risks posed by climate change. Proceedings of the National Academy of Sciences, 115(43), 10953-10958.

Odes, R., Chapman, S., Harrison, R., Ackerman, S., & Hong, O. (2021). Frequency of violence towards healthcare workers in the United States' inpatient psychiatric hospitals: A systematic review of literature. International Journal of Mental Health Nursing, 30(1), 27-46.

Paavola, P., & Tiihonen, J. (2010). Seasonal variation of seclusion incidents from violent and suicidal acts in forensic psychiatric patients. International Journal of Law and Psychiatry, 33(1), 27-34.

Peluola, A., Mela, M., & Adelugba, O. O. (2013). A review of violent incidents in a multilevel secure forensic psychiatric hospital: is there a seasonal variation?. Medicine, Science and the Law, 53(2), 72-79.

Pulsford, D., Crumpton, A., Baker, A., Wilkins, T., Wright, K., & Duxbury, J. (2013). Aggression in a high secure hospital: staff and patient attitudes. Journal of Psychiatric and Mental Health Nursing, 20(4), 296-304.

Ramesh, T., Igoumenou, A., Montes, M. V., & Fazel, S. (2018). Use of risk assessment instruments to predict violence in forensic psychiatric hospitals: a systematic review and meta-analysis. European psychiatry, 52, 47-53.

Reinhart, A. (2018). A review of self-exciting spatio-temporal point processes and their applications. Statistical Science, 33(3), 299-318.

Ros, N., Van der Helm, P., Wissink, I., Stams, G. J., & Schaftenaar, P. (2013). Institutional climate and aggression in a secure psychiatric setting. The Journal of Forensic Psychiatry and Psychology, 24(6), 713-727.

Swinton, M., Hopkins, R., & Swinton, J. (1998). Reports of self-injury in a maximum security hospital. Criminal Behaviour and Mental Health, 8(1), 7-16.

Taiminen, T. J., Kallio-Soukainen, K., Nokso-Koivisto, H., Kaljonen, A., & Helenius, H. (1998). Contagion of deliberate self-harm among adolescent inpatients. Journal of the American Academy of Child & Adolescent Psychiatry, 37(2), 211-217.

Thompson, R., Hornigold, R., Page, L., & Waite, T. (2018). Associations between high ambient temperatures and heat waves with mental health outcomes: a systematic review. Public Health, 161, 171-191.

Wang, S., Zhang, X., Xie, M., Zhao, D., Zhang, H., Zhang, Y., C Herr & Su, H. (2018). Effect of increasing temperature on daily hospital admissions for schizophrenia in Hefei, China: a time-series analysis. Public Health, 159, 70-77.

Weilnhammer, V., Schmid, J., Mittermeier, I., Schreiber, F., Jiang, L., Pastuhovic, V., ... & Heinze, S. (2021). Extreme weather events in europe and their health consequences–A systematic review. International Journal of Hygiene and Environmental Health, 233, 113688.

Weiss, S. J. (2007). Neurobiological alterations associated with traumatic stress. Perspectives in Psychiatric Care, 43(3), 114-122.

Weizmann-Henelius, G. (2000). Violence in a Finnish forensic psychiatric hospital. Nordic Journal of Psychiatry, 54(4), 269-273.

Witt, K., Van Dorn, R., & Fazel, S. (2013). Risk factors for violence in psychosis: systematic review and meta-regression analysis of 110 studies. PloS one, 8(2), e55942.

World Health Organization. (2018). International classification of diseases for mortality and morbidity statistics (11th Revision). Retrieved from https://icd.who.int/browse11/l-m/en

Wright, K. M., Duxbury, J. A., Baker, A., & Crumpton, A. (2014). A qualitative study into the attitudes of patients and staff towards violence and aggression in a high security hospital. Journal of Psychiatric and Mental Health Nursing, 21(2), 184-188.

Yang, C. T., Yip, P. S., Cha, E. S., & Zhang, Y. (2019). Seasonal changes in suicide in South Korea, 1991 to 2015. Plos one, 14(6), e0219048.

Zenere, F. J. (2009). Recognizing and addressing suicide contagion are essential to successful suicide postvention efforts. Principal Leadership.

Appendix A

Jake Easto
Trainee Clinical Psychologist
The State Hospital

Wednesday the 18th of November 2020

Dear Jake,

Re: Exploring the possible social contagion effect of violence and aggression within high secure mental health hospitals

Many thanks for your revised research proposal, based on amendment to the proposal initially reviewed on Thursday the 12th of November 2020. I am happy that you have addressed all of the feedback provided by the research committee and can subsequently provide Research Committee approval for your study as named above. I note that your DPIA has also been completed and approved. So, once you have addressed the Research Ethics approval through the IRAS system I will provide this letter, along with approval letter from REC to our Associate Medical Director who will sign off management approval for the study to commence within TSH. If you require any input to the REC process please let me know.

One condition of the research committees' approval is that you provide the committee with regular 6-monthly progress reports and a final report focused on the study findings appropriate to implementation into current practice. This is an important mechanism by which the committee track progress, and is also a key component of our research governance processes.

If you require any further assistance, or have any feedback on the Research approval process then please do not hesitate to contact me.

Yours sincerely

JAMIE PITCAIRN
Research & Development Manager
The State Hospital

From: HISS Research Ethics
Sent: 18 October 2021 17:08
To: Jake Easto
Cc: O'ROURKE Suzanne; HISS Research Ethics
Subject: Re: CLPS091 Jake Easto - Ethics approval

Dear Jake

Thank you for your email and for providing us with all the relevant documents. We have now checked that your project adheres to any University governance concerns and your application has been logged. As your project has been reviewed and received a favourable opinion by IRAS it does not require further review by the Clinical Psychology Ethics Committee.

If you need to make any changes to the protocol these would go through the REC, but I would appreciate if you could also copy University ethics into any correspondence.

Good luck with the project.

Best wishes,
Karri

Dr Karri Gillespie-Smith
Lecturer in Applied Psychology
Ethics & Integrity Lead

North of Scotland Research Ethics Committee (1)
Summerfield House
2 Eday Road
Aberdeen
AB15 6RE

Telephone: 01224 558458
Email:

27 August 2021

Dr Suzanne O'Rourke
Academic Supervisor
NHS The State Hospital
Carstairs Junction
LANARK
ML11 8RP

Dear Dr O'Rourke

Study title:	**Exploring the possible social contagion effect of violence and aggression within high secure mental health hospitals.**
REC reference:	**21/NS/0106**
Protocol number:	**CAHSS2104/08**
IRAS project ID:	**303408**

The Research Ethics Committee (REC) reviewed the above application at the meeting held on 26 August 2021. I am sorry that you had problems joining via MS Teams, however, Mr Easto kindly attended to discuss the application.

Ethical opinion

The members of the Committee present gave a favourable ethical opinion of the above research on the basis described in the application form, protocol and supporting documentation, subject to the conditions specified below.

Good practice principles and responsibilities

The UK Policy Framework for Health and Social Care Research sets out principles of good practice in the management and conduct of health and social care research. It also outlines the responsibilities of individuals and organisations, including those related to the four elements of research transparency:

1. registering research studies
2. reporting results
3. informing participants
4. sharing study data and tissue

Conditions of the favourable opinion

The REC favourable opinion is subject to the following conditions being met prior to the start of the study.

Appendix B

The State Hospitals Board for Scotland

Patient Privacy Notice

Patient Privacy Notice

While you are a patient in The State Hospital (TSH) your clinical team will try their best to ensure that you receive the highest quality care and treatment (and related services) and appropriate support for your family. We are made up of different organisations including the NHS and South Lanarkshire Council but we are all working together for this purpose.

Having accurate personal information is essential for us to deliver the highest quality of treatment. We therefore need to make sure that you are aware of the personal information that we hold about you, the reasons why we need it, and how it might be shared. In order to protect you, there are strict rules and guidelines to ensure your confidentiality.

What is my personal information?

Your personal information includes information about:

- Characteristics about you, such as your name, date of birth, address, etc.
- Your physical and mental health.
- Your social history and social care.
- Any care and treatment you have received.
- Your education.
- Your offences, convictions and prison sentences.
- Your finances and benefits you may receive.
- You, which helps the Hospital to ensure the safety and security of everyone in the Hospital and others you may come in contact with when you are out of the Hospital environment (security intelligence).

Where do we get your information from?

Information contained within your State Hospital records comes from a variety of sources, including courts, prisons, other healthcare providers, local and national government. We may also hold information relating to you which has been given by other people (such as family members).

Why do we process your personal information?

We process your information in line with the General Data Protection Regulations and Data Protection Legislation as it is necessary to provide healthcare and operate The Hospital, which is in the public interest.

In addition we also may process your information for the benefit of public health and research purposes.

The State Hospital is a 'data controller' under the Data Protection Act. We have notified the Information Commissioner that we process personal data and our registration number is: Z567052X.

The details are publicly available from the:-

Information Commissioner's Office
Wycliffe House
Water Lane
Wilmslow
SK9 5AF

What information do we have and how do we store it?

We keep most of this information and details of the care you are receiving in your patient

record and Social Work on their own client file. Most of your case records are held on computer (electronically) however we may also have some paper notes. There may also be psychometrics (questionnaires), video or audio records, and images such as x-rays.

TSH also holds General Practitioner (GP) records from your own GP practice. On admission you will be registered at TSH GP practice called 'Tinto View'. Your electronic GP record from your own GP practice, and paper records if relevant, will be shared with us.

All your records are kept confidential by storing them securely and only allowing authorised people to have access.

Your health records will be kept by TSH for a period of 30 years after our last contact with you. Some records are kept longer than this if they are of special interest (for example if they contain significant medical or historical information). Social care records are kept for a period of 75 years by Social Work Resources. This is in case you are readmitted, or another healthcare professional (such as another hospital or GP) requests this information. You may also want to access this information after your stay in the Hospital has ended. Health and social care records can be used for research purposes, to check the quality of care that we provide, to protect public health and plan for the future. National guidance decides how long records can be kept for and how often the hospital must review our processes.

Why we need information

Information which does not identify you

- Sometimes the NHS uses relevant information about your health to help improve the general public's health and NHS services, or to check that money has been spent properly. Wherever possible, information that identifies you is removed.
- Apart from very few exceptions provided by the Law, if we require to collect or share any new data which identifies you for teaching or research, you will be asked to provide permission.

Sometimes we remove your name and other details about you from information so that you cannot be identified (Anonymisation). In some cases we will remove details about you so that you cannot be identified without the use of additional information (Pseudoymisation).

Examples of this type of use may be to:

- Collect statistics about the care we provide to ensure it is of the highest standard.
- Support research and/or service evaluation.
- Ensure the Hospital runs as efficiently as possible.
- Help plan for the future needs of our patients.
- Help us to investigate any complaints or incidents.
- Help us to manage the Hospital budgets.
- For the audit of our accounts.

How is my personal information used?

Your information may be shared within your clinical team, who use this information to ensure you get the care and treatment and social services that you need. As well as file information, you may also be interviewed by your clinical team. This information will be added to your records and will be used by your clinical team to assist them in the best way of helping you.

Some of your information is shared with relevant administration staff so that they can provide additional services such as banking, access to benefits and shopping. Some administration staff may also have access to your patient records to ensure information is available to professionals as and when required.

A limited amount of information is shared (such as name, date of birth and diagnosis) with

the Scottish Government Information Services to allow statistical information to be collected and assist with future planning of services. If you are a restricted patient, detailed reports are sent to the Scottish Government on a regular basis.

More detailed information may also be shared with other NHS boards, e.g. if you are referred to a general hospital for physical treatment or when you are ready to transfer.

How do we keep your personal information confidential?

Everyone working within the NHS and Social Work has a legal duty to keep information about you confidential.

There are times when the law requires us to share information without asking for your permission, for example to prevent the spread of a highly contagious disease, during the investigation of a crime, child protection concerns or a court order.

Every NHS Board has a member of staff called the Caldicott Guardian who is responsible for protecting patient confidentiality. TSH Caldicott Guardian is the Associate Medical Director, who is supported by specialist staff including the Data Protection Officer and the Health Records Manager.

Social Work do not have an equivalent of the Caldicott Guardian but they will always seek to protect your personal information. Like the NHS, they are supported by a number of policies to comply with the law and also have specialist staff such as a Data Protection Officer.

Is my information shared with my family?

Your explicit consent is needed for us to tell your relatives, friends and carers about your progress and treatment. You can consent verbally, however most of the time we will ask for you to agree to sharing your information by signing a form.

Information shared with your Named Person

If you nominate a Named Person they will receive copies of certain records or information which is given to you, such as the record made if treatment is given to you which conflicts with your Advance Statement. They will also be given copies of information given to you when certain variations to your circumstances occur, such as if your detention status changes. Your Named Person will also receive copies of information and reports written about you for the purposes of a tribunal. These documents may contain detailed information about you and may be sent by a number of people including the Mental Health Tribunal, your Responsible Medical Officer (RMO) or your Mental Health Officer (MHO), or possibly by the Scottish Government if you are a restricted patient.

When can my information be shared outside the NHS and/or Social Work?

- Sometimes your health information will be shared with people outside the NHS who need it so they can give you care and treatment – for example with a Housing Officer or a social worker – but only information that is relevant for your care.
- Sometimes the law allows the NHS to share your personal health information without your permission, for example to investigate a serious crime or to protect a child or vulnerable adult from harm. This may include sharing information with the Police.
- If you are concerned about your information being shared, you should tell a member of NHS staff involved in your care. If there is no need for sharing your information, you can object.
- If your solicitor requests information about your care and treatment, we will only provide this if they have written authority (a mandate) signed by you.

Who can receive my information?

We may share your information with the following groups in order to inform and support your

care and treatment;

- Social Work
- Other healthcare providers
- Other Councils
- Government (UK, Scottish) and their associated agencies
- The Patients' Advocacy Service
- The Mental Welfare Commission
- Criminal Justice
- The National Archives of Scotland
- Multi-Agency Public Protection Arrangements (MAPPA) Partners

What other rights do I have?

Under the current data protection regulations you have privacy rights.

These include the right:

- To be informed that we hold your information
- To access your records
- For rectification of data
- For erasure of data no longer required
- To restrict the processing of your data
- To portability of your consented data for your own personal purposes
- To object to some uses of your data, such as direct marketing
- To profiling and research

If you want to know more information about your privacy rights, there is extensive information available from the Information Governance and Data Security Officer.

To see any information we hold about you in your health records please contact the Health Records Department for an application form. Alternatively, the Patients' Advocacy Service, Person Centred Improvement Team or a member of your clinical team will be able to support you if you need help to complete the form. Other people such as your Named Person or lawyer may apply on your behalf, however they need to have a signed mandate from you. Some information may be withheld if other people are identified within your case file or if it is felt that it would cause serious harm to you or someone else if it were disclosed.

If you believe information held within your health or social care record is inaccurate, processes are in place to facilitate this being corrected or amended. Members of your clinical team will be able to provide further information about how to do this, or you can contact the Caldicott Guardian, Health Records Manager or Data Protection Officer.

Where you have previously given consent for your information to be used, you have the right to withdraw that consent. This may affect the services that you can access.

Complaints about how we process your personal information

If you are unhappy with the way your personal information has been used and/or protected, you should speak to your RMO, Social Worker or your Keyworker in the first instance. If your query has not been resolved during this discussion, you can contact:

<u>For State Hospital records</u>

The TSH Data Protection Officer is the Information Governance and Data Security Officer, who is contactable at the address below. You can also contact the Complaints Officer.

<u>For Social Work records</u>

The Social Work Team Manager at TSH or their Data Protection Officer.

If you are still have concerns about how we use your information;

You may contact the Information Commissioner's Office regarding the use of your information or to make a complaint by writing to:

The Office of the Information Commissioner
Wycliffe House
Water Lane
Wilmslow
CHESHIRE
SK9 5AF

Your clinical team, the Patients' Advocacy Service or the Person Centred Improvement Team are available to help you make contact with the right person.

How can I find out more information?

If you have any questions about our privacy notice or information we hold about you, you can contact any of the following individuals:

For the State Hospital

Health Records Manager
The State Hospital,
Carstairs,
Lanark
ML11 8RP

Information Governance and Data Security Officer
The State Hospital,
Carstairs,
Lanark
ML11 8RP

Caldicott Guardian
The State Hospital,
Carstairs,
Lanark
ML11 8RP

Complaints Officer
The State Hospital,
Carstairs,
Lanark,
ML11 8RP

For Social Work

Social Work Team Manager
The State Hospital,
Carstairs,
Lanark
ML11 8RP

Data Protection Officer
South Lanarkshire Council,
Council Offices,
Almada Street,
Hamilton
ML3 0AA

If you require this information in another format, please ask staff to contact the Person Centred Improvement Lead who will meet with you to discuss your specific needs.

Published by The State Hospital, Carstairs, Lanark ML11 8RP and on behalf of South Lanarkshire Council, Council Offices, Almada Street, Hamilton ML3 0AA