Describing and evaluating a novel method of clinical risk assessment

Shraddha Kashyap, Bachelor of Science (Honours) & Bachelor of Arts

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THESIS DECLARATION

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ABSTRACT

**Background:** Self-injury includes both non-suicidal self-injury (NSSI) and suicide attempts, and engaging in NSSI is associated with an increased risk of suicide attempts. While cross-sectional correlates of both forms of self-injury, such as psychological distress, have been identified; we still cannot predict which individuals experiencing distress will engage in self-injury, and when this may occur. Hence, the present dissertation aimed to describe and evaluate a novel approach to increasing the precision of clinical risk assessments. We aimed to explore the ability of continuous measurements of psychological distress to improve precision in predicting which inpatients at a psychiatric hospital were at the highest risk of engaging in self-injury.

**Method:** A Five-Item Daily Index measured self-reported anxiety, depression, worthlessness, perceptions of not coping and suicidal ideation amongst inpatients of a psychiatric hospital (Study 2: N=933; Study 3: N=1097; Study 4: N=698). Latent Growth Curve Analysis determined if groups of inpatients changed in distress at different rates during treatment. Chi Square analyses compared rates of self-injury between groups; logistic regression and mean difference tests explored associations between shared trajectories of change and demographic, diagnostic and interpersonal variables.

**Results:** Trajectories indicating a lack of early improvement in psychological distress were associated with higher risks of engaging in self-injury. Conversely, rapid early remitting distress, despite high initial distress, was associated with significantly lower risks of self-injury. Female gender, younger age and being diagnosed with Borderline Personality Disorder were correlates of high risk
trajectories, while Substance Abuse Disorders and male gender were associated with lower risk trajectories. Trans-diagnostic variables proposed by the Interpersonal Theory of Suicide, including thwarted belongingness, perceived burdensomeness and acquired capability; were endorsed at higher levels among individuals sharing higher risk trajectories. The majority of self-injurious behaviour in this clinical population was self-reported NSSI.

**Conclusions:** Change in psychological distress over time was a better indicator of risk of self-injury than initial distress, where a lack of early improvement was associated with the highest risk of self-injury. Preliminary evidence suggests that variables proposed by the Interpersonal Theory of Suicide can help proactively predict risk of NSSI, which may help prevent future NSSI and suicide. Repeated monitoring of distress together with adding relevant measures to existing risk assessment processes may improve our precision in predicting risk. Health systems should therefore be modified to allow more patient-focussed, “real-time” measures of factors associated with risk of self-injury. Future research should aim to examine trajectories of change and risk of NSSI and suicide attempts separately. It should also continue to explore the clinical significance and stability of the groupings based on change over time, the validity of using interpersonal variables to predict risk of NSSI and suicide, and should take into account individuals’ psychiatric history and previous self-injury when predicting current risk.
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## AUTHORSHIP DECLARATION: CO-AUTHORED PUBLICATIONS

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Chapter 1

Describing and evaluating a novel method of clinical risk assessment

Self-injury is a significant public health problem, and includes both non-suicidal self-injury (NSSI) and suicide attempts (Nock, 2010; Orlando, Broman-Fulks, Whitlock, Curtin, & Michael, 2015). The term NSSI is used to describe a broad range of self-injurious behaviours that can vary in terms of the severity of the health impacts (Bresin & Schoenleber, 2015). Specifically, NSSI refers to direct and deliberate harm to one’s body without the intent to die. Often in NSSI, the purposes can be to decrease negative affect, communicate distress, or increase social support (Nock, 2010). Engaging in NSSI is appears to be triggered by significant distress (Nock, 2010). For example, self-reported reasons for engaging in NSSI from a sample of university students included “to cope with uncomfortable feelings”, “to avoid committing suicide”, “to feel something”, “self-hatred”, and “self-punishment” (Paul, Tsypes, Eidlitz, Ernhout, & Whitlock, 2015). Furthermore, engaging in NSSI is associated with an increased risk of suicide attempts (Dickstein et al., 2015). Suicide attempts are defined as potentially self-injurious behaviours performed with the intent to die as a result of that behaviour (Posner, Oquendo, Gould, Stanley, & Davies, 2007). Like self-harm, suicide is a significant health problem, with suicide being the second leading cause of death among people aged 15-29 years, and globally, suicides accounted for 71% of all violent deaths in women, and 50% of violent deaths among men (World Health Organization, 2014).

A plethora of research has explored demographic, psychiatric, and psychosocial factors associated with increased risk of self-injurious thoughts and behaviours. However, we still cannot predict who will engage in NSSI or suicide attempts with enough precision to prevent it from occurring (Carter et al., 2017;
Large et al., 2016; Quinlivan et al., 2017). Novel methods of identifying individuals at the highest risk of engaging in NSSI and suicidal behaviour are therefore required, and the present dissertation aims to describe and evaluate an approach to preventing self-injury.

1. Predicting self-injury: NSSI and suicide attempts

While these two forms of self-injury differ in terms of the intent to die (Andover, Morris, Wren, & Bruzzese, 2012), engaging in NSSI is related to an increased risk of suicidal behaviours (Dickstein et al., 2015; Orlando et al., 2015; Paul et al., 2015). Indeed, it has often been found that the risk of suicidal thoughts and behaviour amongst people who engage in NSSI is greater than amongst those who never did (Kashyap, Hooke, & Page, 2015; Kimbrel et al., 2014; Scott, Pilkonis, Hipwell, Keenan, & Stepp, 2015; Victor & Klonsky, 2014). For example, even after accounting for depression, anxiety and impulsivity; NSSI was the second strongest predictor of suicide attempts (after suicidal ideation) amongst adolescents, undergraduates and adults (Klonsky, May, & Glenn, 2013). Further, adolescents at risk of chronic suicidal ideation were also at a higher risk of engaging in NSSI (and vice-versa), where more frequent suicidal ideation and NSSI significantly increased the risk of suicide attempts over and above previous suicide attempts (Giletta et al., 2015). A recent study also found that engaging in NSSI to serve functions such as “to avoid suicide” and “to feel something” were strongly related to a history of suicidal behaviour (Paul et al., 2015). Finally, adolescents without a history of suicide attempts, who only engaged in NSSI still showed strong implicit attitudes towards suicide/death (Dickstein et al., 2015). Therefore, predicting and preventing both NSSI and suicide attempts can reduce the risk of future self-injurious
behaviour, whatever the intent behind it, given that risk of both forms of self-injury appear to be related.

1b. How might NSSI and suicide attempts be related?

While the mechanism behind the link between NSSI and suicidal behaviours is not yet fully understood, the Interpersonal Theory of Suicide (Joiner, 2005) provides a framework for exploring the association between NSSI and suicide attempts, together with risk factors for both forms of self-injury such as psychological distress.

The Interpersonal Theory of Suicide posits that the desire and the capability to engage in suicidal behaviour are separate constructs (Van Orden et al., 2010). It argues that suicidal thoughts can emerge from the simultaneous presence of thwarted belongingness and perceived burdensomeness; but that suicidal ideation alone is not enough to lead people to act on those thoughts (Van Orden et al., 2010). It suggests that the capability to engage in suicidal behaviour needs to be acquired through repeated exposure to painful and fear-inducing experiences such as habituation to physical pain (Hamza, Stewart, & Willoughby, 2012; Van Orden et al., 2010). One way of acquiring this capability may be through engaging in NSSI, which can act as a ‘gateway’ to using increasingly lethal forms of self-injury (Hamza, Willoughby, & Good, 2013; Mundt et al., 2013). For example, individuals engaging in both NSSI and suicidal behaviour report a higher pain threshold, more pain tolerance, and less pain intensity than control participants (Koenig, Thayer, & Kaess, 2016). Furthermore, the relationship between lifetime NSSI and suicide attempts was stronger among individuals who could persist longer through physical and emotional distress (Law, Khazem, Jin, & Anestis, 2017). Therefore, a higher pain threshold
and the ability to tolerate more physical distress may be risk factors for both NSSI and suicidal behaviour, and might lead to acquiring the capability to progress from NSSI to suicidal behaviour. Indeed, a longitudinal study found a significant unidirectional relationship between engaging in NSSI and higher scores on acquired capability for suicide one year later. That is, those people who engaged in more NSSI tended to have higher scores on acquired capability for suicide one year later (Willoughby, Heffer, & Hamza, 2015). The authors therefore suggested that preventing NSSI could decrease the risk of individuals acquiring the capability to engage in more lethal suicidal behaviours in the future (Willoughby et al., 2015).

Using the framework provided by this theory, together with known psychiatric risk factors, plus monitoring change in distress during treatment may then help in identifying those at the highest risk of engaging in self-injury.

Therefore, a first step the dissertation will take in predicting self-injury is to review factors associated with increased risk of self-injurious behaviour. Given the public health importance of addressing both NSSI and suicidal behaviour, and the link between these two forms of self-injury, the review will be divided into sections which describe the literature about risk factors for both forms of self-injury. The following section will discuss current literature describing demographic, psychiatric, and psychosocial factors associated with risk of NSSI and suicide.

2. Non-Suicidal Self-Injury (NSSI)

Research into the variables that increase the probability of NSSI have focused on a variety of factors. One set of these predictors have included demographic factors. The research has tended to yield mixed results. In one meta-analysis exploring gender differences, women were more likely to report history of
NSSI than men (Bresin & Schoenleber, 2015). Indeed, studies suggest that women were more likely to use “cutting” as a form on NSSI than men (Andover, Primack, Gibb, & Pepper, 2010; Bresin & Schoenleber, 2015). However, no gender differences were found with other methods, such as “punching” (Bresin & Schoenleber, 2015). Furthermore, no gender differences were found in prevalence of NSSI among undergraduates, but males reported beginning to engage in NSSI at an older age (Andover et al., 2010). In addition, among 439 US adults, younger age and single marital status but not gender, ethnicity, education level, or household income level were associated with increased risk of NSSI (Klonsky, 2011). Finally, NSSI among older adults (50+) presenting to emergency departments was associated with fatalities and hospital admissions (Choi, DiNitto, Marti, & Choi, 2016). Therefore, although NSSI is more common among younger individuals, all age groups are at risk and should be monitored. Overall, there do not appear to be any definitive demographic markers of increased risk of NSSI, although probably younger age and female gender may indicate somewhat greater risk.

Regarding individual, psychiatric, and psychosocial risk factors; individuals engaging in NSSI reported higher pain thresholds, greater pain tolerance, and less pain sensitivity than individuals who never engaged in NSSI (Koenig et al., 2016). A meta-analysis of longitudinal studies exploring risk factors of NSSI also found that prior NSSI, hopelessness, and cluster B personality disorders were the strongest predictors of NSSI followed by patient prediction of future NSSI, abuse, prior suicidal thought or behaviour, exposure to peer NSSI, depression, eating disorder pathology, female gender, externalizing symptoms, impulsivity, internalizing symptoms, parental psychopathology and family functioning (Fox et al., 2015). In addition, hopelessness (Steeg et al., 2016), having a history of mental health
treatment (Klonsky, 2011), current depressive symptoms, a diagnosed internalizing disorder (Taliaferro & Muehlenkamp, 2015), and life stress (Liu, Cheek, & Nestor, 2016) were associated with increased rates of NSSI. Therefore, it appears that being able to tolerate physical pain, experiencing psychological distress, and engaging in NSSI can increase the risk of future NSSI.

In addition, individuals who engaged in NSSI report higher levels of impulsivity compared to those who never did (Hamza, Willoughby, & Heffer, 2015). Indeed, a longitudinal analysis of college women exploring different aspects of impulsivity suggested that the tendency to act rashly when distressed, predicted the onset of NSSI, while the tendency to disengage from difficult tasks was associated with continued engagement in NSSI (Riley, Combs, Jordan, & Smith, 2015). However, the effect of self-reported impulsivity on NSSI was reduced when other psychiatric risk factors such as depression, abuse, and post-traumatic stress were taken into account (Hamza et al., 2015). Further, factors associated with NSSI risk identified in longitudinal studies had weak effect sizes (Fox et al., 2015). Finally, the difficulty in reliably and accurately categorising self-injury as NSSI versus suicide attempts, due to a lack of standardized measurement tools suggests that prevalence estimates (Swannell, Martin, Page, Hasking, & St John, 2014) and knowledge about risk factors (Fox et al., 2015) are not yet sufficient to predict and prevent NSSI from occurring. Indeed, a meta-analysis studying life stress and NSSI suggests that due to the cross-sectional nature of most studies, it is not clear whether life stress was a cause or consequence of NSSI (Liu et al., 2016). Thus, individual, psychiatric, and psychosocial risk factors may predict NSSI, but it is not clear if these are causal factors.

3. Suicide
Given the link between NSSI and increased risk of suicide attempts (e.g. Orlando et al., 2015), it is important to understand which variables have been identified as potentially increasing the risk of suicidal ideation and suicide attempts. Furthermore, since individuals who report thinking about suicide do not all engage in suicidal behaviour; we need to understand factors associated with individuals who report suicidal ideation, compared to those who also act on suicidal thoughts (Klonsky & May, 2014). This section will therefore critically discuss current literature describing factors associated with an increased risk of thinking about suicide, and factors associated with an increased risk of engaging in suicidal behaviour.

a. Suicidal Ideation

Demographic and psychiatric factors including younger age, depression, bipolar disorder, and hopelessness were all associated with increased thoughts about suicide (Aaltonen et al., 2016). Indeed, among at-risk male prisoners, hopelessness amplified the association between psychiatric disorders and suicidal ideation (Gooding et al., 2015). Further, among war veterans diagnosed with Posttraumatic Stress Disorder (PTSD) or depression, comorbid alcohol abuse increased the risk of suicidal ideation (Maguen et al., 2015). However, while PTSD, depression, psychosis and generalized anxiety disorder were associated with high severity suicidal ideation among war veterans, they were not associated with suicide attempts (Ashrafioun, Pigeon, Conner, Leong, & Oslin, 2016). A meta-analysis also found that depression and PTSD distinguished between individuals who thought about suicide from those who never did, but it could not differentiate ideators from attempters (May & Klonsky, 2016). Moreover, anxiety disorders only appear to be
weak predictors of suicidal ideation (Bentley et al., 2016). Therefore, more research is needed to identify predictors of suicidal ideation.

Psychosocial risk factors for suicidal ideation include adverse experiences such as peer victimisation during adolescence (Geoffroy et al., 2016). Further, physical and sexual abuse during childhood/adolescence is associated with increased ideation, but not increased risk of suicide attempts (Bruffaerts et al., 2010). Childhood abuse also increases suicidal ideation among adults (Aaltonen et al., 2016); and among war veterans, longer time taken to access mental health care (Maguen et al., 2015) and exposure to suicide (Cerel et al., 2015) increased the risk of suicidal ideation. Therefore, psychiatric disorders and psychosocial adversity have been linked to increased suicidal ideation. However, the weak predictive value of psychiatric disorders (Bentley et al., 2016), and the inability of psychiatric and psychosocial risk factors to distinguish between those who think about suicide and those who act on suicidal thoughts (May & Klonsky, 2016) suggest that a different approach to exploring this issue is needed to improve risk prediction.

b. Suicide attempts and death by suicide

Firstly, research into risk factors for suicide consistently suggests that the strongest predictors of suicide attempts and death by suicide include suicidal ideation, previous suicide attempts, and other self-injurious behaviour, including NSSI (Bentley et al., 2016; Bolton, Pagura, Enns, Grant, & Sareen, 2010; Cornaggia, Beghi, Rosenbaum, & Cerri, 2013; Marangell et al., 2006; Suokas, Suominen, Isometsä, Ostamo, & Lönnqvist, 2001; Suominen et al., 2004; Victor & Klonsky, 2014); especially when more lethal methods are used (Chen et al., 2016; Younes et al., 2015).
Secondly, the literature describing demographic risk factors for suicide attempts and death by suicide includes studies with seemingly contradictory findings. Some suggest that younger age and female gender (Aaltonen et al., 2016; Borges et al., 2010; Chen et al., 2016), while others find that male gender (Chen et al., 2016; Crump, Sundquist, Sundquist, & Winkleby, 2014; LeardMann et al., 2013; Younes et al., 2015) are associated with increased risk. These mixed findings suggest that using only gender as a marker for suicide risk is not conducive to identifying those at the highest risk. Conflicting results could also be due to a tendency for males to use more lethal methods than females (Chen et al., 2016; Younes et al., 2015), however, firm conclusions about gender and risk cannot be made. Furthermore, middle age was also associated with frequency of suicide attempts (Lopez-Castroman et al., 2011) while older age was associated with death by suicide (Chen et al., 2016; Cornaggia et al., 2013; Younes et al., 2015). In contrast, a study into socio-demographic risk factors for suicide in Sweden found that age was not associated with suicide risk (Crump et al., 2014). Therefore, the effects of gender and age on risk of suicide are not clear, or may change in different contexts.

Thirdly, psychosocial risk factors for suicide include experiencing childhood adversity such as sexual or physical abuse (Aaltonen et al., 2016; Borges et al., 2010; Bruffaerts et al., 2010). Additionally, bereavement by suicide compared to sudden deaths by other sudden, unnatural causes significantly increased the risk of young adults attempting suicide (Pitman, Osborn, Rantell, & King, 2016). Furthermore, lower education and income (Borges et al., 2010) interpersonal relationship breaks (Hyman, Ireland, Frost, & Cottrell, 2012; Manoranjitham et al., 2010), and single or unmarried status (Borges et al., 2010; Hyman et al., 2012) are associated with suicide risk. However, a meta-analysis suggests that there are only small to
negligible differences in gender, age, marital status and education levels among individuals who thought about suicide, and those who engaged in suicidal behaviour (May & Klonsky, 2016). Therefore, relying on psychosocial factors alone is not enough to predict who will engage in suicidal behaviour.

Finally, psychiatric risk factors for suicide have been widely studied. One meta-analysis found that being diagnosed with a psychiatric disorder was the second strongest predictor of repeated suicide attempts following previous suicide attempts (Cornaggia et al., 2013). For example, depression has been consistently associated with elevated risk of suicide attempts in both cross-sectional (Aaltonen et al., 2016; Chan et al., 2009; Lopez-Castroman et al., 2011) and longitudinal (Crump et al., 2014; LeardMann et al., 2013; Thompson & Light, 2011) studies. Furthermore, among psychiatric inpatients in France, males who engaged in multiple suicide attempts were more likely to have substance abuse disorders, while females were more likely to have Post-Traumatic Stress Disorder (PTSD; Monnin et al., 2012). PTSD was also associated with an increased risk of suicide attempts among individuals suffering from depression, over and above previous suicidal behaviour (Bolton et al., 2010). In addition, substance abuse was associated with suicide attempts among US war veterans (Ashrafioun et al., 2016; LeardMann et al., 2013), Finnish psychiatric patients (Aaltonen et al., 2016), and in a rural South Indian population (Manoranjitham et al., 2010). Death by suicide was also associated with substance abuse in Hong Kong Chinese (Chan et al., 2009) and Swedish populations (Crump et al., 2014). Indeed, meta analyses have found that substance abuse (May & Klonsky, 2016) and PTSD (Bentley et al., 2016; May & Klonsky, 2016) were associated with increased risk of suicide attempts. Finally, personality disorders (Ansell et al., 2015) and psychosis (Aaltonen et al., 2016; Chan et al., 2009; Crump
et al., 2014; LeardMann et al., 2013; Monnin et al., 2012) can also increase risk of suicide. These results suggest that psychological distress, where psychiatric disorders and substance abuse act as markers of this distress; in many different groups of people is associated with increased risk of suicide.

Overall, while the literature describes factors associated with an increased risk of suicide, results regarding demographic and psychosocial factors are unclear. Moreover, the psychiatric risk factors we know of do not necessarily have strong predictive power (Bentley et al., 2016; Honings, Drukker, Groen, & van Os, 2016). For example, despite several studies finding that anxiety disorders (especially PTSD) are often associated with suicide risk, a meta-analysis found that anxiety disorders were generally weak predictors of suicide attempts and not significantly associated with death by suicide (Bentley et al., 2016). Furthermore, while research has often found that previous suicidal thoughts and behaviours are the strongest predictors of future behaviours, a recent meta-analysis of 172 longitudinal studies suggests that the predictive value of previous suicidal behaviour is also weak (Ribeiro et al., 2016). Another issue is that many identified risk factors for suicidal ideation and attempts arise from research comparing individuals who think about suicide and attempt suicide to those who never think about suicide. It has therefore been argued that we still cannot predict who will engage in suicidal behaviour amongst those reporting suicidal ideation (May & Klonsky, 2016). While small-moderate differences in PTSD, anxiety, drug use, and sexual abuse between individuals who think about suicide versus those who also engage in self-injury were found, they were not strong enough to predict attempts over and above ideation (May & Klonsky, 2016). Thus, if the strongest predictor of future suicide attempts is previous attempts (Cornaggia et al., 2013), and if we still cannot predict initial
attempts over and above suicidal ideation, then the knowledge we have to date is not enough to effectively prevent initial suicide attempts (May & Klonsky, 2016).

Finally, it has been suggested that the list of risk factors for both NSSI and suicide attempts is long, and includes negative life events which could happen to anyone, at any time (May & Klonsky, 2016). Therefore, using these known risk factors alone may not be practical for clinical risk assessments (May & Klonsky, 2016). Indeed, a meta-analysis of longitudinal studies which aimed to predict high and low suicide risk using known risk factors, in clinical populations, over the past 40 years, concluded that our ability to correctly predict those at the highest risk is unreliable (Large et al., 2016). For example, the sensitivity of suicide risk categorisation revealed that suicides were likely to occur even among individuals classified as low-risk (Large et al., 2016). While there have been some attempts to create algorithms using known risk factors to predict risk of self-injury, clinicians were found not to be accurate in their predictions (Gale, Hawley, Butler, Morton, & Singhal, 2016; Wang et al., 2016). More successful algorithms predicted only suicidal ideation (Liu et al., 2016), or only provide preliminary evidence due to small sample sizes (Passos et al., 2016).

Thus, knowing about demographic, psychiatric and psychosocial factors which increase the risk of self-injury is not enough to effectively predict and prevent it. Clinical risk assessments which combine existing knowledge with new methods are required to determine which individuals displaying known risk factors, are the most likely to engage in self-injury (including both NSSI and suicide attempts). This is the issue which the present dissertation aims to address.

One process which may improve precision in assessing risk can be borrowed from psychotherapy effectiveness research. Several studies have been conducted where symptom severity is measured continuously during treatment (e.g. Fairburn, Agras, Walsh, Wilson, & Stice, 2014; Koffmann, 2017; Lutz, Stulz, & Köck, 2009). Results suggest that individuals improve in distress during psychological treatment at different rates, where groups of people shared distinct patterns, or trajectories of symptom reduction. These trajectories were associated with different treatment outcomes, where trajectories showing rapid early change were associated with superior outcomes post treatment (Fairburn et al., 2014; Lutz et al., 2009; Lutz et al., 2014), and after 6 months (Melchior et al., 2016) regardless of initial distress (Koffmann, 2017). Furthermore, among individuals undergoing CBT for eating disorders, it was found that that early reductions in eating pathology were associated with reductions in comorbid personality pathology, anxiety and depression (Turner, Marshall, Wood, Stopa, & Waller, 2016). Therefore, trajectories of change on a construct being measured may have differential associations with another construct.

For instance, just as rapid, early reductions in symptom severity are associated with better treatment outcomes; it could be that early reduction in psychological distress is associated with a lower risk of self-injury. Since self-injury is a negative treatment outcome, then trajectories which do not show early improvement during treatment might be associated with higher risks. Using this process to estimate risk of self-injury is novel as it takes into account individual differences, where it is not only based on psychiatric diagnoses and levels of psychological distress at the beginning of treatment. It may allow for more nuance
in how individuals are categorised into high and low risk, based on how their distress changes over time.

The daily monitoring of symptoms such as depression has already been done with success in a psychiatric hospital (Newnham, Hooke, & Page, 2010). Additionally, in a sample of college students, a group consisting of individuals with more severe symptoms and frequent self-injury, were at a significantly higher risk of displaying suicidal behaviour than other groups, who reported lower symptom severity (Hamza & Willoughby, 2013). Therefore, since symptoms can be monitored, and patients can be grouped according to their symptom severity and risk of self-injury; perhaps repeated monitoring of symptoms during treatment will reveal groups of individuals sharing certain trajectories of change and risks of self-injury. In this way, by continuously monitoring symptom severity, and measuring incidences of self-injury, it may be possible to group people according to their risk and improve the precision with which self-injury can be predicted and prevented. This would improve well-being and reduce the risk of future suicidal behaviour.

Therefore, continuously monitoring change in psychological distress, which is associated with suicidal ideation and self-injury, may improve our ability to identify those at the highest risk during treatment. These markers of psychological distress include depression, anxiety (Christiansen, Goldney, Beutrait, & Agerbo, 2011; Hall, Platt, & Hall, 1999; Haw, 2001; Hawton et al., 2012), feelings of worthlessness (Madge et al., 2011; Martin, Richardson, Bergen, Roeger, & Allison, 2005; Wilburn & Smith, 2005) and perceptions of not coping (Evans, Hawton, & Rodham, 2005; Hagell, 2013; Horwitz, Hill, & King, 2011). Studies also suggest that experiencing several markers of psychological distress together is associated with an even higher risk of self-injury than one symptom alone (Hagell, 2013;
Hawton & James, 2005; Madge et al., 2011; Wilburn & Smith, 2005; Wood et al., 2010). Therefore, considering more than one symptom (i.e. measuring general emotional distress) may result in a better estimation of risk of self-injury rather than focusing on one indicator, such as only suicidal ideation.

If the combination of monitoring psychological distress over time, to determine trajectories of change associated with higher or lower risk of self-injury does improve risk prediction, it can be added to existing risk assessment practices. That is, if we can determine an individual’s likely trajectory of change based on the presence or absence of early improvement in distress; specific interventions targeting modifiable risk factors for self-injury, such as teaching emotion regulation skills (Carter et al., 2017) can be administered to individuals sharing likely higher risk trajectories.

5. Summary

Despite a plethora of research aiming to predict and prevent self-injury including both NSSI and suicide attempts, knowledge about risk factors alone has not allowed us to reliably do this (Large et al., 2016). While demographic, psychosocial, and psychiatric factors associated with increased risk of self-injury have been identified; conflicting results, a dearth of longitudinal studies, and the weak predictive power of variables prevents us from determining which individuals who are experiencing distress or thinking about self-injury will engage in self-injurious behaviour. This dissertation therefore aims to explore the ability of a novel method to improve our precision at predicting which inpatients at a psychiatric hospital are at the highest risk of engaging in self-injury. The proposed method, borrowed from psychotherapy efficacy research, would entail using daily
measurements of psychological distress among inpatients during treatment to
determine whether groups of individuals share trajectories of symptom reduction.
We hypothesise that trajectories of change associated with more positive treatment
outcomes will also be associated with lower risk of self-injury, and trajectories
showing a lack of early symptom reduction will be associated with higher risks of
self-injury. If individuals can be grouped according to different trajectories of
symptom reduction, which are also associated with different risks of self-injury,
information about change trajectories can be added to risk assessments to improve
precision at identifying those at the highest risk. However, before we try to predict
risk, we must first decide whether the present dissertation will focus study on NSSI
and suicide attempts separately, or together. As outlined, the literature suggests that
they are distinct, but related forms of self-injury. The first study was therefore
conducted to decide whether separating NSSI and suicide attempts will be a focus of
this thesis.

The questions outlined above will be addressed through a series of four
studies, written up as manuscripts for the purpose of publication in peer reviewed
journals. The following chapters include papers which are either published (Study
2), currently under review for publication (Study 4), or are formatted for submission
to relevant journals (Studies 1 and 3).
Chapter 2

Study 1 Determining the scope of this thesis, can we reliably separate non-suicidal self-injury and suicidal behaviour based on intent derived from clinical staff reports of adverse incidents?

Abstract

Background: Categorising self-injury as suicidal or non-suicidal consistently based on retrospective reports of the events is challenging. A lack of consistency in the nomenclature used to describe self-injurious behaviour may impede efforts to accurately code and manage risk of non-suicidal self-injury and suicide within and across sites. Aims: This study explored the inter-rater reliability of two systems created to classify self-injury retrospectively, based on records kept by clinical staff. Method: Three independent raters used two scales to code 100 events of self-injury using routinely collected incident reports in an inpatient psychiatric facility. Results: In this context, the scales were found not to be sufficiently reliable with average kappa scores in the ‘fair’ range (κ = 0.27 and κ = 0.39). Conclusions: Low agreement between raters may be due to the lack of clarity around reported patient intent, which has important implications for clinical policy in how adverse incidents are recorded. It could also be due to the scales not being robust to the variation in how routine risk management data in inpatient facilities are not always exhaustive. Therefore, separating SELF-INJURY and suicide attempts based on staff reports will not be a focus of this thesis.

Keywords: Self-injury, Nomenclature, Columbia Classification Algorithm of Suicide Assessment (C-CASA), Self-Directed Violence Classification Scale (SDVCS), Inter-rater Reliability
Difficulties classifying self-injury with routine incident reports; the inter-rater reliability of two scales

Non-suicidal self-injury is defined as self-injury without the intent to die, and can be used means of regulating negative affect (Nock, 2010). However, engaging in non-suicidal self-injury can increase the risk of future suicidal behaviour (Mundt et al., 2013; Victor & Klonsky, 2014; Whitlock et al., 2013) if combined with suicidal ideation (Victor & Klonsky, 2014). Non-suicidal self-injury may increase the risk of future suicidal behaviour by acting as a ‘gateway’ for some individuals to engage in increasingly lethal forms of self-injury (Anestis & Joiner, 2011; Mundt et al., 2013; Van Orden et al., 2010). For example, individuals who reported higher levels of suicidal intent at the time of engaging in self-injury were at a higher risk of subsequent suicide (Harriss, Hawton, & Zahl, 2005). Furthermore, higher values for the wish to die/wish to live ratio amongst psychiatric outpatients who had attempted suicide, acted as a unique risk factor for future suicidal behaviour after controlling for age, psychiatric admissions, previous suicide attempts, depression, bipolar disorder and unemployment status (G. K. Brown, Steer, Henriques, & Beck, 2005). These studies suggest that the intent behind self-injury is an important factor in assessing future suicide risk and should be measured in some way. Given that self-injury with suicidal intent indicates a more acute risk of suicide than self-injury without the intent to die (Harriss et al., 2005), accurately distinguishing between self-injury with and without the intent to die is important when trying to prevent suicide.

Knowledge of the history and pathology of individuals together with the lethality of the incident may aid clinicians in assessing intent behind any self-injury
Coding self-injury as NSSI versus suicide attempts, Study 1

(Posner et al., 2007). However, accurately and consistently labelling self-injurious incidents as suicidal or non-suicidal has proven to be challenging (Kattimani, Bharadwaj, Sarkar, & Mukherjee, 2015; O Carroll, Berman, Maris, Moscicki, & al, 1996). For example, intentions behind self-injury can be ambivalent, concealed and can alternate between suicidal and non-suicidal (Kapur, Cooper, O’Connor, & Hawton, 2013; A. L. Miller & Smith, 2008). Additionally, even if clinicians can use information other than the self-injury itself to aid in assessing intent, additional classification and assessment problems include the existence of numerous criteria for classifying self-injurious behaviour (Matarazzo, Clemans, Silverman, & Brenner, 2013) and the various methods for collecting and reporting adverse events (Gahm et al., 2012). Indeed, a recent study found that when two clinicians used nomenclature proposed by Silverman et al. (2007) to retrospectively classify adverse events in a crisis intervention clinic, authors argued that the moderate inter-rater reliability coefficients for suicide related communication (e.g. intent) were not sufficiently concordant (Kattimani et al., 2015).

Poor consistency could be due to data not being collected for the sole purposes of identifying suicide attempts, how they occurred and the circumstances surrounding them (Gahm et al., 2012). Therefore, assessing suicidality in routine clinical practice may be made upon less than perfect information (Gahm et al., 2012). Indeed, unclear information about adverse incidents can complicate not only the process of consistently labelling incidents as suicidal or non-suicidal, but also comparing prevalence rates of each type of self-injury across studies and sites (Brenner et al., 2011; O Carroll et al., 1996; Posner et al., 2007; Silverman, Berman, Sanddal, O'Carroll, & Joiner, 2007). For example, if events of self-injury are incorrectly and/or inconsistently classified as non-suicidal or suicidal; our
knowledge of predictors and appropriate interventions for each form of self-injury would be insufficient to reduce self-injury (Sheehan, Giddens, & Sheehan, 2014).

These concerns led to the construction of scales to help clinicians and researchers consistently label self-injurious behaviour retrospectively. Two such scales are the Self-Directed Violence Classification Scale (SDVCS; Brenner et al., 2011) and the Columbia Classification Algorithm of Suicide Assessment (C-CASA; Posner et al., 2007). Both scales use a set of defined terms to describe different forms of self-injury, including with or without the intent to die and intent unknown. They also cover thoughts and behaviour associated with self-injury, such as suicidal ideation or behaviour suggesting the intent to self-injure (e.g. preparatory behaviour).

The SDVCS was developed by a group of US government departments, including the Centre for Disease Control (CDC), and the Veterans Integrated Service Network 19 Mental Illness Research Education and Clinical Centre (VISN 19 MIRECC), to address the lack of uniformity in self-injury nomenclature (Matarazzo et al., 2013). It also includes a Clinical Tool (i.e. a decision tree) designed to help raters classify events as one of 22 possible codes (Brenner et al., 2011). These codes were intended to be mutually exclusive, theory and culture neutral; and they include definitions for a range of suicidal thoughts and behaviours (Brenner et al., 2011; Matarazzo et al., 2013). Thoughts can be classified as either non-suicidal self-directed violence ideation, or suicidal ideation. Behaviours are divided into non-suicidal, suicidal and with undetermined intent. Each of these sub-types has different modifiers, which vary by sub-type. For example, raters can choose between preparatory behaviours, behaviours with or without injury, if the act was
Coding self-injury as NSSI versus suicide attempts, Study

fatal, and if the act was interrupted by self or others (Brenner et al., 2011). Inter-rater reliability for the SDVCS was assessed using raters from two VA hospitals, and a clinical tool was developed with the input of suicidologists and VA mental health clinicians (Brenner et al., 2011). The study did not use routine clinical information, but the research team created twenty two vignettes to include all necessary information for classifying each of those events in one of the 22 categories defined by the scale. Raters were then trained in using the scale and the clinical tool, which was revised based on feedback from focus groups made up of clinicians (Brenner et al., 2011). While feedback from clinicians indicated the need for clarification for some categories, for example, only 32% of raters coded “undetermined intent” events correctly and 54% coded non-suicidal events correctly on the final trial; the SDVCS was judged to be generally acceptable (Brenner et al., 2011). For example, 79% of raters correctly identified events related to suicidal self-injury on the final trial (Brenner et al., 2011). Raters were not required to reach consensus prior to testing with the focus group.

The C-CASA (Posner et al., 2007) was commissioned by the US Food and Drug Administration (FDA) as a standardised system to be used to assess suicidality and to code potentially suicidal events during clinical trials of various medications (Gassmann-Mayer et al., 2011; Matarazzo et al., 2013). The C-CASA consists of 8 main categories: Completed suicide (a self-injurious behaviour that resulted in fatality and was associated with at least some intent to die as a result of the act); Suicide attempt (a potentially self-injurious behaviour, associated with at least some intent to die, as a result of the act); Preparatory acts toward imminent suicidal behaviour (the individual takes steps to injure themselves, but is stopped by self or others from starting the self-injurious act before the potential for harm has begun);
Suicidal ideation (passive thoughts about wanting to be dead or active thoughts about killing oneself, not accompanied by preparatory behaviour); Self-injurious behaviour, no suicidal intent (self-injurious behaviour associated with no intent to die); Other, no deliberate self-harm (no evidence of any suicidality or deliberate self-injurious behaviour associated with the event); Self-injurious behaviour, suicidal intent unknown (self-injurious behaviour where associated intent to die is unknown and cannot be inferred); Not enough information (insufficient information to determine whether the event involved deliberate suicidal behaviour or ideation; Posner et al., 2007).

The C-CASA was found to have good overall inter-rater reliability (ICC=0.89) amongst nine experts in suicidology, who rated 427 adverse events which occurred during 25 clinical trials for anti-depressant medication in paediatric patients (Posner et al., 2007). Information available to raters included a report of the adverse event, the age of individuals who engaged in self-injury; their sex, history of suicidality and hospital admissions, current psychosocial stressors, family history of suicide together with information from case report forms and other hospital records (Posner et al., 2007). The ratings were made after raters were trained and arrived at a general consensus over the terms (Posner et al., 2007). The C-CASA categories and definitions have been used widely (e.g. Barlow et al., 2012; Philip et al., 2009).

It is important to note that for both studies investigating the reliability of the classification systems, the raters were either provided with all necessary information to classify the events (SDVCS) or provided with more information (e.g. family and individual history of suicidality, hospitalisations, current stressors; C-CASA) than would be available on a routine adverse incident report form. Therefore, it is not
Coding self-injury as NSSI versus suicide attempts, Study 1

clear the extent to which these findings will generalize to routine hospital settings where all necessary information is not available for every incident, and where incident reports are used to determine risk and inform practice. Similarly, neither system was designed to go through a consensus process for definitions every time it was used, and so the following study aims to explore the generalisability of the reported reliability values when independent raters use the scales without their own consensus on each category.

In summary, considering the psychometric properties of each system, it is clear that although they are promising, key questions remain unanswered. While each classification system has strengths, what is lacking, to our knowledge, is an investigation examining the reliability of the SDVCS and the C-CASA when used with data routinely collected during the operation of hospital clinical service. The extant data show the value of the instruments in research settings, but it is not apparent if these psychometric properties would generalize if used in routine clinical practice relying on mandatory data typically collected in mental health settings. Such a study is needed to determine the relative value of these instruments in this context, where incident reports made by clinicians are relied upon to assess risk and manage adverse events. The results of this study will also define the scope of the following thesis, and clarify whether analyses should separate non-suicidal self-injury and suicide attempts based on clinicians’ records.

**Method**

**Incidents**

Incidents of self-injury included the first 100 incidents which occurred and were reported in an inpatient psychiatric hospital in 2014. They were recorded
Coding self-injury as NSSI versus suicide attempts, Study

routinely by hospital staff as free text on a risk management database as part of the mandatory data collection process regarding adverse events. De-identified incident summaries used by the researchers included a description of the behaviour (report) and the outcome of the incident as assessed by the recorder. The outcomes of incidents were classified by the relevant staff member as one of the following: No adverse outcome, No injury sustained, Injury requiring no intervention, Injury requiring minor intervention, Injury requiring medical assessment, Deterioration in physical health, Enhanced level of observations, Transferred to a medical facility, and Transferred on forms (i.e., as an involuntary patient).

Participants

Three independent raters included two Psychologists and one Counselling Psychologist. None of the raters worked on the inpatient unit.

Statistics

Inter-rater reliability was assessed using Cohen’s kappa ($\kappa$), which measures the extent to which raters assign the same codes to the same items (McHugh, 2012). Values <0 indicate poor agreement; 0.0-0.2 indicate slight agreement; 0.21-0.40 indicate fair agreement; 0.41-0.60 indicate moderate agreement; 0.61-0.80 indicate substantial agreement; and 0.81-1.00 indicate almost perfect agreement (Landis & Koch, 1977). However, it has been argued that in health research, any $\kappa$ below 0.6 should be considered inadequate as that would indicate too high a level of disagreement between raters (McHugh, 2012). The kappa statistic was used instead of other indicators of inter-rater reliability as the data was categorical and not continuous, and other indicators (e.g. inter-class correlations) are not appropriate for categorical data (Hallgren, 2012; Mandrekar, 2011).
Procedure

Raters were given the list of incidents and asked to code them, first using any of the available options on the C-CASA and then the SDVCS. Instructions for the C-CASA (as found in Posner et al., 2007) and the SDVCS (including the Clinical Tool, as found in Brenner et al., 2011) were provided to the raters. Raters were given one week to complete the ratings using both scales and researchers were available to answer any queries regarding the scales.

The main difference in procedure between this study and the one by Posner et al. (2007) is that no general consensus about interpretation occurred. Further, differences between this study and both Posner et al. (2007) and Brenner et al. (2011) include the recruitment of ‘non-experts’ in the field of self-injury as raters, and since these systems were not designed to need a consensus at each site, no additional training (apart from instructions provided by the systems’ authors and clarifications) was provided to the raters. Finally, raters did not have access to patient histories.

In addition, after considering the instructions and the way that incidents were reported in this hospital, two potential sources of variance were addressed. Firstly, despite the instructions provided regarding interruptions (SDVCS), and how to infer intent if it was not stated, there was a potential lack of clarity around the term “interrupted by self or other”, and potential confusion in choosing between non-suicidal intent vs intent unknown for both scales. The following clarifications were added to the instructions and provided to all raters.

- **Interruptions (SDVCS only):**
• **Interrupted by self** should be chosen if the self-injurious behaviour was stopped by the patient themselves (e.g. the report explicitly states that the patient stopped self-injuring before the behaviour served its purpose). **Interrupted by other** should be chosen if the report explicitly states that patient was stopped/interrupted in their self-injury by another person, such as a staff member.

• **Intent (both scales):**

  • Non-suicidal intent can be inferred if intent is not stated or unclear in the description, and the behaviour resulted in superficial injuries, which if were allowed to continue, would still not be lethal (e.g. scratching lower leg). Intent unknown would be chosen if the act had the potential to be lethal, and not enough information was provided in the report to gauge if there was suicidal intent.

Secondly, a lack of a formalised recording of patient reported intent provided in the incident reports, and the lack of information about patient history were addressed by providing information about the risk of the current incident and future incidents. This was judged by clinical staff using a risk matrix. This matrix combined information about the likelihood of the patient engaging in self-injury again, based on their history; and the severity/risk of the current self-injury incident. The risk matrix included definitions for each item. These were:

1. **Likelihood** (predicted frequency of self-injury in the future based on past behaviour):
Almost certain (the event is expected to occur in more circumstances); **Likely** (the event will probably occur in most circumstances); **Possible** (the event shall occur at some time); **Unlikely** (the event could occur at some time); and **Rare** (the event may occur in the most exceptional circumstances).

2. **Consequences** (severity of injury)

*Catastrophic* (e.g. death); *Major* (e.g. extensive injuries); *Moderate* (e.g. medical assistance required); *Minor* (e.g. first aid treatment); and *Insignificant* (e.g. no injuries). Combining the likelihood and consequence of each self-injury incident generated a risk level indicator (*low, moderate, high and extreme*). These indicators, along with the risk matrix were included in the descriptions given to the raters.

**Results**

Of the first 100 recorded incidents in 2014, one incident was classified as “extreme risk”, 34 were classified as “high risk”, 39 were classified as “moderate risk”, and 26 were “low risk”. Five incidents were recorded as suicide attempts by clinical staff (descriptions used included “suicide attempt” (x2); “patient reported suicide attempt” (x1); “patient overdose” (x1); and “patient attempted hanging” (x1)).

1. **SDVCS**

Analyses using the kappa ($\kappa$) statistic for the SDVCS revealed that the agreement between Raters 1 and 2 was $\kappa=.14$ ($p<.05$); agreement between Raters 1 and 3 was $\kappa=.46$ ($p<.01$); and agreement between Raters 2 and 3 was $\kappa=.22$ ($p<.01$). The average agreement for the SDVCS was $\kappa = 0.27$ which is in the “fair” range (Landis & Koch, 1977).
2. C-CASA

Analyses using the kappa (κ) statistic for the C-CASA showed that the agreement between Raters 1 and 2 was κ = .33 \( (p < .01) \); agreement between Raters 1 and 3 was κ = .54 \( (p < .01) \); and agreement between Raters 2 and 3 was κ = .31 \( (p < .01) \). The average agreement for the SDVCS was κ = 0.39 which is also in the "fair" range (Landis & Koch, 1977).

Discussion

The aim of this study was to investigate the reliability of the SDVCS and the C-CASA, when used to retrospectively code incidents of self-injury recorded by staff in a psychiatric facility as suicidal or non-suicidal. Preliminary results show that for both the SDVCS and C-CASA, while there was some variability between raters, the average agreement between raters was in the “fair” range (κ = 0.27 and κ = 0.39 respectively; Landis & Koch, 1977). Further, only one reliability coefficient was above κ = 0.5 (between raters 1 and 3 using the C-CASA). This suggests that inter-rater reliability was not sufficient for either scale when coding incidents of self-injury reported in this facility. This assessment is based on McHugh (2012), who argues that in health research; kappa scores below 0.6 are not adequate as they indicate too high a level of disagreement between raters. Finally, these results are consistent with a recent study where the inter-rater reliability for retrospectively classifying suicide related communication from incident reports in a crisis intervention centre, using nomenclature proposed by Silverman et al. (2007) was found to be poor (κ = 0.016; Kattimani et al., 2015).

The low agreement between raters for both scales in the current study could be related to the type of data being used. For example, for most of the incidents, the
descriptions did not include an explicit statement about the patient’s reported intent behind their act of self-injury. Variability regarding the clarity of intent provided in descriptions of incidents was also an issue reported by Posner et al. (2007). Indeed, Kattimani et al. (2015) found that the moderate inter-rater reliability for classifications of incidents based on suicide related *ideation* and *behaviours* (Silverman et al., 2007) were correlated with a single item which asked explicitly about suicidal intent on the Pierce Suicidal Intent Scale (Kattimani et al., 2015).

Therefore, despite the complications in assessing suicidal intent such as ambivalence (Kapur et al., 2013), it could be that explicitly asking an individual their intent behind an act of self-injury may improve consistency when classifying self-injurious behaviour. Finally, incident descriptions did not include all information required for each category or comprehensive patient histories. This may have hampered raters’ ability to code them consistently.

Equally, it could be that the definitions provided by both scales did not encompass the variety of adverse events which occurred in this facility. For example, Sheehan et al. (2014) argue that the C-CASA categories might not capture all possible combinations of suicidal ideation and behaviour (e.g., some individuals might have a plan for suicide but no *current* suicidal ideation), and that there is some ambiguity in the titles and descriptions of each category which may allow for varied responses. Furthermore, the definitions provided by both scales may not have been robust enough to compensate for the different ways in which incidents were reported as part of the clinicians’ normal routine, or the fact that “non-experts” in the field of self-injury were rating incidents (which would be the case if these scales were to be used as part of the hospital routine). Indeed, Brenner et al. (2011) acknowledged that a barrier to the SDVCS being used consistently could be the novel language
used to describe incidents (e.g. undetermined self-directed violence, with injury, with or without interruption), and that a more detailed knowledge of concepts relating to suicidal behaviour is needed by researchers to use this scale more effectively.

Nevertheless, these “fair” levels of agreement are consistent with the wider literature, which argues that reliably distinguishing between suicidal vs non-suicidal self-injury retrospectively is a challenging area. Indeed, retrospectively labelling an incident as suicidal/non-suicidal is fraught with difficulties due to the numerous motivations which can exist concurrently behind an act of self-injury, suggesting that this issue requires more research (Kapur et al., 2013; Matarazzo et al., 2013). For example, a recent study found results to suggest that non-suicidal self-injury and suicidal behaviours may represent different points on a continuum of self-injurious behaviour rather than mutually exclusive behaviours (Orlando et al., 2015). They therefore propose that one way of determining risk of suicide would be to specify the severity (e.g. mild, moderate, high) of the behaviour along the spectrum of self-injury; taking into account the injury, suicidal intent and other factors such as methods, frequency and previous suicidality rather than relying on intent alone (Orlando et al., 2015).

Limitations

The C-CASA was designed to classify ideation and behaviour based on information already gathered, including intent behind the behaviour. Lower reliability scores may have been due to the incident reports not including explicit measures of intent, and because the SDVCS was not designed for only retrospective classification of behaviour. Further, raters did not receive any more training (while raters in Posner et al., 2007 and Brenner et al., 2011 did receive training), than the
instructions provided by both classification systems. It could be that more specific training would lead to better inter-rater reliability. However, measures which are less resource intensive and do not require specific training to be administered would be more valuable in an inpatient setting, where they can be administered to patients by any clinical staff.

**Conclusions**

In conclusion, consistently classifying self-injury as suicidal vs non-suicidal has implications for the accuracy of knowledge around rates of suicidal behaviours and the efficacy of interventions. While systems such as the C-CASA and SDVCS have been used widely; to our knowledge their inter-rater reliabilities had not been investigated in an inpatient psychiatric facility with routinely collected risk management data. Results of this study suggest that using these instruments with these routinely collected data were not sufficiently reliable. The low reliability could reflect problems in the instruments themselves or it could be due to the variability in the type of information available in routine incident reports. However, in the running of a typical inpatient psychiatric facility, accounts of adverse events and patients involved are not always exhaustive. Future research should continue to investigate this issue and develop studies designed to examine these scales with different types of information, collected from different types of psychiatric facilities. This may lead to changes in clinical policy related to how risk information is collected, or to developing classification systems with robust and diverse categories to account for the variability in incidents occurring in psychiatric facilities.
Foreword to Chapter 3

Results of Study 1 suggest that the scales being tested could not be used reliably to code self-injurious behaviour as either non-suicidal self-injury or suicide attempts, based on retrospective staff reports, in this clinical population. The low inter-rater reliability could have been due the reports not always containing explicit statements of intent, the reports not including all the information required by the scale category, the scale definitions not being robust to the variety or adverse events occurring in this inpatient population and the ambiguity around them, and finally, it could be because the clinicians were not experts in self-injury and were not previously trained to use these measures. However, in a busy clinical setting, it is not always possible to find experts to record adverse incidents, and for a classification scale to be used by a variety of clinical professionals, it would be more accessible if it did not require specific training. Hence, future research should aim to address these issues to improve our ability to reliably and accurately code self-injury. Furthermore, due to the limitations of using retrospective staff reports of adverse incidents, distinguishing between NSSI and suicide attempts when trying to predict risk will not be a focus of this dissertation. Any distinctions between non-suicidal self-injury and suicide attempts will be made based on patient self-reports, where incidents will be coded as suicide attempts only if they were recorded as “patient reported” suicide attempts.

Study 2 will therefore aim to use a novel method, informed by the literature on psychotherapy effectiveness, to improve our ability to predict which inpatients are at the highest risk of engaging in self-injury, where all forms of self-injury (both non-suicidal self-injury and suicide attempts) will be studied together. Research into psychological treatment outcomes suggests that when psychological distress is
measured repeatedly, those who report rapid improvement during the early stages of treatment tend to have superior treatment outcomes, than those who do not. This was found for the construct being measured (e.g. depression; Lutz et al., 2009), and on related clinical constructs (e.g. personality pathology among patients with eating disorders; Turner et al., 2016). Therefore, we suggest that if inpatients in a psychiatric hospital are invited to report their levels of depression, anxiety, suicidal ideation, worthlessness and perceptions of not coping daily, patients will report change in distress at different rates. Based on the psychotherapy effectiveness literature, we hypothesise that inpatients can be grouped according to shared rates of change, where certain change trajectories will be associated with higher and lower risks of self-injury. For example, if rapid early improvement is associated with positive treatment outcomes, it may also be associated with lower risk of self-injury. Therefore, a lack of early improvement may be associated with higher risks of self-injury. If this is the case, then variables associated with high and low risk change trajectories can be studied, and this information can be used to inform risk assessments. Overall, we aim to increase the precision of clinical risk assessments to predict risk of self-injurious behaviour in an inpatient population. Checking if repeated measurements of patient self-reported psychological distress can be used to group inpatients according to shared trajectories of change in distress, and if these trajectories are associated with higher or lower risk, represents a first step in this process, and will be the focus of Study 2.
Chapter 3

Study 2: Identifying risk of self-injury through longitudinal monitoring of psychological distress in an inpatient psychiatric population

Accepted 30th March 2015 as journal article in BMC Psychiatry (please see Appendix 1 for article in journal format, note “self-injury” = “deliberate self-harm” in journal formatting)

Abstract

**Background:** While cross-sectional correlates of self-injury, such as psychological distress, have been identified; it is still difficult to predict which individuals experiencing distress will engage in self-injury, and when this may occur. Therefore, this study aimed to explore the ability of longitudinal measurements of psychological distress to predict self-injury in a psychiatric population. **Method:** Participants (N=933; age range 14-93 (M= 38.95, SD= 14.64; 70% female) were monitored daily in terms of suicidal ideation, depression, anxiety, worthlessness and perceptions of not coping. Latent Growth Curve Analysis was used to check if groups of inpatients reporting suicidal ideation, who shared early change in measures of psychological distress, existed. Logistic regression tested whether different groups were at higher (or lower) risks of self-injury. **Results:** Four groups were found. Of these, Non-Responders (high symptoms, remaining high) were more likely to engage in self-injury than patients with high, medium and low symptoms which improved over one week. Group membership was a greater predictor of self-injury than initial distress scores. Females and patients with personality disorders were significantly more likely to be Non-Responders. **Conclusions:** Repeated monitoring and subsequent grouping of inpatients according to their early change in psychological distress provides a novel and practical approach to risk management. A lack of early improvement in psychological distress may indicate a higher risk of
self-injury. **Keywords:** Self-injury; Risk Management; Suicidal Ideation, Longitudinal Measures.
Identifying risk of self-injury through longitudinal monitoring of psychological distress in an inpatient psychiatric population

Self-injury (including both suicidal behaviours and non-suicidal self-injury) is hard to predict and this makes it a difficult area of clinical case management. Non-suicidal self-injury refers to deliberate, self-inflicted harm on body tissue; not socially/culturally sanctioned and without the intent to die (Andover et al., 2012; Klonsky et al., 2013). Suicide attempts refer to deliberate, self-inflicted, non-lethal injuries, with the intent to die (Andover et al., 2012). Although non-suicidal self-injury differs from suicidal attempts in terms of the intent to die (Mundt et al., 2013; Nock, 2010); non-suicidal self-injury either separately or combined with previous suicide attempts can significantly increase the risk of future suicidal behaviour (Hawton et al., 2012; Victor & Klonsky, 2014.; Whitlock et al., 2013). For example, individuals with multiple previous incidents of self-injury, a history of psychiatric admissions, substance abuse (Hawton et al., 2012; Hawton & James, 2005), and those who engaged in more severe cutting and burning (Hamza et al., 2012) can be at risk of progressing to further suicidal behaviours.

Theoretical frameworks have been proposed to explain the link between non-suicidal self-injury, suicide attempts and future suicidal behaviour. For example, the Interpersonal Theory of suicide posits that while perceived burdensomeness and thwarted belongingness can lead to suicidal ideation as a first step, individuals need to acquire the capacity to harm themselves to act on those suicidal thoughts (Van Orden et al., 2010). This capacity to harm oneself can be acquired either through non-suicidal self-injury, previous suicidal behaviour, or both forms of self-injury (Klonsky et al., 2013). For example, the progression from less lethal self-injury to
more lethal self-injury might occur through the habituation to physical pain (Anestis & Joiner, 2011; Hamza & Willoughby, 2013). This view has been supported by findings where previous non-suicidal self-injury was a strong predictor of future suicidal behaviour (Asarnow et al., 2011; Mundt et al., 2013). For example, non-suicidal self-injury was found to predict suicidal behaviour after controlling for depression (Andover & Gibb, 2010; Asarnow et al., 2011; Hamza et al., 2012), previous suicidal behaviour (Asarnow et al., 2011), hopelessness and symptoms of borderline personality disorder (Andover & Gibb, 2010). Finally, a prospective study found that non-suicidal self-injury in adolescents remained a significant predictor of future suicidal behaviour after accounting for depression and previous suicidality (Guan, Fox, & Prinstein, 2012). Therefore, exploring predictors of non-suicidal self-injury among people at risk of suicidal behaviour (e.g., those experiencing suicidal ideation) may help predict and prevent suicidal behaviour. That is, if a first step towards suicidal behaviour is to have thoughts about suicide, and the next step is to acquire the capacity (such as through non-suicidal self-injury); examining factors associated with non-suicidal self-injury amongst individuals who already report suicidal ideation might add to the precision with which future suicidal behaviour can be predicted. Indeed, since both non-suicidal self-injury and suicidal behaviour can increase the risk of future suicidal behaviour (e.g. (Guan et al., 2012)), both forms of self-injury are referred to as self-injury for the purposes of this study.

However, one difficulty with prediction may be the focus on taking cross-sectional measurements of potential risk factors of self-injury, such as psychiatric disorders and psychological distress (Inder et al., 2014), and expecting them to predict levels of a behaviour which might change over time. For example, a systematic review suggested that while most correlates of self-injury such as
indicators of psychological distress have been recognized retrospectively, there is a lack of knowledge around proximal predictors, which require longitudinal studies to be identified (Fliege, Lee, Grimm, & Klapp, 2009). It has also been argued that further research is needed to identify causal links between risk factors and self-injury (Nock, 2012). For example, it is widely known that depression is associated with suicidal ideation, but it is difficult to predict which people with depression who are considering self-injury will actually engage in self-injury (Nock, 2012).

The difficulties in prediction may arise because factors influencing the risk of self-injury vary both within and between days (Ben-Zeev, Young, & Depp, 2012). Therefore, it is hardly surprising that a measurement taken at a single time point may struggle to predict the probability of an outcome, where its likelihood of occurring may fluctuate along with levels of risk factors. For example, items associated with self-injury such as suicidal ideation (Bebbington et al., 2010; Ben-Zeev et al., 2012; Nock & Banaji, 2007) can change depending on different situations or the presence of certain triggers (Ben-Zeev et al., 2012; Nock & Banaji, 2007). Indeed, it was found that suicidal ideation in adolescents with Borderline Personality Disorder did not remain stable over 6 months (Selby & Yen, 2014). Therefore, cross sectional measurements may not provide a valid measure of the variability in thoughts or feelings associated with self-injury at different times (Ben-Zeev et al., 2012). Therefore, it is still difficult to predict who will display self-injury or when, and with what consequence with sufficient precision to address this problem effectively.

A similar problem exists in psychotherapy research, where scores at the beginning of treatment provided imperfect prediction of post treatment outcomes and provided little information about individual responses to treatment (Lutz,
Martinovich, & Howard, 1999). Recognition of this difficulty led to “patient-focussed” research which suggested that individuals respond to treatment at different rates (Lutz et al., 2009). Importantly, knowing that people who improved rapidly in the early stages of treatment tended to have a better prognosis (Busch, Kanter, Landes, & Kohlenberg, 2006; Stiles et al., 2003); allowed researchers to identify the characteristics that distinguished the “early responders” from later responders (or those who deteriorate). Further it was found that groups of people shared distinct patterns of change, and that early improvement resulted in better treatment outcomes (Lutz et al., 2009). These results suggest that individuals respond to psychotherapy in different ways and that some individuals can be grouped according to shared early treatment responses. It may then be possible to determine who will not respond well to treatment by measuring their changes (e.g. in measures of psychological distress; (Dyer, Hooke, & Page, 2014)) during the early stages of treatment, and estimate their outcomes (e.g. self-injury) based on identified patterns (Lambert, Hansen, & Finch, 2001). For example, it is possible that a lack of early change in psychological distress may be associated with higher risks of engagement in self-injury.

Continuously measuring change in psychological distress would then point to individuals who do not make early improvements.

Indeed, previous research showed that when suicidal ideation was monitored daily in an inpatient psychiatric hospital, where day 1 was the first day that inpatients reported suicidal ideation; five sub-groups of individuals were found who changed in their reported levels of suicidal ideation over 7 days at different rates (Restifo, Kashyap, Hooke, & Page, 2015). It was also found that these sub-groups were associated with different levels of risk of engaging in self-injury, where the group who began with the highest levels of suicidal ideation and did not exhibit any early
improvement was at the highest risk (Restifo et al., 2015). Therefore, to build on those results by studying the effects of other factors associated with both suicidal ideation and self-injury (Dyer et al., 2014; Guan et al., 2012; Hamza & Willoughby, 2013; Victor & Klonsky, 2014); the existence of sub-groups who change at different rates on a combination of indicators of psychological distress, over 7 days of treatment were explored. These factors included; suicidal ideation (Bebbington et al., 2010), depression, anxiety (Cougle, Resnick, & Kilpatrick, 2009; Hantouche, Angst, & Azorin, 2010; Keilp et al., 2012), feelings of worthlessness (Irwin & Austin, 2013; Madge et al., 2011) and perceptions of not coping (Britton, Van Orden, Hirsch, & Williams, 2014; Evans et al., 2005; Hagell, 2013; Horwitz et al., 2011). A combination of distress factors were also found to be associated with an even higher risk of self-injury than one factor alone (Christiansen et al., 2011; Madge et al., 2011). Therefore, by continuously monitoring combined measures of psychological distress during treatment; any groups of individuals who share early change on those factors can be identified. Risk of self-injury could then be estimated based on group membership. This estimation could be more precise than using cross-sectional measures of risk factors of self-injury alone; due to the potential for these factors to fluctuate over time.

In summary, psychotherapy research has shown that individuals can be grouped according to their shared patterns of early change in measures of psychological distress, where early improvements are associated with better outcomes (Lambert et al., 2001; Lutz et al., 2009). Potential risk factors of self-injury, such as indicators of psychological distress may fluctuate and can be monitored daily. If individuals can be grouped according to shared early change in psychological distress during treatment, then certain groups may be at higher risks of
self-injury, such as those who do not show early improvement. Identifying if these groups exist, and measuring the rates of self-injury in each group may improve the precision with which risk is estimated.

In addition, if these groups exist, and one group is at a higher risk of engaging in self-injury, characteristics which predict group membership should be explored. To this end, it was found that lower self-reported improvements in symptoms during treatment, along with higher symptom severity and younger age at admission to hospital were associated with higher rates of re-admission to hospital in a private inpatient psychiatric facility (Byrne, Hooke, & Page, 2010). Higher rates of re-admission to hospital were also associated with greater problems with self-injury as assessed by clinical staff (Byrne et al., 2010). Therefore, number of admissions to this hospital was explored as a predictor of group membership.

Furthermore, while the rate of self-injury in the adult general population is estimated to be between 4-6% and 20% in adult inpatient populations; rates were estimated to be higher during adolescence (Hagell, 2013; Klonsky et al., 2013), and were found to approach 40% in adolescent inpatient populations (Klonsky et al., 2013). Age was therefore explored as another potential predictor of group membership.

Furthermore, in a sample of 89 adolescents exhibiting recent self-injury in a psychiatric facility; 87.6% were found to fit diagnostic criteria for at least one psychiatric diagnosis (Nock, Joiner, Gordon, LloydRichardson, & Prinstein, 2006). Indeed, 67.3% of females met criteria for Axis II disorders where Borderline Personality Disorder (BPD) was the most common (Nock et al., 2006). It was also found that adolescents exhibiting more and severe BPD symptoms were more likely to engage in self-injury (Muehlenkamp, Ertelt, Miller, & Claes, 2011).
Consequently, in the current sample; in addition to demographic variables such as gender, diagnostic categories may prove a useful avenue for exploration of predictors of group membership.

Therefore, this exploratory study aims to build upon previous research (Restifo et al., 2015), to check if different groups of inpatients exist who change in their reported overall psychological distress during treatment at different rates. It then aims to explore whether different groups are at higher/lower risks of engaging in self-injury. Finally, it aims to check if demographic variables such as age and gender; the number of previous admissions to a private psychiatric hospital and diagnoses can predict group membership.

Method

Participants

The relevant measures were made available to inpatients at a 100 bed private psychiatric hospital which specialises in acute mental health care for both day-patients and in-patients, including Psychiatry, Clinical Psychology, Occupational Therapy and Nursing care. All inpatients were invited to complete measures, excluding those who chose not to participate, those that were being admitted/discharged on any particular day of measurement, patients who were on leave, patients not attending treatment, patients who had not yet been allocated a treatment group, and if clinical staff decided it was inappropriate due to factors such as cognitive impairment (e.g. patients undergoing Electro Convulsive Therapy). Further, patients were only chosen if they had a minimum length of stay of seven days, in order to examine changes in distress over several consecutive days. They were then selected if they completed the measure on a minimum of three occasions
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over seven consecutive days during their current admission (which is the required number of responses for conducting the any non-linear longitudinal analyses (Stulz & Lutz, 2007).

The total number of inpatients at the hospital during the time period 1st January 2011 to 13th March 2013 was N=4258. Of these, N= 2538 (59.6%) completed the relevant measures. This study did not require any follow up measures.

Written informed consent and appropriate levels of consent from all patients was obtained, and the research was approved by the Human Research Ethics Office at the University of Western Australia.

Final Selection criteria

The base rate of self-injury amongst participants (N=2538) was 4.3%. This population was then divided into those who never reported suicidal ideation during their admission (N=1063, rate of self-injury = 0.6%) and those who did report suicidal ideation at least once during their admission (N=1475, rate of self-injury= 7.1%). Patients who never reported suicidal ideation were excluded from the final sample. This is because this study was interested in rates of self-injury amongst people who do report suicidal thoughts during treatment, where self-injury occurring after reported suicidal ideation may indicate an acquired capacity for future suicidal behaviours (Van Orden et al., 2010).

This study was also interested in examining how patients expressing suicidal ideation changed in their psychological distress over time. To examine the time-course of changes in distress, it was important to ensure that the first time all patients
expressed suicidal ideation was matched. To this end, as in previous research (Restifo et al., 2015), scores for suicidal ideation were aligned with day 1 becoming the first day any patient reported thoughts about suicide.

Of the 1475 individuals who endorsed suicidal ideation, 542 did not complete the measures on at least three occasions. The final sub-sample of participants therefore included 933 voluntary inpatients at a private inpatient psychiatric clinic. Each patient was diagnosed by their treating psychiatrist, and the main primary diagnoses domains using the ICD-10 classifications (National Centre for Classification in Health Publications, 2002) were Mood Disorders (55.1%), Neurotic, Stress-Related and Somatoform Disorders (18.4%) and Substance Abuse Disorders (9.8%). Cross-sectional measures were also used from this sample to predict self-injury using logistic regression (Field, 2005).

**Outcome Measures**

**Continuous and Cross-sectional Predictors of Self-injury**

Clinical change was measured by the Five Item Daily Symptom Index (DI-5; Dyer et al., 2014) a self-report symptom index developed to track patients’ perception of psychological distress daily during therapy. Patients were asked to complete the DI-5 Index daily as part of routine hospital data collection, and de-identified data were made available to researchers. The severity and frequency of symptoms were rated by patients on a six-point Likert scale, using the format; “Over the previous 24 hours I have felt [depressed]” with responses ranging from 0 (“at no time”) to 5 (“all of the time”). Items scores were added together and higher scores indicated more perceived psychological distress (Dyer et al., 2014). The DI-5 measures five separate items including depression, anxiety, worthlessness, not coping and suicidal ideation. This
measure was found to be appropriate for use with a psychiatric sample as it correlated well with existing mental health measures such as the SF-36 Mental Health ($r = -0.69$, $p < 0.01$) and depression (DASS Depression; $r = 0.65$, $p < 0.01$) (Dyer et al., 2014). It also exhibited high internal consistency (Cronbach’s $\alpha = 0.88$) and good test re-test reliability ($r = 0.75$) in a clinical sample (Dyer et al., 2014); as well as high internal consistency (Cronbach’s $\alpha = 0.82$) and test re-test reliability ($r = 0.72$, $p < 0.01$) in the current sample. Finally, in the current sample, total symptom scores on day 1 correlated significantly with total DASS-Depression scores at admission ($r = 0.48$, $p < 0.01$). This study used the sum of scores for the 5 items (anxiety, depression, suicidal ideation, worthlessness and perceptions of not coping) on each day (DI-5 Index), for seven consecutive days as an independent and continuous variable.

The addition of scores into one variable (DI-5 Index) was deemed appropriate as confirmatory factor analyses (CFA) found that a one factor model provided good fit to the data in a clinical population (Dyer et al., 2014). Similarly, in the current sample, criteria described by (Hoyle, 2012) were used to check if a one factor model adequately fit the data in a CFA. The indices and criteria examined were; standardised root mean square (SRMR; good fit indicated by values close to 0.08 or below), the root mean square error of approximation (RMSEA; good fit indicated by values close to 0.06 or below); and the Tucker-Lewis Index (TLI) and Comparative Fit Index (CFI) which should be close to or more than 0.95 (Hoyle, 2012). The CFI (0.98), TLI (0.96) and SRMR (0.03) indicated that a one factor model provided good fit to the data (Hoyle, 2012). While the RMSEA (0.08) was close to indicating good fit, modification indices suggested that anxiety and not coping were correlated. After these terms were correlated, the RMSEA became 0.02 suggesting that fit improved
absolutely. Overall, the weight of evidence points towards a one factor model providing adequate fit to the data.

The total score on the DI-5 for day 1 for each patient in the sample was used as a cross-sectional measure, to compare predictive abilities on self-injury with the use of continuous measures over seven consecutive days.

**Self-injury**

Self-injury incidents were recorded by hospital staff on the risk management database. The information recorded is part of a standard recording of “risk events” by all Australian hospitals and includes a description of the incident, date and time it occurred and any actions taken. Incidents were categorised as non-suicidal self-injury (1), suicide attempt (2) and suicide (3), and actions taken were requiring no intervention/minor intervention/medical assessment/enhanced level of observation; transfer to medical facility or discharged early. For the purpose of this study, only the first incidence of self-injury for each patient during the current admission was examined, and only the presence or absence of self-injury was studied (this included non-suicidal self-injury and suicide attempts). While it would be ideal to explore NSSI and suicide attempts separately, a distinction between non-suicidal self-injury and suicide attempts was not made when analysing results due to the results of a feasibility study (see Study 1). Results suggested that using the available information about incidents of self-injury in this hospital, assessors could not reliably distinguish between the two. This could be because information about the risk incidents were not collected in a research environment, but a naturalistic clinical environment, where not all the necessary information was always available, and that suicidal behaviour is rare in an inpatient environment.
Predicting risk through longitudinal monitoring, Study

Predictors of Group Membership

Age, gender, number of previous admissions and diagnoses were explored as potential predictors of group membership. This information was collected as part of normal hospital procedures and was available to authors.

Procedure

Patients were invited to complete the DI-5 on a touch screen every day from admission until discharge. Data included pre-treatment and treatment measurements of the DI-5 items for inpatients over seven consecutive days, during their first 30 days of admission; where day 1 was the first day that patients reported suicidal ideation.

Statistics

This study first asked; can cross-sectional measurements such as the DI-5 Index on day 1 be used to predict rates of self-injury in an inpatient psychiatric population? Logistic regression was run self-injury (yes/no) as the dependent variable and DI-5 scores on day 1 as the independent variable (Field, 2005).

The study then asked; do distinct sub-groups of individuals exist who share patterns of early change on the DI-5 Index over seven days; are different groups at different risks of exhibiting self-injury; and do variables such as age, gender, diagnoses predict group membership? To answer these questions, a Latent Growth Curve Analysis (LGCA; Singer & Willett, 2003) was run using the Mplus software (Muthén & Muthén, 2010) to check for groups of inpatients who change in their psychological distress at different rates. The validity of groups found using the LGCA were tested using chi square analyses, which measured any significant
differences between groups and rates of self-injury (Field, 2005). Effect sizes were calculated using the Phi statistic, which measured the strength of association between two categorical variables (Field, 2005). This was followed by logistic regression analyses to check for any significant associations of age, gender, or diagnoses with group membership (Field, 2005).

**Data Analysis**

To deal with missing data full information maximum likelihood (FIML) was used (Graham, 2009). Little’s MCAR tests were non-significant on the DI-5 Index, suggesting that data was missing at random and that no systematic patterns of missing data were present which could confound results. LGCA analyses were then run using a total index variable, where scores for each item were added together on each of the seven time points (days 1-7).

To obtain the best fitting LGCA solution the following indices were examined (Jung & Wickrama, 2008; Moreno & Andrade, 2010; Nylund, Asparouhov, & Muthén, 2007). These included the Bayesian Information Criteria (BIC; Schwarz, 1978) which measures the goodness of fit and parsimony of the model, where a lower BIC indicates better fit (Nylund et al., 2007). In addition, the Vuong-Lo-Mendell-Rubin Likelihood Ratio Test (LMR-LRT; Lo, Mendell, & Rubin, 2001) and the Parametric Bootstrapped Likelihood Ratio Test (BLRT; Nylund et al., 2007) check whether the change in values for models with increasing number of classes is significant (Lutz et al., 2009). Further, high posterior probabilities (i.e. probability for most likely latent class membership; (Jung & Wickrama, 2008) high entropy (a measure of the quality of classification of individuals into latent classes; (Lutz et al., 2009) and higher log-likelihood values
were also taken into account when choosing the optimal number of latent classes. Finally, based on the recommendations of (Nylund et al., 2007); the number of classes being explored stopped increasing the first time the LMR-LRT became non-significant. Further, (Lutz et al., 2009) argue that there is substantial data demonstrating that there is a negatively accelerated (or log-linear) relationship between the amount of treatment provided and progress during treatment. Therefore, log-linear latent growth curve models were tested (see Table 1).

Results

Individuals included in the LGCA analyses did not significantly differ in demographics (age: $t=1.62 \ (1439), p=.11$) or anxiety and stress sub-scales based on DASS-21 scores at admission to hospital (anxiety: $t=.04 \ (1414), p=.97$; stress: $t=.63 \ (1414), p=.53$) compared to individuals in the larger sample. However, individuals in the final data set (32.81) reported significantly lower mean DASS-21 depression sub-scale scores than those in the larger sample (34.09; $t=2.56 \ (1414), p<05$).

The 53 incidences of self-injury for individuals in the sample (N=933) consisted of the following; 73.6% cutting or scratching, 7.5% punching surfaces, 5.7% burning, two self-reported attempted suicides (3.8%), and other instances of self-injury (9.4%). Due to the small number of reported suicide attempts (2 out of 53 incidents), and that this study aimed to predict risk of self-injury based on previously reported suicidal ideation and severity of distress; all forms of self-injury are referred to as self-injury and no distinction was made between suicidal and non-suicidal self-injury.
It was also found that five individuals engaged in their first incidence of self-injury before reporting suicidal ideation. These included two incidents of burning, two incidents of superficial cutting and one incident of punching a surface. Their mean age was 31.2 years old (SD = 14.6), and all 5 individuals were female. Since this study aimed to estimate risk of self-injury in the presence of suicidal ideation and based on early change in distress during treatment; those individuals were excluded from analyses predicting self-injury. This is because any self-harm occurring before an expression of suicidal thoughts was beyond the scope of this study to predict. However, they were not excluded from the LGCA investigating any sub-grouping according to early change in reported distress, as the first aim of this study was to check if those groups existed in the sub-sample of patients reporting suicidal ideation.

Levels of missing DI-5 responses from participants from days 1-7 were as follows; 0%, 38.4%, 48.1%, 51.2%, 52.6%, 54.1%, 39.5%. Of the sub-sample, 653 were female (70%) and ages ranged from 14 to 93 years old (M = 38.95, SD = 14.64). The rate of self-injury in this sample (N=933) consisting only of inpatients who reported suicidal ideation and fit selection criteria was 5.7% (see Figure 2).

**Part 1: Predicting self-injury using a cross-sectional measure**

The predictive value of a cross-sectional measure (initial distress; DI-5 day 1) on self-injury in the final sample (N=928), was compared with the predictive value of the DI-5 groups (days 1 to 7). Higher DI-5 scores on day 1 were found to have a weak positive relationship with self-injury (*Exp. B* (1.2), *p* < .01; B = .15(SE = .04), Nagelkerke *R*² = .06). Therefore, the next step was to check if monitoring symptoms
and grouping patients according to their rates of change increased power in influencing odds of self-injury.

**Part 2: Latent Growth Curve Analyses**

Table 1

*LGCA Model Fit Indices for the DI-5 Index (N=933)*

<table>
<thead>
<tr>
<th>Number of Classes</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Log-Linear</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Log-Likelihood Value</td>
<td>-11675.66</td>
<td>-11384.43</td>
<td>-11262.65</td>
<td>-11212.06</td>
</tr>
<tr>
<td>Adj. BIC</td>
<td>23395.27</td>
<td>22823.81</td>
<td>22591.23</td>
<td>22581.72</td>
</tr>
<tr>
<td>Entropy</td>
<td>.88</td>
<td>.84</td>
<td>.81</td>
<td>.79</td>
</tr>
<tr>
<td>Posterior Probabilities</td>
<td>.96, .97</td>
<td>.95, .93, .90</td>
<td>.88, .91, .93, .86</td>
<td>.78, .92, .90, .86, .83</td>
</tr>
<tr>
<td>LMR-LRT</td>
<td><em>p</em>&lt;.01</td>
<td><em>p</em>&lt;.01</td>
<td><em>p</em>&lt;.01</td>
<td><em>p</em> = .20</td>
</tr>
<tr>
<td>BLRT</td>
<td><em>p</em>&lt;.01</td>
<td><em>p</em>&lt;.01</td>
<td><em>p</em>&lt;.01</td>
<td><em>p</em>&lt;.01</td>
</tr>
</tbody>
</table>

Table 1 presents the model fit indices for the 2, 3, 4 and 5 DI-5 Index log-linear solutions. The 4 class log-linear solution was chosen as the optimal solution after considering all indices which indicated that it was the most reliable.

Figure 1 shows that individuals could be grouped according to their shared early responses to treatment over seven consecutive days in this clinical population, on the DI-5 Index. These groups were; Responder Low Start Class (19.5%)
consisting of patients who reported low symptom severity and improved consistently over the seven days; Responders Medium Start (29.6%) reported medium to high symptom severity and showed early improvement; Responders High Start (28.7%) reported high symptom severity and improved to a smaller extent; and Non-Responders (22.2%) reported high symptom levels and did not improve over the seven days. From this sub-sample, 5 individuals were removed from further analyses due to their self-injury occurring before an expression of suicidal ideation.

![Figure 1. LGCA showing four trajectories of change for DI-5 Index over 7 days (N=933)](image)

Therefore, of individuals who exhibited self-injury after reporting suicidal ideation (N=928); Non-Responders (14.6%) were significantly more likely to self-injure than Responders High Start (4.9%), Responders Medium Start (1.4%) and Responders Low Start (0.6%). However, there was no significant difference in self-injury rates between Responders Medium Start and Responders Low Start (see Table 2). Finally, 59.6% of the self-injury events occurred within 14 days of the first time individuals reported having thoughts about suicide (i.e. day 1 of analyses).
Predicting risk through longitudinal monitoring, Study 2

Table 2

Chi-square ($\chi^2$) tests for differences in self-injury rates between groups on the DI-5 Index ($N=928$)

<table>
<thead>
<tr>
<th>1. Differences in Association With Self-injury</th>
<th>$\chi^2$ Value ($df$)</th>
<th>Significance</th>
<th>Effect Size ($\Phi$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. DI-5 Index Overall</td>
<td>52.82 ($3$)</td>
<td>$p&lt;.01$</td>
<td>.24</td>
</tr>
<tr>
<td>3. Non-Responders vs. Responders Low Start</td>
<td>24.78 ($1$)</td>
<td>$p&lt;.01$</td>
<td>.26</td>
</tr>
<tr>
<td>4. Non-Responders vs. Responders Medium Start</td>
<td>32.00 ($1$)</td>
<td>$p&lt;.01$</td>
<td>.26</td>
</tr>
<tr>
<td>5. Non-Responders vs. Responders High Start</td>
<td>12.84 ($1$)</td>
<td>$p&lt;.01$</td>
<td>.17</td>
</tr>
<tr>
<td>6. Responders High Start vs. Responders Low Start</td>
<td>6.50 ($1$)</td>
<td>$p&lt;.05$</td>
<td>.12</td>
</tr>
<tr>
<td>7. Responders High Start vs. Responders Medium Start</td>
<td>5.67 ($1$)</td>
<td>$p&lt;.05$</td>
<td>.10</td>
</tr>
<tr>
<td>8. Responders Low Start vs. Responders Medium Start</td>
<td>.70 ($1$)</td>
<td>$p=.40$</td>
<td>.04</td>
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</table>
Since groups of patients sharing early change were found to exist, and they significantly differed in their rates of self-injury, the next step in the analysis was to check if continuously measuring symptoms provided more predictive power over self-injury than cross sectional measurements on day 1. Since Non-Responders were at the highest risk of self-injury, when group membership was regressed on self-injury as a categorical variable (Non-Responder = 1, other groups= 0), being a Non-Responder significantly increased the odds of self-injury by an odds ratio of 6.67 \((Exp. B (6.67), p<.01; B=1.89(SE=.31), \text{Nagelkerke } R^2=.12)\). Therefore, being grouped as a Non-Responder provided more than six times predictive power over self-injury in this sample than the cross-sectional measure of initial distress (DI-5 scores on day 1), \((Exp. B (1.2), p<.01; B=.15(SE=.04), \text{Nagelkerke } R^2=.06)\).

An example of how results can be organised is provided below in Figure 2. Figure 2 displays the differences in risk between individuals in this population who reported suicidal ideation before exhibiting self-injury and those who never did during their current admissions.
Figure 2. Comparing risk of self-injury between inpatients admitted January 2011 to March 2013
Part 3: Predicting group membership

Results suggested that it was important to determine which patients would be grouped as Non-Responders; as they were at the highest risk of self-injury in this sample and would have caused concern for any clinical staff due to high distress levels which did not improve. Therefore, one logistic regression analysis explored whether gender, age and number of previous admissions to hospital could predict which patients would be grouped as Non-Responders. Another logistic regression explored whether diagnoses could predict if individuals would be Non-Responders or not. Analyses revealed that females were more likely to be Non-Responders than males in this sample (Exp. B (2.46), \( p < .01 \); B=.90(SE=.21), Nagelkerke \( R^2 = .04 \)). Further, individuals with personality disorders were significantly more likely to be Non-Responders (Exp. B (4.60), \( p < .01 \); B=1.53(SE=.30), Nagelkerke \( R^2 = .04 \)) where 54.2% (n=26) of patients with this diagnosis were Non-Responders. Conversely, individuals with substance abuse disorders were significantly less likely to be Non-Responders (Exp. B (.27), \( p < .05 \); B=-1.3(SE=.40), Nagelkerke \( R^2 = .02 \)) where only 7.8% (n=7) of patients with this diagnosis were Non-Responders. Age, number of admissions and other diagnoses did not show significant relationships with being grouped as a Non-Responder on the DI-5 Index.

Discussion

The aims of this study were to determine whether distinct sub-groups of inpatients reporting thoughts about suicide existed based on shared early responses to treatment. It was predicted that some groups would be at a higher risk of self-injury. It was also expected that when the sum of scores on the DI-5 (suicidal ideation, depression, anxiety, feelings of worthlessness and perceived inability to
cope; (Dyer et al., 2014), was monitored, it would allow for more precision in identifying those at risk of self-injury than cross-sectional measurements alone (i.e. initial distress measured by DI-5 scores on day 1). Finally, potential predictors of group membership (age, gender, number of admissions to hospital and diagnoses) were explored.

**Daily monitoring, groups and self-injury**

Consistent with previous research (Restifo et al., 2015), it was found that patients in this sample could be meaningfully grouped according to their reported improvements in psychological distress during the early stages of treatment. Indeed, these groups acted as a greater predictor of self-injury compared to measures of initial psychological distress. Therefore, continuously monitoring distress improved the precision with which risk of self-injury could be estimated in this sample.

For example, Non-Responders (individuals who reported severe symptoms and did not improve over seven consecutive days) were significantly more likely to use self-injury than any other group (see Figures 1 and 2). Further, when group membership was regressed on self-injury, being a Non-Responder significantly increased the odds of self-injury by a factor of 6.67 compared to just 1.20 by higher symptom scores on day 1. In addition, Responders High Start and Responders Medium Start (see Figure 1) began with similar distress severity; but it was the magnitude of change between days 1 and 2 (i.e. early change) which appeared to significantly distinguish them in terms of risk of self-injury. In this way, the use of daily monitoring made it possible to differentiate between those who were significantly more likely to use self-injury based on their group membership. It is however, important to note that the monitoring and grouping of inpatients would act
as adjuncts to existing clinical risk evaluation procedures. For example, if a potentially high risk individual was flagged via existing risk management procedures, and repeated monitoring revealed that they did not report any improvement by day three; according to Figure 1, they would likely be a Non-Responder. More specifically, by identifying a Non-Responder who was at a 14.6% risk of self-injury (compared to a population risk of 4.3%, see Figure 2) one can predict with 3.4 times more accuracy if that individual will engage in self-injury. Given the potential link between non-suicidal and suicidal self-injury (Miller et al., 2013; Ribeiro, Bodell, Hames, Hagan, & Joiner, 2013), any improved accuracy in predicting self-injury may improve our ability to predict and prevent more lethal self-injury in the future.

However, although non-suicidal and suicidal self-injury have been found to co-occur (Andover et al., 2012), some researchers suggest that they are associated with different risk factors (Andover et al., 2012; Chapman, Gratz, & Turner, 2014). For example, among incarcerated women with a history of non-suicidal self-injury, hopelessness was more strongly associated with the frequency of suicide attempts than that of non-suicidal self-injury (Chapman et al., 2014). Further, among adolescents being treated for depression; poor family functioning at entry into the program was associated only with suicide attempts, while being younger, female, having anxiety disorders and hopelessness was associated with only non-suicidal self-injury (Wilkinson, Kelvin, Roberts, Dubicka, & Goodyer, 2011). Still, it was also found that while non-suicidal and suicidal self-injury served different functions, both behaviours were attributed to relieving high levels of negative emotions (Brown, Comtois, & Linehan, 2002). Consequently, since both suicidal and non-
suicidal self-injury were studied in this sample, results suggest that a potential shared ‘risk’ is a lack of early improvement in psychological distress during treatment.

In summary, higher levels of psychological distress, together with a lack of early improvement during treatment appear to place individuals in this population at the highest risk of self-injury. This is consistent with previous research which found that sub-groups of inpatients changing in reported suicidal ideation at different rates were at different risks of engaging in self-injury (Restifo et al., 2015), and that early change in distress results in more positive outcomes for individuals undergoing psychological treatment (Busch et al., 2006; Stiles et al., 2003). Indeed, identifying sub-groups of individuals who change in distress at different rates led to superior predictions in risk of self-injury than distress scores on day 1 suggesting that continuously monitoring psychological distress amongst inpatients at this psychiatric hospital provided an innovative and useful avenue for risk prediction, and potentially prevention.

Predicting group membership

Preliminary analyses showed that females were more likely to be Non-Responders than males in this sample. It was also found that patients with personality disorders were significantly more likely to be Non-Responders. Given that 47 out of 48 individuals with personality disorders had diagnoses of Borderline Personality Disorder (BPD), these findings are consistent with previous research which found high rates of self-injury in patients diagnosed with BPD (M Nock et al., 2006) and a study which found higher mortality rates, including death by suicide in female vs. male patients diagnosed with personality disorders (Høye, Jacobsen, & Hansen, 2013). Due to the predominance of BPD, the lack of early improvement in
Predicting risk through longitudinal monitoring, Study 2

distress amongst Non-Responders, continued high reported levels of negative affect and self-injury may all be related to other symptoms of BPD such as emotion dysregulation and intolerance of negative affect (Chapman, Gratz, & Brown, 2006; Glenn & Klonsky, 2009). Still, more detailed analyses are required to determine why gender appears to be a significant predictor of risk, and which aspects of personality disorders contribute to self-injury. For example, it was found that higher levels of ‘confusion about self’ and ‘unstable interpersonal relationships’ were associated with both repeated non-suicidal self-injury and suicide attempts amongst adolescents displaying traits consistent with BPD (Muehlenkamp et al., 2011). Nevertheless, the significant associations of gender and diagnoses with group membership suggest that females and individuals with diagnoses of personality disorders should be closely monitored for risk of self-injury during treatment.

Conversely, having substance use disorders made individuals significantly less likely to be Non-Responders, placing them at a lower risk of self-injury in this sample. This could be due to inpatients not having access to substances in a psychiatric facility, which would then reduce the likelihood of them engaging in impulsive behaviours such as self-injury while intoxicated. However, studies have also found associations between substance abuse and self-injury. For example, one study found that not only was substance abuse associated with self-injury during adolescence, but that self-injury increased the risk of substance abuse during adulthood (Moran et al., 2014). Further, a systematic review found self-injury and psychological distress to be significant correlates of substance abuse (Moller, Tait, & Byrne, 2013). Perhaps, the lack of association between being Non-Responders and substance abuse in this sample may also be because only primary diagnoses were examined. Substance abuse may have been a comorbid problem in some cases.
Finally, contrary to expectations, age was not a significant predictor of group membership. This could be due to the wide range of ages found in this sample ($M = 38.95, SD = 14.64$), including much fewer individuals under 18 years old (8.2%) than over 18; and results of previous research suggesting that self-injury is more common, and chronic in adolescents experiencing psychological distress than in adults (Barrocas et al., 2015; Klonsky et al., 2013). This may also explain the low overall rate of self-injury (7.1%) in this sample.

Undoubtedly, relationships between diagnoses and group membership need to be explored in more detail before strong conclusions about risk of self-injury can be drawn. Further study is important, because if information about group predictors can be used to make accurate predictions of individuals at the highest (and lowest) risk of self-injury, based on their probable group membership; it can help prevent adverse incidents from occurring at all. Future research should explore more predictors of group membership and any interactions between them. For example, dividing risk factors into demographic (e.g. gender), clinical, psychosocial (e.g. social support) and institutional factors (e.g. staff training) may help disentangle predictors of self-injury and group membership (Barker, Kõlves, & De Leo, 2014). Finally, studying relationships between theoretical constructs such as perceived burdensomeness, thwarted belongingness and acquired capability for suicide (Van Orden et al., 2010), together with diagnoses and demographic factors; and their effects on group membership may provide characteristics which place individuals at higher risks of self-injury.

Limitations
Firstly, the selection of participants in this study may have resulted in a sample consisting of more severe patients (inpatients for a minimum of seven days, and consisting only of people who reported suicidal ideation). Further, the level of missing data on certain days may limit the generalizability of risk values found in this sample. Missing data on some days may have been due to procedural reasons (e.g. newly admitted patients, or soon to be discharged) or a number of other factors such as a lack of opportunity to complete the measure due to missing a treatment session, or it could be that individuals with lower depression were more likely to respond on at least 3 occasions. Therefore, the numbers in Figure 2 regarding the risk of self-injury should be interpreted with caution. Rather than absolute risk values which can be generalised to all inpatient populations, they should be seen as the relative difference in risk of self-injury in this sample. Nevertheless, the process of determining group membership and resulting risk of self-injury through continuous measurement can still be applied to other populations.

Secondly, since the number of self-injury events recorded in this sample was based only on those reported by hospital staff; there may have been incidents which staff were not aware of, and this might explain the low reported rate of self-injury in this population.

Furthermore, it was found that five individuals who exhibited self-injury did so before reporting suicidal ideation. This could be because these incidents did not indicate an acquired capacity for future suicidal behaviour, or that suicidal ideation developed as a result of the self-injury. Nonetheless, since this model aimed to predict self-injury based on changes in psychological distress after self-reported suicidal ideation; predicting self-injury which did not follow reported thoughts about suicide are beyond the scope of this study.
Finally, it was found that the two individuals who attempted suicide (self-reported) were grouped as Non-Responder and Responder High Start. Therefore, measuring non-suicidal self-injury and suicide attempts separately; and how they may be distributed in groups provides an avenue for future research with larger samples. Indeed, separating non-suicidal and suicidal self-injury could help clarify both the link and the differences between risk factors for the two behaviours. This separation may also clarify relationships between any predictors of group membership, and future research should take this into account.

Conclusions

Results suggest that amongst inpatients reporting suicidal ideation; the daily monitoring of their indicators of psychological distress allowed them to be meaningfully grouped according to shared early change during treatment. This grouping allowed significantly more precision in predicting risk of self-injury according to group membership compared to cross-sectional measures alone. For example, the group with high initial distress and no early change was at the highest risk of self-injury. Results also suggest that females and those with diagnoses of personality disorders should be closely monitored for risk of self-injury. These findings present a novel and practical approach for the first steps in mitigating the risk of self-injury in clinical populations.
Foreword to Chapter 4

Study 2 suggests that when psychological distress among inpatients of a psychiatric hospital was monitored continuously, shared trajectories of change in distress were associated with different levels of risk of self-injury. The data also suggest that individuals who reported suicidal ideation, who began with high distress, which was sustained over 7 days, were at the highest risk of self-injury. That is, trajectories showing high initial distress plus a lack of early change were associated with high risk. What Study 2 did not identify however, was a group of individuals with a change trajectory showing rapid early improvement. Recent research into psychotherapy effectiveness suggests that trajectories showing rapid early improvement in psychological distress are associated with positive outcomes post-treatment (e.g. Fairburn, Agras, Walsh, Wilson, & Stice, 2014; Lutz et al., 2009; Lutz et al., 2014). In the context of self-injury, the positive outcome would be low risk of self-injury, despite the presence of high initial psychological distress. Therefore, based on the results of Study 2, where sustained distress increased risk of self-injury, research into psychotherapy effectiveness suggests that rapid early change, despite high initial distress would protect against risk of self-injury.

The lack of a rapid early change group in Study 2 could be due to the moderate levels of missing data (ranging from 0% - 54.1% on different days); due to patients not completing the DI-5 regularly during their inpatient admission. This may have led to individuals who were experiencing rapid early improvement being excluded from analyses, due to not having enough DI-5 data points (i.e. at least three), for a longitudinal analysis to be conducted on MPLUS. Efforts to provide patients with more opportunities to complete the DI-5, such as making it available on electronic tablets, lead to more individuals completing the DI-5 more often. In
addition, it could be that seven days was a not long enough time period to give individuals the opportunity to complete the DI-5 as many times as possible. Therefore, a larger sample size, consisting of more patients who have had the opportunity to complete the DI-5 at least three times, over a longer period of time might help us identify a rapid early change trajectory group, if it exists. Based on the recent literature in psychotherapy effectiveness, an early change group may be at the lowest risk of self-injury, despite experiencing high initial psychological distress. Study 3 therefore aims to check if rapid early improvement in psychological distress is associated with positive outcomes, where it protects against risk of self-injury. If rapid early change in distress, despite higher initial distress is associated with lower risk, this knowledge will help further narrow down the group of individuals at the highest risk of self-injury. That is, it could be that high initial distress would not necessarily indicate high risk if distress improves rapidly within the first few days of treatment.

Finally, it is important for research to go beyond identifying different groupings, and to have a clearer understanding of what characterises individuals who share change trajectories. Study 3 will therefore continue to study variables associated with shared change trajectories. Study 2 suggested that female gender and Borderline Personality Disorder (BPD) were associated with highest risk. These findings are consistent with the wider literature which often finds high rates of self-injury among females and individuals diagnosed with BPD. Indeed, engaging in self-injury is a symptom of BPD. However, since a rapid early change group was not found, we still cannot say if females and individuals diagnosed with BPD who report high distress plus rapid early change, would have a lower risk of self-injury than those who reported sustained high distress. Study 3 therefore aims to firstly
check if female gender and BPD are reliably associated with higher risk, and to see if any other demographic or diagnostic variables are found to be associated with highest and lowest risk. If variables with good predictive power are identified, then they could be measured in risk assessments and help create more targeted interventions to individuals at the highest risk of self-injury in this inpatient population.
Chapter 4

Study 3: Does rapid early improvement in psychological distress protect against risk of self-injury?

Abstract

**Background:** To explore trajectories of change which protect against risk of self-injury. This study also aimed to explore demographic and diagnostic variables associated with different change trajectories. **Method:** Adult inpatients (N=1103) reporting suicidal ideation completed a Daily Index measuring psychological distress over ten days. Latent Growth Curve Analysis identified groups of inpatients who shared trajectories of change in distress. Risk of self-injury and variables associated with lowest and highest risk trajectories were explored using chi square analyses and logistic regression. **Results:** Inpatients who reported rapid early change were at the lowest risk of self-injury despite beginning with high initial distress. Older age and male gender were associated with increased odds of reporting rapid early improvement; effect sizes were small. **Conclusions:** Rapid early improvement was associated with lower risk of self-injury despite the presence of suicidal ideation and high initial psychological distress. Future research should explore trans-diagnostic predictors of change trajectories.
Does rapid early improvement in psychological distress protect against risk of self-injury?

Study 2 proposed that how individuals’ distress changed over seven days was a more precise predictor of risk of self-injury than pre-treatment distress (Kashyap et al., 2015). Specifically, a group of individuals who began with high levels of distress and showed no improvement were at the highest risk of self-injury (Kashyap et al., 2015). Therefore, without continuously monitoring levels of distress we could not have discovered that a lack of change predicted the highest risk of self-injury in that sample (Kashyap et al., 2015). This finding can improve our ability to identify those who require additional monitoring or intervention to prevent self-injury. Equally, if a lack of change was associated with higher risk, it could be that rapid early change is associated with lower risk. Indeed, research into psychotherapy efficacy has consistently found that individuals who show rapid early improvement during treatment tend to show superior outcomes (Fairburn, Agras, Walsh, Wilson, & Stice, 2014; Lutz et al., 2014; Lutz, Stulz, & Köck, 2009). However, study 2 did not find a group which showed rapid early improvement in self-reported distress, and associated positive outcomes such as lower risk of self-injury. A larger sample size, together with monitoring distress over a longer period of time may provide conditions more favourable to identifying individuals who show rapid early improvement, if they exist.

Therefore, through daily monitoring of psychological distress among inpatients of a psychiatric hospital, we can check if the results of study 1 can be replicated. That is, we can re-assess if inpatients do share rates of change in their psychological distress over ten days, and if different change trajectories are in fact associated with different rates of self-injury. We then aim to check if groups of
inpatients who report rapid early change are at the lowest risk of self-injury. Furthermore, while it was found that risk of self-injury was associated with different change trajectories (Kashyap et al., 2015; Restifo et al., 2015), knowledge around what characterises individuals who share trajectories of change is limited.

Preliminary results suggested that females and patients with Borderline Personality Disorder were at increased odds of being grouped amongst those at the highest risk of self-injury (Kashyap et al., 2015). However, the reliability of the association between those variables and risk of self-injury is yet to be established. Therefore, the following study aims to build on these findings and further explore demographic and diagnostic variables associated with change trajectories.

In summary, based on previous results (Kashyap et al., 2015; Restifo et al., 2015), we predict that if sub-groups of patients who share trajectories of change do exist, individuals who show a rapid early decline in distress will be at significantly lower risks of self-injury than those who show sustained high levels of distress. Variables associated with different trajectories of change may include younger age (Byrne et al., 2010), female gender (Bresin & Schoenleber, 2015) and having an emotional disorder (Bentley, Cassiello-Robbins, Vittorio, Sauer-Zavala, & Barlow, 2015), as these variables were found to be associated with elevated risks of engaging in self-injury. Specifically, a recent meta-analysis found that among emotional disorders, Post-Traumatic Stress Disorder had a strong association with self-injury, and Bipolar disorder had the weakest association with self-injury (Bentley et al., 2015). Previous research has also found that Personality Disorders were associated with high rates of self-injury (Nock et al., 2006). Therefore, this study will explore if individuals can be grouped according to their trajectories of change in
Does rapid improvement protect against risk of self-injury, Study 3

psychological distress and associations between trajectories of change and age, gender and diagnoses will be explored.

Finally, if individuals showing rapid early improvement are found to be at the lowest risk of self-injury, and variables associated with rapid change are identified; then our ability to more precisely detect and efficiently target interventions to those at the highest risk will be improved. This would aid clinicians in preventing self-injury. Furthermore, since engaging in both non-suicidal self-injury and suicide attempts has been often been associated with an increased risk of future suicidal behaviour (e.g. Dickstein et al., 2015; Giletta et al., 2015; Hamza & Willoughby, 2013; Orlando, Broman-Fulks, Whitlock, Curtin, & Michael, 2015; Paul, Tsypes, Eidlitz, Ernhout, & Whitlock, 2015); preventing all forms of self-injury may also help in preventing future suicidal behaviour.

**Method**

**Participants**

The total number of inpatient admissions at the hospital during the time period 12th December 2012 to 10th September 2014 was N= 2861 Of these, N=2570 (89.8%) completed the relevant measures at least once during the first 30 days of their admission. This study did not require any follow up measures. Of the 2570 inpatients who completed the relevant measures, those who never reported suicidal ideation during the first 30 days of their admission (N= 955) were excluded. This is because this study (see Kashyap et al., 2015; Restifo et al., 2015) was interested in rates of self-injury amongst people who did report suicidal thoughts during treatment; where self-injury occurring in the presence of suicidal ideation may
facilitate acquiring the capability for future lethal self-injury (Van Orden et al., 2010).

Patients were then chosen if they had a minimum length of stay of four days, in order to examine changes in distress over several consecutive days. They were then selected if they completed the measure on a minimum of three occasions over ten consecutive days during the first 30 days of their admission, as three responses are the required number for conducting the longitudinal analyses (Stulz & Lutz, 2007). Of the 1615 patients who reported experiencing suicidal ideation at least once during the first 30 days of their admission, 512 individuals were excluded as they did not have a length of stay of at least 4 days, and they did not complete the measures on at least three occasions during the first 10 days of their admission (see Figure 3 for flow diagram).

Therefore, the final sub-sample of patients included 1103 voluntary inpatients at a private psychiatric clinic (admitted between 6th March 2013 and 10th September 2014), where the main primary diagnoses (provided by treating Psychiatrists) using the ICD-10 classifications (National Centre for Classification in Health Publications, 2002) were Mood Disorders (58.9%), Neurotic, Stress-Related and Somatoform Disorders (19.9%), Personality Disorders (7.1%), Substance Abuse Disorders (7.1%) and Schizophrenic Disorders (3.4%). Of this sub-sample, 838 were female (76%) and the mean age was 37.82 years old (SD= 15.30).

Socio-economic information was retrieved from the Australian Bureau of Statistics using the socio-economic indexes for areas (SEIFA; Australian Bureau of Statistics (ABS), 2011). SEIFA scores rank areas according to the relative advantage/disadvantage and collective socio-economic characteristics of people
Does rapid improvement protect against risk of self-injury, Study 3

living within a certain postcode. Lower scores indicate relatively more disadvantaged people living within an area (1-10; Pink, 2011). This information was collected during the census, and in this population, 82.6% of participants lived in areas with SEIFA scores of above 5 indicating higher socio-economic backgrounds.

Written informed consent for participation in the study was obtained upon admission to the hospital, and ethics was obtained from the University’s Human Research Ethics Office.

![Figure 3](image)

**Figure 3.** Participant selection flowchart for inpatients admitted between 6th March 2013 and 10th September 2014.

**Measures**

**Continuous and Cross-sectional Predictors of Self-injurious Behaviours**

Clinical change was measured by the Five Item Daily Symptom Index (DI-5; (Dyer et al., 2014) a self-report symptom index developed to track patients’ perception of psychological distress daily during therapy. The severity and frequency of
symptoms were rated by patients on a six-point Likert scale, using the format; “Over the previous 24 hours I have felt [depressed]” with responses ranging from 0 (“at no time”) to 5 (“all of the time”). Items scores were added together and higher scores indicated more perceived psychological distress (Dyer et al., 2014). The DI-5 measures depression, anxiety, worthlessness, perceptions of not coping and suicidal ideation. This measure was found to be appropriate for use with a psychiatric sample as it correlated well with existing mental health measures such as the SF-36 Mental Health ($r = -0.69, p < 0.01$) and depression (DASS Depression; $r = 0.65, p < 0.01$) (Dyer et al., 2014). It also exhibited high internal consistencies (Cronbach’s $\alpha = 0.88$ & 0.82; Dyer et al., 2014; Kashyap et al., 2015) and good test re-test reliability ($r = 0.75$; Dyer et al., 2014) in clinical samples; as well as high internal consistency (Cronbach’s $\alpha = 0.82$) in the current sample. This study used the sum of scores of anxiety, depression, suicidal ideation, worthlessness and perceptions of not coping on each day (DI-5 Index), for ten consecutive days as a continuous variable.

**Self-Injurious Behaviours**

Self-injury incidents were recorded by hospital staff on the risk management database. The information recorded is part of a standard recording of “risk events” by Australian hospitals and includes a description of the incident, date and time it occurred and any actions taken. Incidents were categorised as non-suicidal self-injury (1), suicide attempt (2) and suicide (3), and actions taken were; requiring no intervention/minor intervention/ medical assessment/enhanced level of observation; transfer to medical facility or discharged early. For the purpose of this study, only the first incidence of self-injury for each patient after they reported suicidal ideation during the current admission was examined, and only the presence or absence of self-injury (yes/no) was studied.
Predictors of Group Membership

Female gender (Bresin & Schoenleber, 2015), psychiatric diagnoses (Bentley et al., 2015) and age (Byrne et al., 2010) were explored as potential predictors of group membership. This information was collected as part of normal hospital procedures and de-identified data were made available to authors.

Procedure

Relevant measures were made available to all inpatients excluding those who chose not to participate; those that were being admitted/discharged on any particular day of measurement; patients who were on leave, patients not attending treatment, patients who had not yet been allocated a treatment group; and if clinical staff decided it was inappropriate due to factors such as cognitive impairment (e.g., patients undergoing Electro Convulsive Therapy).

Patients were invited to complete the DI-5 on a touch screen every day from admission until discharge, and these data were collected as a part of routine hospital data collection. De-identified data comprising of the treatment measurements of the DI-5 items for inpatients during their first 30 days of admission were provided to authors. Longitudinal analyses from days 1-10 of patient’s admissions were then run, where scores for each item on the DI-5 Index were added together on each of the ten time points (days 1-10). Day 1 of analyses was defined as the first day that patients reported suicidal ideation because this study aimed to examine the time-course of changes in psychological distress after the first report of suicidal thoughts (see Kashyap et al., 2015). It was therefore important to ensure that the first time all patients expressed suicidal ideation was matched. As a result, scores for suicidal ideation were aligned, where day 1 of analyses was the first day any individual
reported experiencing suicidal ideation (i.e. where scores for an item measuring suicidal ideation was more than 0).

**Data Analytic Plan**

To examine if distinct sub-groups of individuals exist who share patterns of early change on the DI-5 Index over ten days, a Latent Growth Curve Analysis (LGCA; Singer & Willett, 2003) was run using the *Mplus* software (Muthén & Muthén, 2010). To obtain the best fitting LGCA solution, the Bayesian Information Criteria (BIC; (Schwarz, 1978)), the Vuong-Lo-Mendell-Rubin Likelihood Ratio Test (LMR-LRT; (Lo et al., 2001); the Parametric Bootstrapped Likelihood Ratio Test (BLRT; (Nylund et al., 2007) higher posterior probabilities (i.e. probability for most likely latent class membership; (Jung & Wickrama, 2008); higher entropy and higher log-likelihood values were taken into account when choosing the optimal number of latent classes.

Associations between group membership and self-injury, and variables associated with group membership were tested using chi square analyses (effect size = phi) and logistic regression (Field, 2005).

**Results**

Full information maximum likelihood (FIML) was used to deal with missing data (Graham, 2009). Little’s MCAR tests were non-significant on the DI-5 Index, suggesting that no systematic patterns of missing data were present which could confound results.

Compared to individuals in the final data set used for LGCA analyses (mean age= 37.82 years), individuals who had endorsed suicidal ideation at least once
during their admission had a higher mean age (40 years; t=2.4 (1534), p<.05).

However, these samples were not different on the depression (t=.42 (1515), p=.67),
anxiety (t=1.5 (1515), p=.13) or stress (t=.68 (1515), p=.49) sub-scales of the DASS-21.

**Part 1: Determining the number of latent classes**

Lutz et al (2009) argue that change in distress during treatment occurs in a
negatively accelerated trajectory, and so log-linear trajectories were explored. To
obtain the most reliable log-linear LGCA solution, the number of classes being
explored stopped increasing when the LMR-LRT became non-significant (Nylund et
al.,2007). Successive classes demonstrated improved fit until the 5 class solution was
explored. While the entropy value for the 5 class solution was lower than with 4
classes, it demonstrated adequate fit and on balance when considering all fit
statistics, the 5 class LGCA solution (see Figure 4) provided the most reliable fit (see
Table 3; Jung & Wickrama, 2008).

![Figure 4](image_url)

*Figure 4.* LGCA showing observed means for the 5 class solution (N=1103)
Table 3 presents fit statistics for the 2, 3, 4 and 5 class models. On balance, the 5 class model was chosen as the most reliable solution.

**Part 2a: Self-injury (non-suicidal self-injury and suicide attempts)**

The base rate of self-injurious behaviour, including both non-suicidal self-injury and suicide attempts (yes/no) amongst inpatients who completed the DI-5 (N= 2570) was 6.9%. The proportion of individuals who engaged in self-injury at least once without ever reporting suicidal ideation (N= 955) was 0.3%, and amongst those who did report suicidal ideation during their admission (N= 1615), 10.9% of

---

**LGCA Model Fit Indices for the DI-5 Index N=1103**

<table>
<thead>
<tr>
<th>Number of Classes</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Log-Linear Value</td>
<td>-20855.89</td>
<td>-20297.27</td>
<td>-20026.76</td>
<td>-19896.70</td>
<td>-19832.53</td>
</tr>
<tr>
<td>Adj. BIC</td>
<td>41769.23</td>
<td>40663.48</td>
<td>40133.94</td>
<td>39885.31</td>
<td>39768.46</td>
</tr>
<tr>
<td>Entropy</td>
<td>.90</td>
<td>.86</td>
<td>.84</td>
<td>.82</td>
<td>.80</td>
</tr>
<tr>
<td>Posterior Probabilities</td>
<td>.97, .96</td>
<td>.95, .92, .95</td>
<td>.89, .92, .90, .93</td>
<td>.91, .82, .86, .93, .88</td>
<td>.81, .80, .90, .77, .71, .93</td>
</tr>
<tr>
<td>LMR-LRT</td>
<td><em>p&lt;.01</em></td>
<td><em>p&lt;.01</em></td>
<td><em>p&lt;.05</em></td>
<td><em>p&lt;.05</em></td>
<td><em>p=0.18</em></td>
</tr>
<tr>
<td>BLRT</td>
<td><em>p&lt;.01</em></td>
<td><em>p&lt;.01</em></td>
<td><em>p&lt;.01</em></td>
<td><em>p&lt;.01</em></td>
<td><em>p&lt;.01</em></td>
</tr>
</tbody>
</table>
individuals engaged in self-injurious behaviour. The rate of self-injurious behaviour (yes/no) in the final sample (N=1103) consisting only of inpatients who reported suicidal ideation and fit selection criteria was 11.6%, where 128 individuals engaged in self-injury (see Figure 5) These incidents included 69.7% cutting, 11.4% burning, 2.5% overdoses, 16.4% other self-injury.

Six individuals engaged in self-injury before endorsing suicidal ideation. Since this study was interested in how people change in their distress levels after endorsing suicidal ideation; and if group membership is related to risk of self-injury in the presence of suicidal ideation, those six individuals were excluded from further analyses predicting risk of self-injury (see Figure 5 and Kashyap et al., 2015; Restifo et al., 2015).
Does rapid improvement protect against risk of self-injury, Study 3

Figure 5. Comparing risk of non-suicidal self-injury between sub-groups of inpatients admitted between March 2013 and September 2014. Note: Risk = number of individuals who engaged in self-injury at least once during their hospital inpatient admission.
**Part 2b: Rates of self-injury in each group (N=1097)**

The rates of self-injury (yes/no) in each group were explored, and differences between groups were analysed using chi square analyses (see Table 4). It was found that individuals in the High Start Non-Remitting group (35.3% risk) were significantly more likely to engage in self-injury compared to all other groups. High Start Slow Remitters (12.5% risk) and Medium Start Remitters (9.1% risk) had significantly more self-injury than Rapid Remitters (2.9% risk) and Low Start Remitters (1.5% risk). However the differences in rates of self-injury between High Start Slow Remitters vs Medium Start Remitters, and Rapid Remitters vs Low Start Remitters were non-significant (see Table 4). Therefore, despite beginning with the second highest level of distress (see Figure 4), Rapid Remitters were at the lowest risk of self-injury, where their risk of self-injury (2.9%) was lower than the sample base rate (11.6%). Table 4 presents the chi square values for differences in rates of self-injury between groups.

Table 4

*Chi-square ($\chi^2$) tests for differences in self-injury rates between groups on the DI-5 Index (N=1097)*

<table>
<thead>
<tr>
<th>Differences in Association With Self-injury</th>
<th>$\chi^2$ Value (df)</th>
<th>Significance</th>
<th>Effect Size ($\Phi$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DI-5 Index Overall</td>
<td>121.00 (4)</td>
<td>$p&lt;.01$</td>
<td>.33</td>
</tr>
<tr>
<td>High Start Non-Remitting vs. Low Start Remitting</td>
<td>71.21 (1)</td>
<td>$p&lt;.01$</td>
<td>-.45</td>
</tr>
<tr>
<td>High Start Non-Remitting vs.</td>
<td>48.94 (1)</td>
<td>$p&lt;.01$</td>
<td>-.32</td>
</tr>
<tr>
<td>Medium Start Remitting</td>
<td>58.10 (1)</td>
<td>$p &lt; .01$</td>
<td>-.42</td>
</tr>
<tr>
<td>------------------------</td>
<td>-----------</td>
<td>-----------</td>
<td>------</td>
</tr>
<tr>
<td>High Start Non-Retaining vs. Rapid Remitting</td>
<td>30.01 (1)</td>
<td>$p &lt; .01$</td>
<td>-.27</td>
</tr>
<tr>
<td>High Start Non-Retaining vs. High Start Slow Remitting</td>
<td>18.48 (1)</td>
<td>$p &lt; .01$</td>
<td>-.20</td>
</tr>
<tr>
<td>High Start Slow Remitting vs. Low Start Remitting</td>
<td>1.73 (1)</td>
<td>$p = .18$</td>
<td>-.06</td>
</tr>
<tr>
<td>High Start Slow Remitting vs. Medium Start Remitting</td>
<td>12.24 (1)</td>
<td>$p &lt; .01$</td>
<td>-.17</td>
</tr>
<tr>
<td>Rapid Remitting vs. Low Start Remitting</td>
<td>.76 (1)</td>
<td>$p = .38$</td>
<td>-.05</td>
</tr>
<tr>
<td>Rapid Remitting vs. Medium Start Remitting</td>
<td>6.81 (1)</td>
<td>$p &lt; .01$</td>
<td>.12</td>
</tr>
<tr>
<td>Medium Start Remitting vs. Low Start Remitting</td>
<td>11.77 (1)</td>
<td>$p &lt; .01$</td>
<td>-.15</td>
</tr>
</tbody>
</table>
Part 3: Variables associated with rapid early change (lowest risk of self-injury; N=1097)

Since Rapid Remitters had the lowest rate of self-injury (2.9%, along with Low Start Remitters, 1.5%), variables associated with this group compared to the other four groups were explored using logistic regressions. Variables were entered into a logistic regression in one step, and included gender, age and diagnoses. Diagnoses were separated into affective disorders (depression, bipolar), neurotic somatoform and stress disorders (posttraumatic stress disorder and other anxiety disorders), substance abuse, schizophrenic disorders and personality disorders (where 87% of diagnoses were Borderline Personality Disorder). Only significant associations are described below.

a. Rapid Remitters vs. High Start Non-Remitters

Older age (Exp (B) = 1.02, B=.02 (S.E=.01), p<.05, CI 95% =1.00-1.04) increased odds of being a Rapid Remitter compared to High Start Non-Remitter. Female gender (Exp (B) = .27, B=-1.31 (S.E=.32), p<.01, CI 95% =.15-.50); decreased odds of being a Rapid Remitter compared to a High Start Non-Remitter. This model accounted for 19.3% of variance in odds of being a Rapid Remitter (Nagelkerke R²=.193) showing a small effect size.

b. Rapid Remitters vs High Start Slow Remitters

Older age increased odds (Exp (B) = 1.02, B=.02 (S.E=.01), p<.01, CI 95% =1.00-1.04), and female gender decreased odds (Exp (B) = .38, B=-.98 (S.E=.24), p<.01, CI 95% =.23-.60) of being a Rapid Remitter compared to a High Start Slow Remitter. Finally, being diagnosed with a substance abuse disorder increased odds
of being a Rapid Remitter compared to a High Start Slow Remitter (Exp (B) = 3.95, $B=1.37$ (S.E=.70), $p<.05$, CI 95% =1.01-15.50). This model accounted for 13.7% of variance in odds of being a Rapid Remitter (Nagelkerke $R^2=.137$) showing a small effect size.

c. Rapid Remitters vs. Medium Start Remitters

Only female gender was associated with decreased odds of being a Rapid Remitter compared to a Medium Start Remitter (Exp (B) = .52, $B=-.66$ (S.E=.21), $p<.01$, CI 95% =.34-.78).

There were no significant differences in age, gender or diagnoses between Rapid Remitters and Low Start Remitters.

Discussion

The current study aimed to check if inpatients experiencing suicidal ideation shared trajectories of change in psychological distress during treatment. We then aimed to determine if different trajectories were associated with different risks of self-injury, specifically, if rapid early change was associated with lowest risk of self-injury. Finally, we aimed to explore variables associated with shared change trajectories.

The results of this study suggest that individuals in this sample were grouped in five ways according to their shared trajectories of change in psychological distress over 10 days, and that different groups were associated with different rates of self-injury. The group of individuals reporting rapid early improvement are labelled “Rapid Remitters”. It was found that Rapid Remitters (2.9% risk) were at the lowest risk of self-injury in this sample despite beginning with high levels of psychological
distress equivalent to the High Start Slow Remitters (12.5% risk), which had a significantly higher risk of self-injury. This suggests that rapid early improvement protected against risk of self-injury in this sample, despite the presence of suicidal ideation and high levels of psychological distress.

Furthermore, this study, as well as previous studies in adult (Kashyap et al., 2015; Restifo et al., 2015) and adolescent inpatient populations (Czyz & King, 2015) found that groups showing higher, sustained levels of distress were at the highest risk of self-injury. Specifically, in this study, the High Start Non-Remitting group was at the highest risk of self-injury (35.3% risk), followed by High Start Slow Remitters (12.5% risk), where both of these groups had higher rates of self-injury than the sample average (N=1097, 11.1%). The remaining groups had rates of self-injury below the sample average, suggesting that dividing individuals into these five shared trajectories of change through continuous measurement improved accuracy in estimating risk of self-injury. This also supports the argument that longitudinal measurements of psychological distress can be used to improve the precision with which we predict risk of self-injury, compared to cross-sectional measurements alone, such as initial distress (Ben-Zeev et al., 2012; Czyz & King, 2015). That is, not all individuals experiencing high initial distress were at equivalent risks of engaging in self-injury. What we found suggests that suicidal ideation, plus high initial distress; plus a lack of rapid early improvement during treatment placed individuals at higher risks of engaging in self-injury.

**Variables associated with rapid early improvement**

Older age and male gender were associated with increased odds of reporting rapid early improvement, compared to individuals with high initial distress who
showed no improvement and slow improvement. This is consistent with previous research where females were more likely to be grouped amongst those at the highest risk of self-injury (Kashyap et al., 2015), and since individuals in the larger sample had an older mean age, age may not be a clinically significant correlate. Finally, being diagnosed with a substance abuse disorder increased odds of having a rapid remitting change trajectory compared to slow remitting distress. This finding is consistent with Study 2, and could be due to the larger number of males diagnosed with substance abuse disorders in this sample, and the larger number of males showing rapid remitting psychological distress.

**Limitations and future research**

While five groups of inpatients showing different trajectories of change were identified using LGCA, High Start Slow Remitters did not have significantly higher rates of self-injury than Medium Start Remitters. Therefore, it is unclear how different these groups are clinically, despite their statistical difference. In addition, it could be that a lack of early improvement in distress during treatment resulted in increased suicidal ideation or general distress, whereby the Non-Remitting group remained with high levels of distress due to not improving early on. Nevertheless, it may still be the combination of high initial distress and a lack of early improvement which was associated with their high risk of self-injury, regardless of the cause of their sustained distress.

Finally, regression models testing the association between gender, age and diagnoses with group membership had small effect sizes. Apart from age and gender, variables were based on diagnostic categories, and only substance abuse was significantly associated with rapid remitting distress compared to slow remitting
distress. Indeed, it has been argued that risk of self-injury is trans-diagnostic (Bentley et al., 2015; Bentley, Nock, & Barlow, 2014) and future research should aim to explore trans diagnostic factors to predict change trajectories and/or risk of self-injury. Trans-diagnostic variables could include factors associated with the Interpersonal Theory of Suicide (IPTS), such as perceived burdensomeness, thwarted belongingness and acquired capability (Van Orden et al., 2010; Willoughby et al., 2015). The IPTS argues that perceived burdensomeness and thwarted belongingness can lead to suicidal desire, but that they are not enough to result in suicidal behaviour (Van Orden et al., 2010). It suggests that individuals need to acquire the capability to harm themselves in increasingly lethal ways (e.g. by engaging in frequent self-injury) as well as suicidal desire for desire to turn into action (Van Orden et al., 2010; Willoughby et al., 2015). Therefore, according to the IPTS, suicidal ideation plus high risk of self-injury may place individuals at a higher risk of future suicide.

Future research could explore this idea through repeated monitoring, as the results of Study 2 and the current study have suggested that using regular measurements of psychological distress to divide individuals into higher and lower risk groups is a reliable method of determining risk of self-injury among inpatients.

**Conclusion**

Taking into account the limitations of this study, the continued replication and validation of inpatients being grouped according to shared trajectories of change and differences in risk of self-injury (Kashyap et al., 2015; Restifo et al., 2015), suggests that longitudinal monitoring of patient progress can be reliably used to assess risk of self-injury in this inpatient psychiatric hospital. This and previous research suggests that while not all individuals experiencing distress will engage in self-injury, those who showed high sustained levels of distress were at significantly
higher risks than those with high distress who showed a rapid early decline. The significance of rapid early change could not have been detected without continuously monitoring psychological distress. Moreover, this study demonstrates that continuous measurements can allow us to distinguish between which individuals experiencing distress were at a higher risk of self-injury. That is, this study adds more precision to determining who should be closely monitored for risk of self-injury by suggesting that suicidal ideation plus high overall psychological distress, plus a lack of rapid early improvement during treatment placed individuals at the highest risk of self-injury. Conversely, the presence of rapid early improvement was protective against the risk of self-injury despite suicidal ideation and high initial distress. This information can help identify those at the highest and lowest risk of self-injury, and inform more targeted interventions. Taken together with established risk management procedures in psychiatric facilities, it can aid clinicians in preventing adverse events more efficiently by improving the accuracy of risk prediction compared to using initial distress scores alone, as it has done in this and previous samples. While the absolute numbers indicating risk in this sample may not generalise to other populations, the process of grouping individuals who change in psychological distress along different trajectories by monitoring their distress continuously can be used in other settings.

Finally, what we need next is knowledge about trans-diagnostic variables associated with change trajectories, which can be identified on admission to hospital and which are amenable to interventions to prevent self-injury before it occurs.
Foreword to Chapter 5

Studies 2 and 3 suggest that individuals who report suicidal ideation, high initial psychological distress and sustained high distress are at the highest risk of engaging in self-injury. Study 3 goes on to suggest that while suicidal ideation and high initial, sustained distress can increase risk of self-injury; suicidal ideation and high initial distress followed by rapid early improvement can protect against risk of self-injury. Further, the results of both Studies 2 and 3 suggest that females were more likely to be grouped amongst those at the highest risk, and that individuals diagnosed with substance abuse disorders were at lower risk. However, while Study 2 suggested that Borderline Personality Disorder (BPD) was associated with highest risk, Study 3 did not replicate this. This may be due to the identification of the group of individuals showing rapid remitting distress in Study 3, where perhaps the change trajectory had a stronger association with risk of self-injury than the diagnosis of BPD. Indeed, Study 3 suggested that male gender and older age were the most common predictors of the low risk trajectories after taking into account all diagnoses. This suggests that diagnoses may not be the most effective predictors of change trajectories, and this is consistent with recent literature which argues that risk of self-injury is likely trans-diagnostic (Bentley et al., 2015, 2014). However, given that being diagnosed with substance abuse disorders was significantly associated with lower risk trajectories in both Studies 2 and 3, future research should include diagnoses in any analysis of trans-diagnostic predictors to further investigate their predictive power.

Therefore, while we have some information about which patients might be grouped at the highest risk (e.g. females, younger patients), the next step is to try and proactively predict which individuals are more likely to present with the highest risk
trajectory, before their distress is sustained over several days. Study 4 aims to test the hypothesis that non-diagnostic psychological variables are associated with high risk change trajectories, and that those variables are associated with high risk over and above gender, age and identified psychiatric disorders (e.g. BPD and substance abuse disorders).

One avenue for choosing trans-diagnostic variables is provided by the Interpersonal Theory of Suicide. This theory posits that high levels of perceived burdensomeness and thwarted belongingness can lead to thoughts about suicide; while an acquired capability to harm oneself is required for individuals to act on those thoughts (Van Orden et al., 2010). One way of acquiring the capability to harm oneself lethally may be through engaging in non-suicidal self-injury (Willoughby et al., 2015). This is also one explanation for the link between non-suicidal self-injury and suicide attempts, where engaging in increasingly lethal forms of non-suicidal self-injury may lead to a suicide attempt or death by suicide (Whitlock et al., 2013). Additionally, while the Interpersonal Theory of Suicide was designed to predict suicidal behaviours, Study 4 aims to test whether variables proposed by the theory are also associated with non-suicidal self-injury (which has been linked to future suicidal behaviour). This is because the vast majority of self-injurious behaviour occurring in the inpatient hospital was non-suicidal self-injury (96% in Study 2 and 3), and associations between IPTS variables and non-suicidal self-injury is supported by recent literature (Assavedo & Anestis, 2015; Willoughby et al., 2015). Indeed, studying associations between perceived burdensomeness, thwarted belongingness, acquired capability and non-suicidal self-injury may help further clarify the relationship between non-suicidal self-injury and suicide attempts.
Therefore, given the large body of evidence connecting risk of non-suicidal self-injury to risk of suicidal behaviour, and the significantly low number of adverse events which are patient reported suicide attempts compared to non-suicidal self-injury in this inpatient hospital; Study 4 aims to use variables proposed by the Interpersonal Theory of Suicide to predict higher and lower risk of non-suicidal self-injury. Any distinction between non-suicidal self-injury and suicide attempts will be made based on patient reports of intent, due to the results of Study 1.

Overall, we suggest that individuals with high initial perceived burdensomeness and thwarted belongingness will also report high initial psychological distress. We aim to test whether individuals high on perceived burdensomeness and thwarted belongingness are also more likely to report sustained high distress, which would place them at high risk of self-injury according to Studies 2 and 3. In addition, we aim to test whether individuals who have engaged in self-injury also report higher acquired capability than those who did not, and if individuals showing high risk trajectories have higher acquired capability than those in lower risk trajectories. If this is the case, then high perceived burdensomeness, thwarted belongingness and acquired capability at admission to hospital would add to the information we have and help make a more informed and precise assessment about which patients are likely to show high risk trajectories. This information can be gathered from clinical risk assessments and combined with routinely collected information, as well as patients’ rate of change in distress during the first few days of treatment to allow early identification and efficient intervention.

Finally, while Studies 2 and 3 excluded inpatients who never reported suicidal ideation, Study 4 aims to check whether high and low risk trajectories of change exist when all inpatients are studied, and not only those reporting suicidal
ideation. This will add to the generalisability of using continuous distress monitoring for assessing risk of self-injury to inpatients who may be high in psychological distress (e.g. high on depression, anxiety, worthlessness and/or not coping) but not actively thinking about suicide at the time of measurement.

Furthermore, while Studies 2 and 3 looked at changes in distress during the first 7 and 10 days of an inpatient admission respectively, after reporting suicidal ideation, Study 4 aims to learn about trajectories of change in psychological distress over an entire inpatient admission. The wider time frame may allow different trajectories of change to be identified, if they exist, and help assess the reliability of grouping patients according to rates of change over an entire period of treatment.

In conclusion, Study 4 aims to measure psychological distress daily among inpatients, and to check if individuals share trajectories of change over their entire admission, which are associated with higher/lower risks of non-suicidal self-injury. If these groups of individuals do exist, then levels of perceived burdensomeness, thwarted belongingness and acquired capability will be measured in each shared trajectory. We predict that individuals at the highest risk of non-suicidal self-injury will show higher, sustained distress during their admission together with significantly higher levels of perceived burdensomeness, thwarted belongingness and acquired capability at the beginning of their admission. If this is the case, then those variables can be measured during risk assessments. If higher levels of those variables are associated with high risk trajectories over and above previously identified demographic and diagnostic variables, they would empirically add to our ability to more precisely determine individuals at the highest risk of self-injury, at the beginning of treatment. When used together with existing indicators of risk measured during risk assessments on admission, we may be able to use this
information to proactively predict and prevent self-injury in this and other clinical populations.
Chapter 5

Study 4: Predicting inpatient non-suicidal self-injury using longitudinal monitoring of psychological distress and the Interpersonal Theory of Suicide: Are perceived burdensomeness, thwarted belongingness, and acquired capability associated with different trajectories of change in distress?

Abstract

Objective: Predicting and preventing non-suicidal self-injury (NSSI) is important due to its association with significant distress and increased suicide risk. Given that inpatients can be divided into those at higher and lower risk of self-injury, based on their shared trajectories of change in psychological distress during treatment; risk assessments could be more precise at pre-determining risk of NSSI by predicting high or low risk change trajectories. We expected that higher perceived burdensomeness, thwarted belongingness and acquired capability (which are associated with suicide risk) will also be associated with high risk change trajectories. Method: A Five-Item Daily Index measured self-reported anxiety, depression, worthlessness, perceptions of not coping and suicidal ideation amongst inpatients of a psychiatric hospital (N=698, 73.2% female; mean age: 42.34, SD=14.82). Latent Growth Curve Analysis determined if groups of inpatients changed in distress at different rates during treatment. Chi Square analyses compared rates of self-injury between groups, and mean difference tests explored associations between perceived burdensomeness, thwarted belongingness, and acquired capability with group membership. Results: High Risk Groups of inpatients (high initial and non/slower remitting distress) were at higher risks of NSSI than Low Risk Groups (rapid remitting and lower initial distress). Significantly higher
levels of thwarted belongingness, perceived burdensomeness and acquired capability were found in the High Risk Groups. Conclusions: Change in psychological distress over time was a better indicator of NSSI risk than initial distress. Preliminary evidence suggests that variables proposed by the Interpersonal Theory of Suicide can help proactively predict risk of NSSI, which may help prevent future NSSI and suicide.

Keywords: Non-Suicidal Self-injury, Interpersonal Theory of Suicide, Longitudinal Monitoring, Latent Growth Curve Analysis, Inpatients.
Predicting inpatient non-suicidal self-injury with longitudinal monitoring of psychological distress; exploring associations with perceived burdensomeness, thwarted belongingness and acquired capability

Clinical risk assessments are essential for mental health care. However, we are unable to predict risk of self-injury with enough precision to target timely prevention strategies (Roy-Byrne, 2013). It may be because risk of self-injury fluctuates over time in response to different stressors (Ben-Zeev, Young, & Depp, 2012). Continuously monitoring factors associated with risk may then improve precision in predicting which at-risk individuals will engage in self-injury. For example, when inpatients’ psychological distress was monitored daily, individuals who began with, and sustained high levels of distress during treatment were at the highest risk of self-injury (Kashyap, Hooke, & Page, 2015; Restifo, Kashyap, Hooke, & Page, 2015). However, while high initial distress suggests higher risk; we cannot yet pre-determine which individuals with high initial distress will show sustained distress. This paper aims to add questions to risk assessments to better gauge risk of self-injury.

Self-injury causes direct and deliberate harm to oneself (Hamza, Stewart, & Willoughby, 2012). There is an important distinction between non-suicidal self-injury (NSSI) and suicide attempts (Nock, 2010; Orlando, Broman-Fulks, Whitlock, Curtin, & Michael, 2015). While intent behind these forms of self-injury differ (Andover, Morris, Wren, & Bruzzese, 2012), engaging in NSSI increases the risk of suicidal behaviours (Dickstein et al., 2015; Giletta et al., 2015; Kashyap et al., 2015; Kimbrel et al., 2014; Klonsky, May, & Glenn, 2013; Orlando et al., 2015; Paul, Tsypes, Eidlitz, Ernhout, & Whitlock, 2015; Scott, Pilkonis, Hipwell, Keenan, & Stepp, 2015; Victor & Klonsky, 2014). The mechanism linking NSSI and suicidal
behaviours is not clear, thus it is important to understand what characterises people at risk of engaging in NSSI, to prevent NSSI and potentially suicidal behaviour.

Efforts to predict self-injury have shown that indicators of psychological distress such as suicidal ideation (Kashyap et al., 2015; Klonsky et al., 2013), depression (Barrocas, Giletta, Hankin, Prinstein, & Abela, 2015), anxiety (Bentley, Cassiello-Robbins, Vittorio, Sauer-Zavala, & Barlow, 2015; Thibodeau, Welch, Sareen, & Asmundson, 2013) worthlessness (O’Connor, Rasmussen, & Hawton, 2014) and difficulties coping with negative affect (Nock, 2010) are associated with increased risk. However, not all individuals experiencing psychological distress will self-injure. Nevertheless, studies and 2 and 3 suggest that continuously monitoring inpatients of a psychiatric hospital on daily measures of psychological distress (depression, anxiety, suicidal ideation, worthlessness, and coping) during treatment, revealed that the group with high initial and sustained distress over 7 days were at the highest risk of NSSI (Kashyap et al., 2015). Longitudinal measures which allow grouping of individuals may then help improve precision in predicting self-injury (Glenn & Nock, 2014; Hamza & Willoughby, 2014).

Therefore, while initial psychological distress is necessary in assessing risk of self-injury, it is not sufficient. Another component is the different ways that individuals change in distress over time (Lutz, Stulz, & Köck, 2009), and change can only be assessed through repeated monitoring. However, knowledge around what characterises these individual differences is unclear. The Interpersonal Theory of Suicide may provide variables which are associated with group membership. It posits that the desire and the capability to engage in suicidal behaviour are separate constructs, and argues that suicidal thoughts can emerge from the simultaneous presence of thwarted belongingness and perceived burdensomeness; but that suicidal
ideation alone will not lead to acting on thoughts (Van Orden et al., 2010). Instead, it suggests the capability to engage in suicidal behaviour needs to be acquired through repeated exposure to painful and/or fear inducing experiences such as habituation to physical pain (Hamza et al., 2012; Van Orden et al., 2010). One way of acquiring this capability may be through engaging in NSSI, which can act as a ‘gateway’ to using increasingly lethal forms of self-injury (Hamza, Willoughby, & Good, 2013; Mundt et al., 2013). While the Interpersonal Theory of Suicide concerns suicide risk, since associations were also found between perceived burdensomeness thwarted belongingness, and acquired capability with NSSI (Assavedo & Anestis, 2015; Willoughby, Heffer, & Hamza, 2015); these variables may be associated with both suicidal behaviour and NSSI. Indeed, engaging in NSSI was associated with higher scores on acquired capability for suicide one year later (Willoughby et al., 2015); which suggests that preventing NSSI could decrease acquired capability to engage in future suicidal behaviours (Willoughby et al., 2015). Therefore, an important step in preventing future suicidal behaviours could be to prevent NSSI. To do this, we need to assess risk of NSSI before it occurs, such as through predicting highest risk group membership.

Therefore, the present study aims to firstly explore whether individuals in this sample can be grouped according to their trajectories of change in psychological distress, and to investigate whether higher perceived burdensomeness, thwarted belongingness and acquired capability are associated with membership of a group with higher rates of NSSI. If this is the case, then burdensomeness, belongingness and acquired capability could be measured in a risk assessment, and individuals identified as potentially high risk can be managed appropriately.
Method

Participants

The number of voluntary inpatient admissions at the hospital from 1\textsuperscript{st} July 2014 to 29\textsuperscript{th} April 2015 was N= 1653. Of these, N= 1385 (83.7\%) completed longitudinal measures of psychological distress at least once. To have at least 3 measures of psychological distress between admission and discharge, patients were chosen if they had a minimum length of stay of five days (N=1376); as three responses are the minimum number for the required longitudinal analysis (Stulz & Lutz, 2007). N=698 individuals completed the continuous measure at least 5 times (including measures at admission and discharge), and the longitudinal analysis was conducted with this sample (see Figure 6 for flow diagram).

Patients admitted to hospital between 1\textsuperscript{st} July 2014 and 29\textsuperscript{th} April 2015 were also invited to complete measures related to risk of self-injury at admission and discharge (N=271). Individuals were excluded (N=103) if they had completed the risk measures but not the continuous psychological distress measures, because longitudinal analyses for this study could only be performed with both these measures (see Figure 6). Therefore, a sub-set of the sample (N=168) included inpatients who completed longitudinal measures and risk measures. Analyses exploring associations between group membership and measures of risk at admission were done using this sub-sample (N=168).

The final sample of patients included 698 voluntary inpatients at a private psychiatric clinic, where the main primary diagnoses (provided by treating Psychiatrists) using the ICD-10 classifications (National Centre for Classification in Health, 2002) were Mood Disorders (49.6\%), Neurotic, Stress-Related and
Somatoform Disorders (15.5%), Personality Disorders (3.6%), Substance Abuse Disorders (10.5%) and Schizophrenic Disorders (4.4%). Of this sample, 511 were female (73.2%) and the mean age was 42.34 years old (SD=14.82).

Figure 6. Flow chart showing participant selection from inpatient sample (admitted from 1st July 2014 to 29th April 2015).

Socio-economic information was retrieved from the Australian Bureau of Statistics using the socio-economic indexes for areas (SEIFA; Australian Bureau of Statistics (ABS), 2011). SEIFA scores rank areas according to the relative advantage/disadvantage and collective socio-economic characteristics of people living within a certain postcode. Lower scores indicate relatively more disadvantaged people living within an area (1-10; Pink, 2011). This information was collected during the census in 2011, and in this sample, 85.9% of participants lived in areas with SEIFA scores of above 5, indicating higher socio-economic
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Written informed consent for participation in the study was obtained upon admission to the hospital, and ethics was obtained from the University’s Human Research Ethics Office.

**Measures**

The **Five Item Daily Symptom Index (DI-5)** (Dyer, Hooke, & Page, 2014) measured longitudinal clinical change and tracks patients’ daily perception of psychological distress. Patients rate frequency and severity of symptoms a six-point Likert scale; “Over the previous 24 hours I have felt [anxious]” where responses range from 0 (“at no time”) to 5 (“all of the time”). Higher scores indicated more psychological distress (Dyer et al., 2014). The DI-5 measures anxiety, depression, suicidal ideation, worthlessness and perceptions of not coping; and is appropriate for use with a psychiatric sample for the following reasons. It correlated well with measures of mental health such as the SF-36 Mental Health ($r = -0.69, p < 0.01$) and depression (DASS- Depression; $r = 0.65, p < 0.01$) (Dyer et al., 2014). It also exhibited high internal consistencies (Cronbach’s $\alpha = 0.88 \& 0.82$; (Dyer et al., 2014; Kashyap et al., 2015), good test re-test reliability ($r = 0.75$ (Dyer et al., 2014)) and construct validity (Dyer, Hooke, & Page, 2016) in clinical samples. The DI-5 Index showed high internal consistency (Cronbach’s $\alpha = 0.87$) and DI-5 Index sores on day 1 correlated well with measures of depression (DASS-Depression) at admission ($r = 0.77, p < 0.01$) in the current sample. This study used the sum of scores of anxiety, depression, suicidal ideation, worthlessness and perceptions of not coping on each day (DI-5 Index) as a continuous variable.

The **Interpersonal Needs Questionnaire (INQ)**; (Van Orden, Cukrowicz, Witte, & Joiner, 2012)) consists of 15 items which measure current beliefs about the
extents to which individuals feel like a burden to people in their lives (perceived burdensomeness, nine items) and the extent to which they feel connected to others (thwarted belongingness, 6 items; (Van Orden, Witte, Gordon, Bender, & Joiner, 2008)). Items are scored on a 7-point Likert scale, and higher scores indicate higher levels of burdensomeness (PB) and higher belongingness (TB) (Van Orden et al., 2008). Both the PB (α=.85) and TB (α=.89) sub-scales were found to have good internal consistency in a sample of undergraduates (Van Orden et al., 2008). The 15-item INQ was also reliable in a clinical sample, and had good convergent validity with related interpersonal constructs (social support and social worth; (Van Orden et al., 2012). Finally, both the PB (α=.92) and TB (α=.84) scales showed good internal consistency and were significantly correlated with frequency of thoughts of suicide (TB: r=.35, p<.01; PB: r=.38, p<.01) measured by the Self-Injurious Thoughts and Behaviours Interview (SITBI; Nock, Holmberg, Photos, & Michel, 2007) in the current sample.

The Acquired Capability with Rehearsal for Suicide Scale (ACWRSS (AC); George, Page, Hooke, & Stritzke, 2016) measures three facets of acquired capability. The 6-item ACWRSS scale consists of three subscales measured by two items per subscale, scored on a 9 point Likert scale (ranging from 0=agree not at all to 8= agree very strongly), where higher scores indicate higher acquired capability (George et al., 2016). The subscales are Pain Tolerance (“I can tolerate pain much more than I used to”, “I have learned to overcome fear of pain”); Fearlessness of Death (“picturing my own death is a very scary thing for me”, “even if I wanted to, killing myself is too scary to follow through with it”; these items are reverse scored), and Preparation for Suicide (“I have thought of ways to kill myself that would be the least difficult for me to pull off”, “I have considered whether some ways to kill myself
would be easier than others”; (George et al., 2016). The 6-item ACWRSS was found to have good internal consistency in a subset of the current clinical sample (N=108, \(\alpha=.88\); (George et al., 2016)), and in the current sample (N=158, \(\alpha=.83\)). Total ACWRSS scores in the current sample were associated with prior suicide attempts \((r=.38, p<.01)\), frequency of thoughts of suicide \((r=.59, p<.01)\), frequency of NSSI thoughts \((r=.32, p<.01)\), and frequency of prior non-suicidal self-injury \((r=.32, p<.01)\), measured by the SITBI (Nock et al., 2007).

**Self-injury**

Hospital staff recorded incidents on the risk management database following a standard recording of “risk events” by Australian hospitals. This included descriptions of the incident, date and time it occurred and any actions taken. Incidents were coded as non-suicidal self-injury (1), suicide attempt (2) and suicide (3). Possible actions were; requiring no intervention/minor intervention/medical assessment/enhanced level of observation; transfer to medical facility or early discharge.

**Procedure**

The DI-5 Index was made available daily to all inpatients excluding (i) individuals who decided not to participate; (ii) patients who were being admitted or discharged on any particular day where measurements were taken; (iii) those patients on leave; and if, due to factors such as cognitive impairment, clinical staff decided it was not appropriate.

Patients were invited to complete the DI-5 on computers every day during their admission as part of routine hospital data collection. De-identified DI-5 measurements were provided to authors. Scores for the five items on the DI-5 Index
were added together to act as indicators of psychological distress at each time point. The first and last data point for each patient was their admission and discharge scores. The rest of their three scores included their first DI-5 measurements from each tricile of their admissions. The first available score from the day which was the first 33%, the second 33% and final 33% of their hospital admission were used as time points in between admission and discharge scores. Tricile scores were used to account for the differences in lengths of stay across patients. Measures of perceived burdensomeness, thwarted belongingness and acquired capability were administered by nurses to all patients as an optional measure from 1st July 2014 to 29th April 2015.

**Statistical analyses**

Latent Growth Curve Analysis (LGCA; Singer & Willett, 2003) was run using the *Mplus* software (Muthén, 2010) to examine if distinct sub-groups of individuals exist who share patterns of change on the DI-5 Index over ten days. The Parametric Bootstrapped Likelihood Ratio Test (BLRT; Nylund, 2007)), Bayesian Information Criteria (BIC; Schwarz, 1978), Vuong-Lo-Mendell-Rubin Likelihood Ratio Test (LMR-LRT; Lo, Mendell, & Rubin, 2001); and higher log-likelihood values were examined when choosing the optimal number of latent classes. Higher posterior probabilities, which indicate probability for most likely latent class membership (Jung, 2008), and higher entropy were also studied. Chi square analyses (effect size = phi; Field, 2005) tested associations between group membership and self-injury. Mean difference tests were used on the subset of individuals who completed the DI-5, INQ and AC scales (N=168) to study variables associated with group membership and differences in acquired capability between those who engaged in NSSI, and those who did not. Finally, logistic regression (Field, 2005) was used to measure which items on the INQ and AC scales accounted
for the most variance in high risk group membership (if any), and if those items were
associated with high risk trajectories over and above variables identified in studies 1
and 2 (i.e. age, gender, diagnoses).

**Results**

Full information maximum likelihood was used to deal with missing data
(Graham, 2009). Little’s MCAR tests were non-significant on the DI-5 Index,
suggesting that no systematic patterns of missing data were present which could
confound results. Individuals selected for the LGCA (N=698) did not significantly
differ from the larger sample (N=1385) on demographics (age: \( t=1.3 \) (1383),
p=.20)or clinical variables measured by the DASS-21 at admission to hospital, on
either the depression (\( t=-1.71 \) (1289), p=.08), anxiety (\( t=-.87 \) (1295), p=.39) or
stress (\( t=-1.08 \) (1265), p=.28) sub-scales.

**Determining the number of latent classes**

Since change in distress during treatment was found to occur in a negatively
accelerated trajectory (Lutz et al., 2009), log-linear trajectories were used. To obtain
the most reliable log-linear LGCA solution, the number of classes being explored
stopped increasing when the LMR-LRT became non-significant (Nylund, 2007).
Successive classes demonstrated improved fit until the 5 class solution was explored.
When considering fit statistics, the 4 class LGCA solution (see Figure 7) provided
the most reliable fit (Table 5; (Jung, 2008)).
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Figure 7. LGCA showing observed means for the 4 class solution (N=698). Note:

Time 1= admission, Time 2= trecile 1, Time 3= trecile 2, Time 4= trecile 3, Time 5=discharge.

Table 5. LGCA Model Fit Indices for the DI-5 Index N=698

<table>
<thead>
<tr>
<th>Number of Classes</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Log-Linear</td>
<td>-8830.75</td>
<td>-8675.72</td>
<td>-8611.09</td>
<td>-8590.61</td>
</tr>
<tr>
<td>Adj. BIC</td>
<td>17695.83</td>
<td>17396.07</td>
<td>17277.09</td>
<td>17246.46</td>
</tr>
<tr>
<td>Entropy</td>
<td>0.84</td>
<td>0.78</td>
<td>0.81</td>
<td>.79</td>
</tr>
<tr>
<td>Posterior</td>
<td>.93, .96</td>
<td>.89, .91, .92</td>
<td>.91, .92, .87, .83, .93, .92, .92, .88, .72, .88</td>
<td></td>
</tr>
<tr>
<td>LMR-LRT</td>
<td>p&lt;.01</td>
<td>p&lt;.01</td>
<td>p&lt;.01</td>
<td>p=.10</td>
</tr>
<tr>
<td>BLRT</td>
<td>p&lt;.01</td>
<td>p&lt;.01</td>
<td>p&lt;.01</td>
<td>p&lt;.01</td>
</tr>
</tbody>
</table>
Table 5 shows that the 4 class solution provided the most reliable fit.

**Measuring Non-Suicidal Self-injury (NSSI)**

Fifty five individuals engaged in self-injury at least once. Only the first incident of self-injury (yes/no) per admission was analysed in this study. Four individuals reported suicide attempts, and since this study aimed to predict NSSI, they were excluded. Therefore, of the 51 NSSI events; 37 (72.5%) were cutting, 9 (17.6%) were burning, 2 (3.9%) were head-banging, and 3 (5.9%) were other forms of self-injury.
Figure 8. Groups of inpatients from July 2014 to April 2015 and associated risk of NSSI. Note: NSSI Risk = number of individuals who engaged in NSSI at least once during their hospital inpatient admission.
Exploring rates of NSSI in each group

The rate of NSSI in each group was the number of individuals who engaged in NSSI during their admission at least once. These were compared across the four groups (see Table 6). Table 6 shows that High Start Non-Remitters had higher rates of NSSI than all other groups. High Start Slow Remitters had higher rates of NSSI than Low Start Remitters, but not Rapid Remitters.

Due to the small number of individuals grouped as High Start Non-Remitters (7.7%) compared to the other three groups, to improve the statistical power for the following analyses, the two groups with higher and lower rates of NSSI than the sample base rate (7.22%) were combined to form High Risk Groups and Low Risk Groups respectively (see Figure 8). Indeed, when High Start Non-Remitters and High Start Slow Remitters were combined (High Risk Groups), their rate of NSSI was significantly higher than both Rapid Remitters and Low Start Remitters, and higher than a combination of these two groups (i.e. Low Risk Groups).

Table 6. Chi-square ($\chi^2$) tests for differences in rates of non-suicidal self-injury between groups on the DI-5 Index (N=694)

<table>
<thead>
<tr>
<th>Differences in Association With Self-injury</th>
<th>$\chi^2$ Value (df=1)</th>
<th>Significance</th>
<th>Effect Size ($\Phi$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>40.95 (df=3)</td>
<td>$p&lt;.01$</td>
<td>.24</td>
</tr>
<tr>
<td>High Start Non-Remitting vs. Low Start Remitting</td>
<td>44.25</td>
<td>$p&lt;.01$</td>
<td>.41</td>
</tr>
<tr>
<td>High Start Non-Remitting vs. Rapid Remitting</td>
<td>20.13</td>
<td>$p&lt;.01$</td>
<td>-.26</td>
</tr>
</tbody>
</table>
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<table>
<thead>
<tr>
<th>Comparison</th>
<th>t</th>
<th>p-value</th>
<th>r</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Start Non-Retaining vs. High Start Slow Remitting</td>
<td>10.68</td>
<td>&lt;.01</td>
<td>-.22</td>
</tr>
<tr>
<td>High Start Slow Remitting vs. Low Start Remitting</td>
<td>11.99</td>
<td>&lt;.01</td>
<td>.17</td>
</tr>
<tr>
<td>High Start Slow Remitting vs. Rapid Remitting</td>
<td>1.29</td>
<td>.25</td>
<td>.05</td>
</tr>
<tr>
<td>Rapid Remitting vs. Low Start Remitting</td>
<td>6.57</td>
<td>&lt;.05</td>
<td>.12</td>
</tr>
<tr>
<td>High Risk Groups vs Rapid Remitting</td>
<td>6.28</td>
<td>&lt;.05</td>
<td>.12</td>
</tr>
<tr>
<td>High Risk Groups vs Low Start Remitting</td>
<td>21.29</td>
<td>&lt;.01</td>
<td>.22</td>
</tr>
<tr>
<td>High Risk Groups vs Low Risk Groups</td>
<td>18.46</td>
<td>&lt;.01</td>
<td>.16</td>
</tr>
</tbody>
</table>

Variables associated with groups (N=168)

Our next aim was to check if variables described by the Interpersonal Theory of Suicide were associated with group membership. Therefore, whether or not individuals in the High Risk Groups have significantly higher perceived burdensomeness, thwarted belongingness and acquired capability than those in the Low Risk Groups was explored using independent t-tests; and acquired capability among individuals who engaged in NSSI versus those who didn’t was studied.
Perceived Burdensomeness and Thwarted Belongingness

Mean perceived burdensomeness scores in the High Risk Groups (µ=19) were higher than the Low Risk Groups (µ=13.4; t=-3.13 (166), p<.01). Similarly, mean thwarted belongingness scores in the High Risk Groups (µ=32.5) were higher than the Low Risk Groups (µ=27; t=-3.03 (166), p<.01). Furthermore, within the High Risk Groups, both mean perceived burdensomeness and thwarted belongingness were higher among High Start Non-Remitters (burdensomeness: µ=26, belongingness: µ=38.38) than High Start Slow Remitters (burdensomeness: µ=17.56; t=-2.21 (45), p<.05; belongingness: µ=31.26; t=-2.02 (45), p<.05).

Finally, both mean perceived burdensomeness and thwarted belongingness scores were significantly higher among High Start Non-Remitters (burdensomeness: µ=26, belongingness: µ=38.38) compared to Rapid Remitters (burdensomeness: µ=17.00; t=2.50 (76), p<.05; belongingness: µ=30.69; t=-2.24 (76), p<.05). Therefore, among individuals reporting high levels of distress at the beginning of treatment, higher perceived burdensomeness and thwarted belongingness scores can distinguish between individuals who will likely improve rapidly versus those who will sustain high distress.

Acquired Capability

Mean total acquired capability scores in the High Risk Groups (µ= 26.38) were higher than the Low Risk Groups (µ= 19.17; t=-3.98 (156), p<.01). Mean differences for all the acquired capability subscales in the High Risk Groups were also higher than the Low Risk Groups (Preparation for Suicide: HRGµ=10.09, LRGµ=6.72; t=-3.95 (156), p<.01; Pain Tolerance: HRGµ=7.59, LRGµ=5.62; t=-2.85 (156), p<.01; Fearlessness about death: HRGµ=8.70, LRGµ=6.82; t=-2.46 (156), p<.01). Furthermore, mean total acquired capability scores were significantly
higher among High Start Non-Remitters ($\mu=30.75$) than Rapid Remitters ($\mu=22.08$; $t=2.23$ (72), $p<.05$). This suggests that higher acquired capability scores at the beginning of treatment can also distinguish between individuals who will improve rapidly, versus those who do not improve at all.

**Efficient risk screening**

The next step was to determine if there were certain items in the INQ and AC scales which accounted for the most variance in odds of being grouped amongst those at higher risks of NSSI. We aimed to check if some items accounted for more variance than others, in an effort to create efficient risk screening tools, rather than administering entire scales during risk assessment interviews. The INQ and AC scale items were then used to predict membership of the High Risk Groups in logistic regressions.

Logistic regression showed that all the items in the INQ and AC scales together accounted for 32.2% (Nagelkerke $R^2=0.322$) of variance in membership of High Risk Groups. Forward LR logistic regression showed that “these days I think I am a burden on society” (ExpB=1.53 ($B=.43$, $SE=.13$), 95% CI=1.20-1.96, $p<.01$) and the Preparation for Suicide subscale of the AC scale increased odds of being in the High Risk Groups (ExpB=1.12 ($B=.02$, $SE=.15$), 95% CI=1.02-1.23, $p<.05$). Conversely, “these days, I think my death would be a relief to the people in my life” decreased odds of being in the High Risk Groups (ExpB=.78 ($B= -.24$, $SE=.12$), 95% CI= .62-.99, $p<.05$). These questions alone accounted for 24% of variance in odds of being in the High Risk Groups.

We then aimed to check if those questions were associated with high risk group membership over and above previous associates of high risk trajectories.
Previous studies (Kashyap et al., 2015) found that younger age, female gender and certain diagnoses (Borderline Personality Disorder (BPD) and Substance Abuse Disorders) were associated with higher risk trajectories. Therefore, stepwise logistic regression analyses were conducted where age, gender and diagnoses (Substance Abuse and Borderline PD) were added as predictors as in a first step, followed by “these days I think I am a burden on society”, “these days, I think my death would be a relief to the people in my life” and the Preparation for Suicide sub-scale of the AC scale (“I have thought of ways to kill myself that would be the least difficult for me to pull off”, “I have considered whether some ways to kill myself would be easier than others”; George et al., 2016). Only younger age (ExpB=.96 (B=-.04, SE=.02), 95% CI=.93-.99, p<.01), feeling like a burden on society (ExpB=1.50 (B=.40, SE=.13), 95% CI=1.15-1.92, p<.01) and higher scores on suicide preparation (ExpB=1.11 (B=.10, SE=.05), 95% CI=1.01-1.22, p<.05) were significantly associated with high risk trajectories, and this model accounted for 34.1% (Nagelkerke R²=0.341) of variance in odds of having a high risk trajectory.

Therefore, one item from the INQ, one AC sub-scale and younger age were associated with significantly increased chances of being grouped among those at the highest risk of NSSI, even after accounting for gender and diagnoses. This suggests that these items from the INQ and AC scale (together with age) can empirically improve our ability to proactively detect which individuals, among those reporting high initial psychological distress, are more likely to show little or no improvement. This trajectory would place them at the highest risk of engaging in NSSI, and so these items would be valuable additions to clinical risk assessments.
**Discussion**

This study aimed to proactively determine which inpatients were at higher risks of non-suicidal self-injury (NSSI). We aimed to check if variables from the Interpersonal Theory of Suicide can be applied to predicting risk of NSSI, by checking if they are associated with membership of high risk NSSI groups. Four groups of individuals who shared trajectories of change in psychological distress at different rates were found (see Figure 7). High Start Non-Remitters, who began with the highest initial distress and reported no improvement, were at the highest risk of NSSI, followed by High Start Slow Remitters. When individuals who shared higher risk trajectories were combined into High Risk Groups, their rate of NSSI was higher than Rapid Remitters and Low Start Remitters separately; and when these lower risk trajectories were combined (i.e. Low Risk Groups; see Figure 8 and Table 6). Therefore, high initial distress plus no/slow improvement placed individuals at higher risks of NSSI than rapid improvement/lower initial distress. In this way, repeated monitoring of psychological distress and grouping according to reported changes over time allowed dynamic data to define a dynamic risk state.

This study then aimed to check if measuring potential predictors of risk could help proactively predict high risk change trajectories, with the aim of using these measures in clinical risk assessments. Potential predictors of high NSSI risk were variables thought to be associated with suicide risk according to the Interpersonal Theory of Suicide. These were, higher perceived burdensomeness, thwarted belongingness and acquired capability (Van Orden et al., 2010). We expected that two groups beginning with high psychological distress and reporting the slowest remitting distress (i.e. High Risk Groups), would have significantly higher scores on those variables than groups which showed rapidly remitting and lower initial
psychological distress (Low Risk Groups). Results supported this hypothesis, and suggested that mean burdensomeness and belongingness scores were significantly higher in the High Risk Groups than the Low Risk Groups. Indeed, mean burdensomeness and belongingness scores at admission to hospital were significantly higher among High Start Non-Remitters than Rapid Remitters, suggesting that higher scores on these variables can help distinguish between individuals who would likely show rapid improvement compared to those who would likely show sustained distress, at the beginning of treatment. Therefore, a combination of high initial psychological distress, plus high levels of burdensomeness and thwarted belongingness at admission to hospital may place individuals at risk of being grouped amongst those who do not report improvements in distress. This would also place them at the highest risk of NSSI, and in this way, measuring burdensomeness and belongingness at the beginning of treatment can improve our ability to pre-determine who might engage in NSSI among those at risk.

The Interpersonal Theory of Suicide also argues that acquiring the capability to harm oneself will increase the risk of self-injury (Van Orden et al., 2012). Results of this study support this idea as mean total acquired capability was higher among individuals who engaged in NSSI compared to those who did not. Further, mean pain tolerance levels were also higher among those who engaged in NSSI, and this is consistent with a recent study which found that fearlessness of pain amplified the association between suicidal ideation and suicide attempts (Smith, Stanley, Joiner, Sachs-Ericsson, & Van Orden, 2016). Finally, mean AC scores were significantly higher among individuals with a high risk trajectory (i.e. no improvement) versus those with low risk trajectory (i.e. rapid improvement). Therefore, these results provide preliminary support for applying the Interpersonal Theory of Suicide to
predicting risk of NSSI, via predicting higher risk group membership. Specifically, higher perceived burdensomeness, thwarted belongingness and acquired capability were found in High versus Low Risk Groups; and engaging in NSSI was associated with higher acquired capability. Therefore, measuring perceived burdensomeness, thwarted belongingness and acquired capability at the beginning of treatment during a clinical risk assessment could help distinguish between individuals with high initial psychological distress who improve rapidly from those who show sustained distress. Since sustained distress was consistently associated with highest risk of NSSI in this study, and studies 1 and 2; distinguishing between remitters and non-remitters will help identify those at the highest risk.

Finally, out of all the questions on the INQ and AC scales, two items from the INQ scale (“these days I think I am a burden on society”, “these days, I think my death would be a relief to the people in my life”) and the Preparation for Suicide subscale of the AC scale accounted for the most variance in odds of being in a High Risk Group. When these variables were added to a regression which included variables previously found to be associated with high risk group membership (including age, gender, diagnoses (BPD, Substance Abuse Disorders)); only younger age, feeling like a burden on society and higher preparation for suicide were associated with high risk. The INQ and AC items (plus age) were therefore associated with high risk groups over and above gender and diagnoses, suggesting that they have additional empirical value in predicting high risk individuals, and could be added to risk assessment interviews.

These results have important clinical implications, as in this sample; high initial psychological distress suggested the possibility of High Risk Group membership. Higher scores on acquired capability, thwarted belongingness and
perceived burdensomeness significantly distinguished between those who showed rapid improvement compared to those who showed no improvement, and increased odds of having a high risk trajectory. Finally, a lack of improvement in distress during treatment further increased chances of being amongst those at the highest risk of engaging in NSSI. Notably, information about how patients change in distress over time can only be gathered via *continuously* monitoring distress. Therefore, measuring perceived burdensomeness, thwarted belongingness and acquired capability, together with *continuously* monitoring distress can improve precision in risk assessment. This study also suggested that measuring perceived burdensomeness and acquired capability can be done efficiently during risk assessment interviews, where three items can be included.

**Limitations**

There was no significant difference in NSSI risk between High Start Slow Remitters and Rapid Remitters, despite them ending treatment at different levels of distress. This questions the clinical utility of separating these groups, despite their statistical difference. Indeed, due to the small number of High Start Non-Remitters, to complete analyses regarding the interpersonal variables, the two higher risk groups and lower risk groups had to be combined. Future research would require a larger sample of individuals who completed both the continuous measures and measures of burdensomeness, belongingness and acquired capability to allow analyses using four separate groups. This would also allow one analysis which could take into account predictors of group membership as well as risk of NSSI, such as a growth mixture model, rather than the three step approach using LGCA as in this study. Further, the association between NSSI and acquired capability could be due to NSSI being one way of acquiring the capability for suicidal behaviour.
Continuously monitoring distress and the Interpersonal Theory of Suicide, Study 4 (Hamza et al., 2012). More research is needed to clarify the relationship between burdensomeness, belongingness, acquired capability and NSSI. Since those variables were proposed as correlates of suicide risk, and the relationship between NSSI and suicidal behaviour is not clear; future research should explore the impact of factors such as previous NSSI, suicide attempts and psychiatric history. Finally, the three items from the INQ and AC scales together with age only accounted for 34.1% variance in odds of having a high risk trajectory, showing a medium effect size. Future research should investigate these scales further to see if these or other variables can account for more variance in odds of high risk.

Conclusion

Results suggest that continuously monitoring psychological distress can help identify inpatients at higher risks of NSSI, based on how they change in distress over time. Results of this study go on to suggest that measurements of perceived burdensomeness, thwarted belongingness and acquired capability during clinical risk assessments; together with information about initial distress plus change over time, can aid early detection of high risk group membership. Three items from the INQ and AC scales together with younger age were significantly associated with high risk over and above previously identified variables such as gender and diagnoses, suggesting that including them in risk assessments could increase precision in determining which individuals are at the highest risk of NSSI, at the beginning of treatment. Therefore, preliminary results from this study suggest that we can improve our ability to proactively predict which individuals will likely engage in NSSI among those at risk, and administer interventions to prevent NSSI in a psychiatric hospital. Preventing NSSI can reduce distress, and potentially prevent future suicide. However, firm conclusions about applying the Interpersonal Theory
of Suicide to predicting risk of NSSI cannot yet be drawn. Future research should therefore aim to replicate these results with inpatient, outpatient and non-clinical populations to determine to what extent longitudinal monitoring and the Interpersonal Theory of Suicide can be applied to predicting risk of NSSI.
Chapter 6
General Discussion

Despite decades of research, knowledge about risk factors themselves is not enough to predict which individuals engaged in self-injury, and to prevent these adverse events from occurring (Carter et al., 2017; Large et al., 2016; Quinlivan et al., 2017). Hence, the present dissertation aimed to describe and evaluate a novel approach to improving the precision of clinical risk assessments. However, before we discuss the new method, we will first discuss what risk of self-injury means in this dissertation.

Self-injury

The results of Study 1 suggest that we could not reliably differentiate between NSSI and suicide attempts based solely on retrospective clinician reports, and so any distinction between the two forms of self-injury were based on patient self-report. The low levels of inter-rater reliability are consistent with the wider literature (e.g. Silverman et al., 2007) and may have been due to a number of reasons. For example, the data provided to raters (i.e. the descriptions of the incidents) did not always include an explicit statement about the intent behind the self-injurious behaviour. However, even if patients were directly asked about intent after every act of self-injury, researchers have argued that intent itself can be ambivalent, and can change from non-suicidal to suicidal (e.g. Kapur et al., 2013; Miller & Smith, 2008). Therefore, relying on reported intent alone may not be enough to accurately code incidents. Indeed, it has been suggested that NSSI and suicide attempts exist on the same continuum, and can be differentiated based on the severity of the injury, history of self-injury and history of suicidality together (Orlando et al., 2015). This is what future research should continue to explore.
Other reasons for the low reliability may include incident descriptions not containing all the information required for the categories outlined by the scales, or that the scales did not encompass the variety of incidents which occurred in the inpatient facility. Furthermore, since over 90% of self-injurious behaviours in all the samples used for Studies 2-4 were self-reported NSSI, the small number of self-reported suicide attempts prevented us from exploring differences in predictors of NSSI versus suicide attempts. Therefore, distinguishing between predicting risk of NSSI and suicide attempts was not a focus of this dissertation. However, while NSSI and suicidal behaviour are distinct forms of self-injury, a large and growing body of research suggests that engaging in NSSI can increase the risk of future suicidal behaviour (Chesin et al., 2017; Dickstein et al., 2015; Orlando et al., 2015; Zhang et al., 2017). For example, new research suggests that if individuals with mood disorders engaged in NSSI as youth, they were twice as likely to attempt suicide as adults compared to adults who did not engage in youth NSSI (Chesin et al., 2017). Further, among female adolescents, engaging in NSSI fully mediated the relationship between negative emotions and suicide attempts over 6 months (Zhang et al., 2017). Therefore, Study 4 focussed on predicting which inpatients would likely be at higher risks of engaging in self-reported NSSI, where NSSI may act as a distal indicator of suicide risk.

Nonetheless, future research should aim to determine whether the same method of estimating risk would apply to both forms of self-injury. This would require sample sizes large enough to compare numbers of relatively rare suicide attempts to NSSI events. It would also depend on finding a reliable way to retrospectively code self-injurious behaviour as NSSI or suicide attempts, and this is an important avenue for further study.
**Novel approach to predicting risk of self-injury**

The approach was informed by the psychotherapy effectiveness literature, which often suggests that individuals reporting early improvement in psychological distress during treatment tend to have the best overall treatment outcomes (e.g. Lutz, Stulz, & Köck, 2009; Lutz et al., 2014). Thus, we proposed that reporting early improvement during psychological treatment would also be associated with lower risk of self-injury. By the same token, we argued that a lack of early improvement in psychological distress would be associated with a higher risk of self-injury. Testing this hypothesis required individuals’ psychological distress to be monitored continuously during treatment, to identify trajectories of change, and to check if groups of individuals shared trajectories. Results of Studies 2, 3 and 4 all suggest that inpatients at a psychiatric hospital can be grouped according to shared trajectories of change in psychological distress. They also suggest that trajectories indicating high initial, and slower or non-remitting distress were associated with significantly higher risks of self-injury than those showing rapidly remitting distress.

These results applied to short-term change trajectories, where day 1 was defined as the first day inpatients reported suicidal ideation (i.e., over 7 and 10 days, as in Studies 2 and 3); as well as trajectories of change over entire admissions, as in Study 4. Notably, Studies 2 and 3 only applied this method to inpatients who reported suicidal ideation, and may have limited the population to those at the more severe end of the spectrum. Nevertheless, Study 4 looked at all inpatients who completed the relevant measures, where day one was defined as their first day of treatment (i.e. admission to hospital), and results of Study 4 also suggest that early change was associated with a lower risk of self-injury compared to a lack of early change. Another way of interpreting these data could be that a lack of, or very slow
improvement during treatment is what lead to a higher likelihood of engaging in self-injury, possibly due to frustration about non-remitting levels of distress. Nevertheless, results of Studies 2-4 suggest that it was the shape of the trajectory which pointed to individuals who may be at a higher risk, where early improvement was associated with lower risk and a lack of early improvement was associated with higher risk. Therefore, even if higher risk was associated with a lack of improvement due to frustration about not feeling better, it was the non-remitting distress which was associated with the highest risk of self-injury. It is this knowledge which increased precision in determining which patients were likely at the highest risk compared to looking only at initial distress. Therefore, Studies 2-4 provide compelling evidence that certain change trajectories, even when time 1 is defined using different criteria, are associated with higher and lower risks of engaging in self-injury during an inpatient admission.

These results are consistent with the current direction of research into risk prediction, which is moving towards more continuous measurements of risk factors. For example, monitoring suicidal ideation among adolescents at 3, 6 and 12 months post-discharge from hospital revealed that individuals could be grouped according to their rates of change, where three main trajectories were found (Czyz & King, 2015). Results suggested that the group with high, persistent levels of suicidal ideation were significantly more likely to attempt suicide than the two groups showing declining ideation and sub-clinical ideation (Czyz & King, 2015). Therefore, continuously monitoring distress and using trajectories to predict risk of self-injury can be applied to risk of suicide attempts as well as NSSI. These results also support the idea that persistently high levels of distress (or a lack of improvement) are associated with increased risk of self-injury, and that this knowledge gained from continuously
monitoring distress allows a more precise estimation of risk than only one measure of suicidal ideation at hospitalization (Czyz & King, 2015).

Moreover, recent studies have taken the idea of continuously monitoring distress to predict risk even further by monitoring risk factors more frequently and over shorter periods of time. For example, researchers interviewed adults admitted to hospital within 24 hours of a suicide attempt (Bagge, Littlefield, & Glenn, 2017). Using a timeline follow-back methodology, levels of fear, hostility, sadness, and guilt were reported by patients every hour, for the 48 hours prior to the suicide attempt. The time period of primary interest was hours 6-1 before the suicide attempt and measurements of affect during earlier hours were used as a comparison, where the aim was to address the issue of why the attempt occurred when it did, despite potentially high levels of negative affect during the previous day (Bagge et al., 2017). Latent class analysis revealed four sub-groups of individuals, who showed different patterns of changes in negative affect from the control period compared to the case period (6 hours before the suicide attempt). That is, while negative affect was found to increase in the 6 hours prior to the suicide attempt for all participants, one group reported relatively lower distress across both time periods, another group reported a mixture of low and higher distress depending on the type of affect being measured, and one group reported low distress during the control time and high distress during the case period (Bagge et al., 2017). Therefore, authors argued that we cannot assume that all individuals at high risk will display similar patterns of affect change, rather, they suggest that a more individual, patient centred approach to measuring risk continuously is more conducive to predicting risk of self-injury (Bagge et al., 2017). Future research needs to bear this in mind, as even if those at the highest risk can be separated from individuals at lower risks (e.g. based
on a lack of early improvement in distress), there may be variation within the high risk group, and changes in distress levels should continue to be monitored more acutely. However, this study used a retrospective approach to monitoring distress, where patients would have had to estimate their hourly distress levels before attempting suicide. This leaves room for under or over estimating negative affect, whereas a prospective approach may allow for a more accurate trajectory.

Indeed, in a clinical population of adults who had either attempted suicide or who were suicidal, levels of suicidal ideation, hopelessness, loneliness and burdensomeness were measured prospectively, and were found to vary over time (Kleiman et al., 2017). Levels of all these variables even varied over the span of a few hours, and changing levels of hopelessness, burdensomeness and loneliness were positively correlated with changing levels of suicidal ideation (Kleiman et al., 2017). These results further support the idea that factors associated with risk of self-injury, even amongst people at high risk, vary over time and that monitoring them continuously would provide a more accurate picture of an individual’s psychological distress. Further, the positive correlation between changing levels of hopeless, burdensomeness and loneliness with suicidal ideation provide support for the Interpersonal Theory of Suicide, and lends some support to the results of Study 4, where interpersonal variables were significantly higher amongst individuals with higher risk trajectories. Moreover, since burdensomeness and loneliness also varied across time, perhaps future research should aim to measure the interpersonal variables continuously together with the DI-5 measures of psychological distress. According to the results of Kleiman et al. (2017), they may vary along with depression, anxiety, worthlessness, not coping and suicidal ideation, and this added information may improve our accuracy in predicting risk. Furthermore, measuring
interpersonal variables and DI-5 variables more frequently (since risk factors can vary over hours), may further improve the accuracy of risk prediction, and potentially pin point events or changes in distress levels which occurred right before individuals engaged in self-injury. However, while hopelessness and burdensomeness at time T predicted suicidal ideation at T+1, once suicidal ideation was taken into account, hopelessness and burdensomeness were no longer significant predictors (Kleiman et al., 2017). Therefore, more study is needed to identify predictors of changes in negative affect, which may also help predict self-injury. Nevertheless, there is growing support for the idea that when distress is monitored continuously, individuals who report persistently high levels of distress tend to be at higher risks of engaging in self-injury (e.g. Czyz & King, 2015; Kashyap et al., 2015; Restifo et al., 2015). New research suggests that even among those at high risk, levels of suicidal ideation and negative affect can vary dramatically over the span of a few hours and that risk prediction needs to take this into account and use a more “real-time” (Kleiman et al., 2017), patient-centred approach to studying risk.

However, to use this information in a practical way to inform clinical intervention, it was important to explore variables which may be associated with high and low risk change trajectories. Therefore, the next question we aimed to address was how can this information be used to improve clinical risk assessments? 

**Improving precision in risk assessment**

If variables associated with high risk trajectories could be identified, then measuring these at a risk assessment, at the beginning of treatment, could improve precision in predicting who might go on to have a high risk trajectory. Demographic and diagnostic variables such as younger age, female gender and Borderline
Personality Disorder were associated with higher risk trajectories; while male gender and Substance Abuse disorders were associated with lower risk trajectories (see Studies 2 and 3). Conversely, it has been argued that risk of self-injury is trans-diagnostic (Bentley et al., 2015), and so we also explored trans-diagnostic variables as potential predictors of change trajectories. For example, the Interpersonal Theory of Suicide posits that a combination of perceived burdensomeness, thwarted belongingness, and acquired capability increase the risk of engaging in suicidal behaviour (Joiner, 2005). The literature also suggests that engaging in NSSI may increase the acquired capability for individuals to engage in suicidal behaviour (Hamza et al., 2012). Since engaging in NSSI is associated with increased risk of future suicide (Klonsky et al., 2013), Study 4 tested the hypothesis that interpersonal variables were also associated with higher risks of NSSI.

We found that scores for perceived burdensomeness, thwarted belongingness, and acquired capability were indeed significantly higher among individuals showing higher risk trajectories. Furthermore, four variables accounted for the most variance in whether an individual would be grouped into a high risk trajectory after accounting for gender, age, diagnoses and the interpersonal variables. These were younger age, endorsing feeling like a burden on society and endorsing the two preparation for suicide items. Therefore, items measuring whether an individual feels like a burden on society, and whether they have thought about preparing for suicide (“I have thought of ways to kill myself that would be the least difficult for me to pull off”, “I have considered whether some ways to kill myself would be easier than others”) could be added to existing risk assessments. If patients endorse these items at a risk assessment on admission to hospital, their levels of distress can then be closely monitored. If their reported distress does not improve during the early
stages of treatment, then they may go on to have a higher risk change trajectory and targeted interventions can be administered as required.

However, Study 4 only provides preliminary evidence that preparation for suicide and feeling like a burden on society together with younger age are associated with higher risk trajectories. Future research would need to evaluate the benefit of using these three items alone compared to the full scales measuring perceived burdensomeness, thwarted belongingness and acquired capability as predictors of risk. It would also need to investigate the effects of predicting risk of NSSI separate to risk of suicide attempts. In addition, it would be beneficial to administer the scales measuring the interpersonal variables, together with the DI-5 to all individuals involved in such an analysis. A larger sample of individuals who have completed both the DI-5 and interpersonal measures would allow us to detect group membership, risk of self-injury, as well as levels of perceived burdensomeness, thwarted belongingness and acquired capability in a single analysis which can account for all these variables at once. This could be achieved by using a growth mixture model rather than a latent growth curve analysis followed by logistic regressions, as in Study 4.

Nevertheless, results of this dissertation suggest that a stepped approach to risk assessment may improve precision in predicting which individuals are at the highest risk of engaging in self-injury. That is, firstly, Studies 2-4 suggest that individuals who report high initial distress and a lack of early improvement during treatment are at higher risks of engaging in self-injury. Secondly, adding relevant questions to risk assessments associated with higher risk, together with monitoring distress among those patients, would point to individuals who will most likely be at the highest risk (i.e. those who do not report early improvement). If a patient is
found to not report early improvement, specific interventions (e.g. teaching emotion regulation skills; Carter et al., 2017) can be administered at that point, and as often as needed depending on the judgement of their clinician; who will be able to track their trajectory of change in distress during treatment. This could prevent higher risk individuals from engaging in self-injurious behaviour during treatment.

Furthermore, since engaging in NSSI is strongly associated with future NSSI (Fox et al., 2015), preventing NSSI during treatment could prevent future self-injury. This would not only improve wellbeing, but could also reduce the risk of future suicide (Willoughby et al., 2015). Finally, all the steps described above require the repeated monitoring of patients’ psychological distress, and it is this method which can allow clinicians to detect a lack of early change, and adjust their interventions accordingly.

**Broader implications**

This dissertation aimed to improve our ability to predict which inpatients at a psychiatric hospital were at the highest risk of self-injury, with the ultimate aim of preventing these adverse incidents from occurring. While factors associated with risk of self-injury have been identified, our ability to predict who is likely to engage in self-injury is inadequate. The evidence supporting the predictive power of demographic factors such as gender and age is unclear, psychosocial factors such as negative life events could happen to anyone and not everyone who experiences negative events engages in self-injury (May & Klonsky, 2016). Finally, although psychological distress is a consistent correlate of risk of self-injury, psychological disorders can still be weak predictors of suicide attempts (Bentley et al., 2016; Honings et al., 2016). Indeed, a meta-analysis of longitudinal studies which aimed to predict risk found that suicides occurred even among individuals classified as low-risk (Large et al., 2016). This suggests that our health systems need to be modified
to improve risk prediction and the prevention of self-injury. Therefore, using the information already provided by the literature in a novel way (i.e. continuously monitoring psychological distress) is how we proposed to begin to improve precision in predicting risk. To be able to use trajectories to estimate risk, continuous measurement is required, and for continuous measurement to occur, institutions require the infrastructure and technology to facilitate these methods. For example, at Perth Clinic, daily monitoring is made possible due to inpatients being able to rate their levels of distress on a user-friendly, touch screen tablet. These tablets are made available either in their private rooms or by the clinician after group or individual therapy sessions. This also allows the clinician to track the patient’s progress during treatment and provide feedback when necessary (e.g. if the patient is deteriorating). Furthermore, clinical support tools tailored to each patient’s initial distress are also available in this hospital. For example, an algorithm which shows the clinician whether the patient is on track to improving or not, gives the clinician more information about the progress of their patient and whether treatment needs to be changed or adjusted.

The effect of progress monitoring together with adjusting interventions accordingly has been widely studied. For example, one meta-analysis suggests that regular feedback to patients about their progress can improve treatment outcomes (Shimokawa, Lambert, & Smart, 2010). Further, results of a recent randomised controlled trial suggests that the effects of progress monitoring and providing feedback to patients are strongest under certain conditions, and one of these conditions is when patients are not improving well (De Jong et al., 2014). Therefore, if patients are not improving, according to results of Studies 2-4, this would also place them at a higher risk of engaging in self-injury. Thus, a stepped approach to
risk assessment may improve precision at predicting risk. The stepped nature of this approach refers to the addition of extra steps during assessment; including adding relevant questions to risk assessments, plus monitoring change in distress repeatedly, together with using change trajectories to provide feedback and adjust interventions. This may lead to improved treatment outcomes, which could then reduce individuals’ future risk of engaging in self-injury. However, a recent Cochrane review suggests that there is insufficient high quality evidence to strongly conclude that providing feedback can improve treatment outcomes, and this is another important area for future study (Kendrick et al., 2016). Nonetheless, the potential for improved risk prediction together with more targeted interventions could lead to preventing self-injury when psychological distress is continuously monitored. The term targeted refers to the idea of honing in on those inpatients at the highest risk of self-injury, identified as a result of the added steps in assessment. While it is unlikely that those at the highest risk will receive more intensive interventions which are withheld from inpatients at lower risks of self-injury, perhaps individuals at the highest risk can be monitored more closely, for a longer period of time compared to those at a lower risk.

It is also important to note that the current sample was made up of inpatients, who attended treatment and completed questionnaires. This limits the generalizability of results to those individuals who sought treatment for psychological distress, and who were willing, or well enough to complete the measures more than once during their inpatient admission. It could be that inpatients who chose not to complete the measures on more than one occasion (see Study 1) were more distressed, thus potentially skewing results towards those who were not as distressed, and possibly at lower risks of engaging in self-injury. However, there
were no differences in depression between samples in studies 2 or 3. Finally, results of this dissertation can be used to make relatively short term predictions about risk of self-injury (e.g. during an inpatient admission), future studies should explore how repeated measures may be used to make longer term predictions about risk.

For example, repeated monitoring could be applied across a range of clinical populations, for purposes other than predicting negative outcomes such as risk. For example, it has been applied successfully to outpatients, where depression was measured monthly (Lutz et al., 2009). Results suggested that a group of patients showing rapid remitting depression was associated with more positive treatment outcomes even 18 months after treatment ended (Lutz et al., 2009). These results are consistent with those of Study 3, where individuals reporting rapidly remitting distress over 10 days were at the lowest risk of self-injury in that sample. Being at the lowest risk of self-injury, and reporting rapid improvement during treatment despite high initial distress suggests that something about the intervention, the individual, or a combination of these two factors may be associated with more positive outcomes. Therefore, future research should explore individual, treatment, and contextual factors associated with patients who show rapid remitting distress during treatment. Studying those individuals who report high initial, but rapid remitting distress in more detail can help identify individual and treatment variables which may be the most advantageous, and can inform the development of future interventions.
Fulbright Scholarship: studying resilience among survivors of torture and trauma at the Bellevue/NYU Program for Survivors of Torture

One area where the process of repeated monitoring would be particularly helpful is among asylum seekers and refugees. That is, if psychological distress among individuals who have experienced significant trauma and are currently undergoing psychological treatment can be monitored continuously, perhaps a group of individuals will be found who show rapidly remitting distress. If individual, treatment, and contextual factors associated with rapid remitting distress can be identified, then treatment for an often under-resourced clinical population can be made more effective and efficient. However, given the limited means often available to clinics which provide services to this client population (e.g. the Bellevue/NYU Program for Survivors of Torture, New York City), significant barriers related to funding and clinical resources would need to be overcome for such a study to be conducted. Indeed, devoting significant resources to repeated monitoring (especially attempting to measure distress hourly) is a problem that many clinical institutions will need to resolve, and it may represent a significant obstacle to modifying the way our mental health systems work. Nevertheless, the growing number of clinical studies which are using continuous measurements suggests that it is possible, and the process of repeated monitoring should be advocated for by the clinical community.

Limitations and conclusion

Firstly, we were not able to study the ability of this new approach to predict risk of NSSI and suicide attempts separately. This may have improved our understanding of the similarities and differences between the two forms of self-injury. Indeed, since NSSI can be one way of acquiring the capability to engage in
suicidal behaviour, the positive relationship between NSSI and acquired capability found in Study 4 could be because they are measuring the same concept. Secondly, the groups of inpatients who shared trajectories of change in psychological distress were statistically different; however, there were no significant differences in risk of self-injury between high start slow remitters and medium start remitters in Study 3, and between high start slow remitters and rapid remitters in Study 4. Therefore, it is not clear whether the grouping is clinically significant or stable over time. Grouping individuals using techniques such as latent growth curve analysis is still a statistical estimation of best fit, and it does not represent every single individual’s trajectory of change. Thirdly, the effect sizes associated with predictors of high and low risk trajectories such as Borderline Personality Disorder, Substance Abuse Disorders, age and gender were small. Nevertheless, while the interpersonal variables together with younger age accounted for a moderate amount of variance in having a high risk trajectory, more research is needed into individual, contextual and treatment variables, and how they might interact, to check if there are factors with large effects on risk. This is what would make risk assessments precise enough to prevent self-injury from occurring. Further, studies in this dissertation did not take into account previous suicidality, previous NSSI, reasons for admission (e.g. suicidality) and psychiatric history. This added information would provide a richer pool of information from which risk of self-injury can be assessed in the future. Finally, the DI-5 was chosen as a measure of psychological distress as it was already used as part of routine hospital data collection, this may have limited results compared to more than one measure of distress being used.

Another issue to note that any change in risk assessments are limited to the context of inpatient mental health treatment facilities, where inpatients have access
to and appear to be willing to complete self-report measures. This may not have an
effect on rates of self-injury among individuals who never seek treatment, or for
those individuals who might be too unwell to complete measures. Indeed, even if
risk assessments were more accurate and precise in this inpatient setting, it is
unlikely that patients found to be “lower risk” would have less intensive
interventions, as withholding treatment would be unethical. Therefore these results
may be better placed in the contest of a multi-layered prevention model, which was
found to be effective at reducing suicide rates in the US Air Force (Knox et al.,
2010). This intervention included involving military leadership, providing
psychoeducation about suicide prevention as part of professional military training,
community education on suicide prevention, providing guidelines to commanders on
how to use mental health services, and other integrated service delivery processes
(Knox et al., 2010). Perhaps educating mental health service providers (in both
inpatient, and primary care facilities), consumers, and the community at large about
risk factors for self-injury, progress monitoring and the risks of non-remitting
distress during treatment could be one way of using these results to inform public
health education around prevention of self-injury.

Finally, this thesis makes two broad assumptions about our abilities to predict
and prevent suicidal behaviour. First, it assumes that self-injury can be predicted on
an individual level if we can advance our knowledge far enough. Second, it assumes
that prediction of individual risk is needed to prevent self-injury and suicide deaths.
It could be that prediction on an individual level is not necessary for prevention, and
that prevention does not rely solely on our ability to predict extremely rare events.
For example, again, we could learn from public health approaches to preventing
heart attacks (Knox et al., 2004). This public health campaign did not focus on
precise predictions of individuals who would have heart attacks, but found that targeting common risk factors such as diet and exercise was an effective method of addressing the problem of cardiovascular disease (Knox et al., 2004). Furthermore, difficulties in accurately predicting low base-rate events, such as suicidal behaviour, have often been reported. For example, when trying to predict low base-rate violent behaviour, such as lone-actor terrorist attacks, authors suggested that using risk factors alone may not be a useful way of predicting events (Gill et al., 2016). For example, they argue that looking at risk factors in isolation may not be appropriate, as some risk may replace others when they are absent; risk factors may work in clusters, and different risk factors may have stronger influence in different environmental contexts (Gill et al., 2016). Indeed, a meta-analysis of studies which aimed to predict (rare) adverse effects of cardiovascular medication argues that methodological issues involved in predicting such events limit the validity of results (Lane, 2017). For example, one method of dealing with the low rate of adverse events could be to pool the results of drug trials, to limit the number of trials with zero adverse events (Lane, 2017). However, the author argues that the heterogeneity of study factors between different clinical trials means that any finding would need to be interpreted cautiously (Lane, 2017).

Notwithstanding the above limitations, the concept of using change trajectories to estimate risk of self-injury is novel, and builds on research which identified factors associated with an increased risk of self-injury, but was not sufficient to effectively prevent individuals from engaging in self-injurious behaviour. Repeated monitoring of psychological distress therefore allows for a more nuanced, patient centred risk assessment and does not simply use initial distress as a guide for wellbeing. The current literature is pointing towards a more
“real-time” focus for monitoring risk (e.g. Kleiman et al., 2017), and so future studies should aim to build on these results, and lessons learned from public health approaches to suicide prevention by using longitudinal measurements to predict risk, whether they are monthly, weekly, daily, or even hourly. Further study should also seek to reliably distinguish between NSSI and suicide attempts using retrospective clinician reports to help us better understand the differences and similarities between these forms of self-injury. By identifying differential risks of self-injury associated with different trajectories of change, and by providing preliminary evidence suggesting that certain variables are associated with higher and lower risk trajectories; results of this dissertation move us a step forward in making clinical risk assessments more effective.
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APPENDIX 1

Study 2 in published format:


Identifying risk of deliberate self-harm through longitudinal monitoring of psychological distress in an inpatient psychiatric population

Shraddha Kashyap1*, Geoffrey R Hooke2 and Andrew C Page3

Abstract

Background: While cross-sectional correlates of deliberate self-harm, such as psychological distress, have been identified; it is still difficult to predict which individuals experiencing distress will engage in deliberate self-harm, and when this may occur. Therefore, this study aimed to explore the ability of longitudinal measurements of psychological distress to predict deliberate self-harm in a psychiatric population.

Method: Participants (N = 933; age range 14–93 (M = 38.95, SD = 14.64; 70% female) were monitored daily in terms of suicidal ideation, depression, anxiety, worthlessness and perceptions of not coping. Latent Growth Curve Analysis was used to check if groups of inpatients reporting suicidal ideation, who shared early change in measures of psychological distress, existed. Logistic regression tested whether different groups were at higher (or lower) risks of deliberate self-harm.

Results: Four groups were found. Of these, Non-Responders (high symptoms, remaining high) were more likely to engage in deliberate self-harm than patients with high, medium and low symptoms which improved over one week. Group membership was a greater predictor of deliberate self-harm than initial distress scores. Females and patients with personality disorders were significantly more likely to be Non-Responders.

Conclusions: Continuous monitoring and subsequent grouping of inpatients according to their early change in psychological distress provides a novel and practical approach to risk management. A lack of early improvement in psychological distress may indicate a higher risk of deliberate self-harm.

Keywords: Deliberate self-harm, Risk management, Suicidal ideation, Longitudinal measures
previous suicidal behaviour, or both forms of deliberate self-harm [2]. For example, the progression from less lethal deliberate self-harm to more lethal deliberate self-harm might occur through the habituation to physical pain [11,12]. This view has been supported by findings where previous non-suicidal deliberate self-harm was a strong predictor of future suicidal behaviour [4,13]. For example, non-suicidal deliberate self-harm was found to predict suicidal behaviour after controlling for depression [9,13,14], previous suicidal behaviour [13], hopelessness and symptoms of borderline personality disorder [14]. Finally, a prospective study found that non-suicidal deliberate self-harm in adolescents remained a significant predictor of future suicidal behaviour after accounting for depression and previous suicidality [15]. Therefore, exploring predictors of non-suicidal deliberate self-harm among people at risk of suicidal behaviour (e.g., those experiencing suicidal ideation) may help predict and prevent suicidal behaviour. That is, if a first step towards suicidal behaviour is to have thoughts about suicide, and the next step is to acquire the capacity (such as through non-suicidal deliberate self-harm); examining factors associated with non-suicidal deliberate self-harm amongst individuals who already report suicidal ideation might add to the precision with which future suicidal behaviour can be predicted. Indeed, since both non-suicidal deliberate self-harm and suicidal behaviour can increase the risk of future suicidal behaviour (e.g. [15]), both forms of self-injury are referred to as deliberate self-harm for the purposes of this study.

However, one difficulty with prediction may be the focus on taking cross-sectional measurements of potential risk factors of deliberate self-harm, such as psychiatric disorders and psychological distress [16], and expecting them to predict levels of a behaviour which might change over time. For example, a systematic review suggested that while most correlates of deliberate self-harm such as indicators of psychological distress have been recognized retrospectively, there is a lack of knowledge around proximal predictors, which require longitudinal studies to be identified [17]. It has also been argued that further research is needed to identify causal links between risk factors and deliberate self-harm [18]. For example, it is widely known that depression is associated with suicidal ideation, but it is difficult to predict which people with depression who are considering deliberate self-harm will actually engage in deliberate self-harm [18].

The difficulties in prediction may arise because factors influencing the risk of deliberate self-harm vary both within and between days [19]. Therefore, it is hardly surprising that a measurement taken at a single time point may struggle to predict the probability of an outcome, where its likelihood of occurring may fluctuate along with levels of risk factors. For example, items associated with deliberate self-harm such as suicidal ideation [19-21] can change depending on different situations or the presence of certain triggers [19,21]. Indeed, it was found that suicidal ideation in adolescents with Borderline Personality Disorder did not remain stable over 6 months [22]. Therefore, cross sectional measurements may not provide a valid measure of the variability in thoughts or feelings associated with deliberate self-harm at different times [19]. Therefore, it is still difficult to predict who will display deliberate self-harm or when, and with what consequence with sufficient precision to address this problem effectively.

A similar problem exists in psychotherapy research, where scores at the beginning of treatment provided imperfect prediction of post treatment outcomes and provided little information about individual responses to treatment [23]. Recognition of this difficulty led to "patient-focussed" research which suggested that individuals respond to treatment at different rates [24]. Importantly, knowing that people who improved rapidly in the early stages of treatment tended to have a better prognosis [25,26]; allowed researchers to identify the characteristics that distinguished the "early responders" from later responders (or those who deteriorate). Further it was found that groups of people shared distinct patterns of change, and that early improvement resulted in better treatment outcomes [24]. These results suggest that individuals respond to psychotherapy in different ways and that some individuals can be grouped according to shared early treatment responses. It may then be possible to determine who will not respond well to treatment by measuring their changes (e.g. in measures of psychological distress; [27]) during the early stages of treatment, and estimate their outcomes (e.g. deliberate self-harm) based on identified patterns [28]. For example, it is possible that a lack of early change in psychological distress may be associated with higher risks of engagement in deliberate self-harm. Continuously measuring change in psychological distress would then point to individuals who do not make early improvements.

Indeed, previous research showed that when suicidal ideation was monitored daily in an inpatient psychiatric hospital, where day 1 was the first day that inpatients reported suicidal ideation; five sub-groups of individuals were found who changed in their reported levels of suicidal ideation over 7 days at different rates [29]. It was also found that these sub-groups were associated with different levels of risk of engaging in deliberate self-harm, where the group who began with the highest levels of suicidal ideation and did not exhibit any early improvement was at the highest risk [29]. Therefore, to build on those results by studying the effects of other factors associated with both suicidal ideation and deliberate self-harm [6,12,15,27]; the existence of sub-groups
who change at different rates on a combination of indicators of psychological distress, over 7 days of treatment were explored. These factors included: suicidal ideation [20], depression, anxiety [30-32], feelings of worthlessness [33,34] and perceptions of not coping [35-38]. A combination of distress factors were also found to be associated with an even higher risk of deliberate self-harm than one factor alone [34,39]. Therefore, by continuously monitoring combined measures of psychological distress during treatment; any groups of individuals who share early change on those factors can be identified. Risk of deliberate self-harm could then be estimated based on group membership. This estimation could be more precise than using cross-sectional measures of risk factors of deliberate self-harm alone; due to the potential for these factors to fluctuate over time.

In summary, psychotherapy research has shown that individuals can be grouped according to their shared patterns of early change in measures of psychological distress, where early improvements are associated with better outcomes [24,28]. Potential risk factors of deliberate self-harm, such as indicators of psychological distress may fluctuate and can be monitored daily. If individuals can be grouped according to shared early change in psychological distress during treatment, then certain groups may be at higher risks of deliberate self-harm, such as those who do not show early improvement. Identifying if these groups exist, and measuring the rates of deliberate self-harm in each group may improve the precision with which risk is estimated.

In addition, if these groups exist, and one group is at a higher risk of engaging in deliberate self-harm, characteristics which predict group membership should be explored. To this end, it was found that lower self-reported improvements in symptoms during treatment, along with higher symptom severity and younger age at admission to hospital were associated with higher rates of re-admission to hospital in a private inpatient psychiatric facility [40]. Higher rates of re-admission to hospital were also associated with greater problems with deliberate self-harm as assessed by clinical staff [40]. Therefore, number of admissions to this hospital was explored as a predictor of group membership. Furthermore, while the rate of deliberate self-harm in the adult general population is estimated to be between 4-6% and 20% in adult inpatient populations; rates were estimated to be higher during adolescence [2,37], and were found to approach 40% in adolescent inpatient populations [2]. Age was therefore explored as another potential predictor of group membership.

Furthermore, in a sample of 89 adolescents exhibiting recent deliberate self-harm in a psychiatric facility; 87.6% were found to fit diagnostic criteria for at least one psychiatric diagnosis [41]. Indeed, 67.3% of females met criteria for Axis II disorders where Borderline Personality Disorder (BPD) was the most common [41]. It was also found that adolescents exhibiting more and severe BPD symptoms were more likely to engage in deliberate self-harm [42]. Consequently, in the current sample; in addition to demographic variables such as gender, diagnostic categories may prove a useful avenue for exploration of predictors of group membership.

Therefore, this study aims to build upon previous research [29], to check if different groups of inpatients exist who change in their reported overall psychological distress during treatment at different rates. It then aims to explore whether different groups are at higher/lower risks of engaging in deliberate self-harm. Finally, it aims to check if demographic variables such as age and gender; the number of previous admissions to a private psychiatric hospital and diagnoses can predict group membership.

Method
Participants
The relevant measures were made available to inpatients at a 100 bed private psychiatric hospital which specialises in acute mental health care for both day-patients and in-patients, including Psychiatry, Clinical Psychology, Occupational Therapy and Nursing care. All inpatients were invited to complete measures, excluding those who chose not to participate, those that were being admitted/discharged on any particular day of measurement, patients who were on leave, patients not attending treatment, patients who had not yet been allocated a treatment group, and if clinical staff decided it was inappropriate due to factors such as cognitive impairment (e.g. patients undergoing Electro Convulsive Therapy). Further, patients were only chosen if they had a minimum length of stay of seven days, in order to examine changes in distress over several consecutive days. They were then selected if they completed the measure on a minimum of three occasions over seven consecutive days during their current admission (which is the required number of responses for conducting the longitudinal analyses [43]).

The total number of inpatients at the hospital during the time period 1st January 2011 to 13th March 2013 was N = 4258. Of these, N = 2538 (59.6%) completed the relevant measures. This study did not require any follow up measures.

Written informed consent and appropriate levels of consent from all patients was obtained, and the research was approved by the Human Research Ethics Office at the University of Western Australia.

Final selection criteria
The base rate of deliberate self-harm amongst participants (N = 2538) was 4.3%. This population was then
divided into those who never reported suicidal ideation during their admission (N = 1063, *rate of deliberate self-harm* = 0.6%) and those who did report suicidal ideation at least once during their admission (N = 1475, *rate of deliberate self-harm* = 7.1%). Patients who never reported suicidal ideation were excluded from the final sample. This is because this study was interested in rates of deliberate self-harm amongst people who do report suicidal thoughts during treatment, where deliberate self-harm occurring after reported suicidal ideation may indicate an acquired capacity for future suicidal behaviours [10].

This study was also interested in examining how patients expressing suicidal ideation changed in their psychological distress over time. To examine the time-course of changes in distress, it was important to ensure that the first time all patients expressed suicidal ideation was matched. To this end, as in previous research [29], scores for suicidal ideation were aligned with day 1 becoming the first day any patient reported thoughts about suicide.

Of the 1475 individuals who endorsed suicidal ideation, 542 did not complete the measures on at least three occasions. The final sub-sample of participants therefore included 933 voluntary inpatients at a private inpatient psychiatric clinic. Each patient was diagnosed by their treating psychiatrist, and the main primary diagnoses domains using the ICD-10 classifications [44] were Mood Disorders (55.1%), Neurotic, Stress-Related and Somatoform Disorders (18.4%) and Substance Abuse Disorders (9.8%). Cross-sectional measures were also used from this sample to predict deliberate self-harm using logistic regression [45].

**Outcome measures**

**Continuous and cross-sectional predictors of deliberate self-harms**

Clinical change was measured by the Five Item Daily Symptom Index (DI-5; [27]) a self-report symptom index developed to track patients’ perception of psychological distress daily during therapy. Patients were asked to complete the DI-5 Index daily as part of routine hospital data collection, and de-identified data were made available to researchers. The severity and frequency of symptoms were rated by patients on a six-point Likert scale, using the format; “Over the previous 24 hours I have felt [depressed]” with responses ranging from 0 (“at no time”) to 5 (“all of the time”). Items scores were added together and higher scores indicated more perceived psychological distress [27]. The DI-5 measures five separate items including depression, anxiety, worthlessness, not coping and suicidal ideation. This measure was found to be appropriate for use with a psychiatric sample as it correlated well with existing mental health measures such as the SF-36 Mental Health (r = −0.69, *p < 0.01) and depression (DASS Depression; *r* = 0.65, *p < 0.01) [27]. It also exhibited high internal consistency (Cronbach’s α = 0.88) and good test re-test reliability (*r* = 0.75) in a clinical sample [27]; as well as high internal consistency (Cronbach’s α = 0.82) and test re-test reliability (*r* = 0.72, *p < .01) in the current sample. Finally, in the current sample, total symptom scores on day 1 correlated significantly with total DASS-Depression scores at admission (*r* = 0.48, *p < .01). This study used the sum of scores for the 5 items (anxiety, depression, suicidal ideation, worthlessness and perceptions of not coping) on each day (DI-5 Index), for seven consecutive days as an independent and continuous variable.

The addition of scores into one variable (DI-5 Index) was deemed appropriate as confirmatory factor analyses (CFA) found that a one factor model provided good fit to the data in a clinical population [27]. Similarly, in the current sample, criteria described by [46] were used to check if a one factor model adequately fit the data in a CFA. The indices and criteria examined were; standardised root mean square (SRMR; good fit indicated by values close to 0.08 or below), the root mean square error of approximation (RMSEA; good fit indicated by values close to 0.06 or below); and the Tucker-Lewis Index (TLI) and Comparative Fit Index (CFI) which should be close to or more than 0.95 [46]. The CFI (0.98), TLI (0.96) and SRMR (0.03) indicated that a one factor model provided good fit to the data [46]. While the RMSEA (0.08) was close to indicating good fit, modification indices suggested that anxiety and not coping were correlated. After these terms were correlated, the RMSEA became 0.02 suggesting that fit improved absolutely. Overall, the weight of evidence points towards a one factor model providing adequate fit to the data.

The total score on the DI-5 for day 1 for each patient in the sample was used as a cross-sectional measure, to compare predictive abilities on deliberate self-harm with the use of continuous measures over seven consecutive days.

**Deliberate self-harm**

Deliberate self-harm incidents were recorded by hospital staff on the risk management database. The information recorded is part of a standard recording of “risk events” by all Australian hospitals and includes a description of the incident, date and time it occurred and any actions taken. Incidents were categorised as non-suicidal deliberate self-harm (1), suicide attempt (2) and suicide (3), and actions taken were requiring no intervention/minor intervention/ medical assessment/enhanced level of observation; transfer to medical facility or discharged early. For the purpose of this study, only the first incidence of deliberate self-harm for each patient during the current
admission was examined, and only the presence or absence of deliberate self-harm was studied (this included non-suicidal self-injury and suicide attempts).

**Predictors of group membership**

Age, gender, number of previous admissions and diagnoses were explored as potential predictors of group membership. This information was collected as part of normal hospital procedures and was available to authors.

**Procedure**

Patients were invited to complete the DI-5 on a touch screen every day from admission until discharge. Data included pre-treatment and treatment measurements of the DI-5 items for inpatients over seven consecutive days, during their first 30 days of admission; where day 1 was the first day that patients reported suicidal ideation.

**Statistics**

This study first asked; can cross-sectional measurements such as the DI-5 Index on day 1 be used to predict rates of deliberate self-harm in an inpatient psychiatric population? Logistic regression was run deliberate self-harm (yes/no) as the dependent variable and DI-5 scores on day 1 as the independent variable [45].

The study then asked; do distinct sub-groups of individuals exist who share patterns of early change on the DI-5 Index over seven days; are different groups at different risks of exhibiting deliberate self-harm; and do variables such as age, gender, diagnoses predict group membership? To answer these questions, a Latent Growth Curve Analysis (LGCA; [47]) was run using the Mplus software [48] to check for groups of inpatients who change in their psychological distress at different rates. The validity of groups found using the LGCA were tested using chi square analyses, which measured any significant differences between groups and rates of deliberate self-harm [45]. Effect sizes were calculated using the Phi statistic, which measured the strength of association between two categorical variables [45]. This was followed by logistic regression analyses to check for any significant associations of age, gender, or diagnoses with group membership [45].

**Data analysis**

To deal with missing data full information maximum likelihood (FIML) was used [49]. Little’s MCAR tests were non-significant on the DI-5 Index, suggesting that data was missing at random and that no systematic patterns of missing data were present which could confound results. LGCA analyses were then run using a total index variable, where scores for each item were added together on each of the seven time points (days 1–7).

To obtain the best fitting LGCA solution the following indices were examined [50-52]. These included the Bayesian Information Criteria (BIC; [53]) which measures the goodness of fit and parsimony of the model, where a lower BIC indicates better fit [52]. In addition, the Vuong-Lo-Mendell-Rubin Likelihood Ratio Test (LMR-LRT; [54]) and the Parametric Bootstrapped Likelihood Ratio Test (BLRT; [52]) check whether the change in values for models with increasing number of classes is significant [24]. Further, high posterior probabilities (i.e. probability for most likely latent class membership; [50] high entropy (a measure of the quality of classification of individuals into latent classes; [24]) and higher log-likelihood values were also taken into account when choosing the optimal number of latent classes. Finally, based on the recommendations of [52]; the number of classes being explored stopped increasing the first time the LMR-LRT became non-significant. Further, [24] argue that there is substantial data demonstrating that there is a negatively accelerated (or log-linear) relationship between the amount of treatment provided and progress during treatment. Therefore, log-linear latent growth curve models were tested (see Table 1).

**Results**

The 53 incidences of deliberate self-harm for individuals in the sample (N = 933) consisted of the following; 73.6% cutting or scratching, 7.5% punching surfaces, 5.7% burning, two self-reported attempted suicides (3.8%), and other instances of deliberate self-harm (9.4%). Due to the small number of reported suicide attempts (2 out of 53 incidents), and that this study aimed to predict risk of deliberate self-harm based on previously reported suicidal ideation and severity of distress; all forms of self-injury are referred to as deliberate self-harm and

**Table 1 LGCA Model Fit Indices for the DI-5 Index (N = 933)**

<table>
<thead>
<tr>
<th>Number of classes</th>
<th>Log-Linear</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Log-likelihood value</td>
<td>−11675.66</td>
<td>−11384.43</td>
<td>−11262.65</td>
<td>−11212.06</td>
</tr>
<tr>
<td>Adj. BIC</td>
<td>23395.27</td>
<td>22823.81</td>
<td>22591.23</td>
<td>22581.72</td>
</tr>
<tr>
<td>Entropy</td>
<td>.88</td>
<td>.84</td>
<td>.81</td>
<td>.79</td>
</tr>
<tr>
<td>Posterior probabilities</td>
<td>.96, .97</td>
<td>.95, 93, 90</td>
<td>.88, 91, 93, 86</td>
<td>.78, 92, 90, 86, 83</td>
</tr>
<tr>
<td>LMR-LRT</td>
<td>p&lt;.01</td>
<td>p&lt;.01</td>
<td>p&lt;.01</td>
<td>p =.20</td>
</tr>
<tr>
<td>BLRT</td>
<td>p&lt;.01</td>
<td>p&lt;.01</td>
<td>p&lt;.01</td>
<td>p&lt;.01</td>
</tr>
</tbody>
</table>
no distinction was made between suicidal and non-suicidal deliberate self-harm.

It was also found that five individuals engaged in their first incidence of deliberate self-harm before reporting suicidal ideation. These included two incidents of burning, two incidents of superficial cutting and one incident of punching a surface. Their mean age was 31.2 years old (SD = 14.6), and all 5 individuals were female. Since this study aimed to estimate risk of deliberate self-harm in the presence of suicidal ideation and based on early change in distress during treatment; those individuals were excluded from analyses predicting deliberate self-harm. This is because any self-harm occurring before an expression of suicidal thoughts was beyond the scope of this study to predict. However, they were not excluded from the LGCA investigating any sub-grouping according to early change in reported distress, as the first aim of this study was to check if those groups existed in the sub-sample of patients reporting suicidal ideation.

Levels of missing DI-5 responses from participants from days 1–7 were as follows; 0%, 38.4%, 48.1%, 51.2%, 52.6%, 54.1%, 39.5%. Of the sub-sample, 653 were female (70%) and ages ranged from 14 to 93 years old (M = 38.95, SD = 14.64). The rate of deliberate self-harm in this sample (N = 933) consisting only of inpatients who reported suicidal ideation and fit selection criteria was 5.7% (see Figure 1).

**Part 1: predicting deliberate self-harm using a cross-sectional measure**

The predictive value of a cross-sectional measure (initial distress; DI-5 day 1) on deliberate self-harm in the final sample (N = 928), was compared with the predictive value of the DI-5 groups (days 1 to 7). Higher DI-5 scores on day 1 were found to have a weak positive relationship with deliberate self-harm (Exp. B (1.2), p < .01; B = .15 (SE = .04), Nagelkerke $R^2 = .06$). Therefore, the next step was to check if monitoring symptoms and grouping patients according to their rates of change increased power in influencing odds of deliberate self-harm.

**Part 2: latent growth curve analyses**

Table 1 presents the model fit indices for the 2, 3, 4 and 5 DI-5 Index log-linear solutions. The 4 class log-linear solution was chosen as the optimal solution after considering all indices which indicated that it was the most reliable.

Figure 2 shows that individuals could be grouped according to their shared early responses to treatment over seven consecutive days in this clinical population, on the DI-5 Index. These groups were; Responder Low Start Class (19.5%) consisting of patients who reported low symptom severity and improved consistently over the seven days; Responders Medium Start (29.6%) reported medium to high symptom severity and showed early improvement; Responders High Start (28.7%) reported high symptom severity and improved to a smaller extent; and Non-Responders (22.2%) reported high symptom levels and did not improve over the seven days. From this sub-sample, 5 individuals were removed from further analyses due to their deliberate self-harm occurring before an expression of suicidal ideation.

Therefore, of individuals who exhibited deliberate self-harm after reporting suicidal ideation (N = 928); Non-Responders (14.6%) were significantly more likely to self-injure than Responders High Start (4.9%), Responders Medium Start (1.4%) and Responders Low Start (0.6%). However, there was no significant difference in deliberate self-harm rates between Responders Medium Start and Responders Low Start (see Table 2). Finally, 59.6% of the deliberate self-harm events occurred within 14 days of the first time individuals reported having thoughts about suicide (i.e. day 1 of analyses).

Since groups of patients sharing early change were found to exist, and they significantly differed in their rates of deliberate self-harm, the next step in the analysis...
was to check if continuously measuring symptoms provided more predictive power over deliberate self-harm than cross sectional measurements on day 1. Since Non-Responders were at the highest risk of deliberate self-harm, when group membership was regressed on deliberate self-harm as a categorical variable (Non-Responder = 1, other groups = 0), being a Non-Responder significantly increased the odds of deliberate self-harm by an odds ratio of 6.67 (Exp. B (6.67), p < .01; B = 1.89 (SE = .31), Nagelkerke $R^2 = .12$). Further, individuals with personality disorders were significantly more likely to be Non-Responders (Exp. B (4.60), p < .01; B = 1.53(SE = .30), Nagelkerke $R^2 = .04$) where 54.2% (n = 26) of patients with this diagnosis were Non-Responders. Conversely, individuals with substance abuse disorders were significantly less likely to be Non-Responders (Exp. B (.27), p < .05; B = −1.3(SE = .40), Nagelkerke $R^2 = .02$) where only 7.8% (n = 7) of patients with this diagnosis were Non-Responders. Age, number of admissions and other diagnoses did not show significant relationships with being grouped as a Non-Responder on the DI-5 Index.

Discussion

The aims of this study were to determine whether distinct sub-groups of inpatients reporting thoughts about suicide existed based on shared early responses to treatment. It was predicted that some groups would be at a higher risk of deliberate self-harm. It was also expected that when the sum of scores on the DI-5 (suicidal ideation, depression, anxiety, feelings of worthlessness and perceived inability to cope; [27]), was monitored, it would allow for more precision in identifying those at risk of deliberate self-harm than cross-sectional measurements alone (i.e. initial distress measured by DI-5 scores on day 1). Finally, potential predictors of group membership (age, gender, number of admissions to hospital and diagnoses) were explored.

### Table 2 Chi-square ($\chi^2$) tests for differences in deliberate self-harm rates between groups on the DI-5 Index (N=928)

<table>
<thead>
<tr>
<th>Differences in association with deliberate self-harm</th>
<th>$\chi^2$ value (df)</th>
<th>Significance</th>
<th>Effect size ($\Phi$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DI-5 index overall</td>
<td>52.82 (3)</td>
<td>p &lt; .01</td>
<td>.24</td>
</tr>
<tr>
<td>Non-Responders vs. Responders low start</td>
<td>24.78 (1)</td>
<td>p &lt; .01</td>
<td>.26</td>
</tr>
<tr>
<td>Non-Responders vs. Responders medium start</td>
<td>32.00 (1)</td>
<td>p &lt; .01</td>
<td>.26</td>
</tr>
<tr>
<td>Non-Responders vs. Responders high start</td>
<td>12.84 (1)</td>
<td>p &lt; .01</td>
<td>.17</td>
</tr>
<tr>
<td>Responders high start vs. Responders low start</td>
<td>6.50 (1)</td>
<td>p &lt; .05</td>
<td>.12</td>
</tr>
<tr>
<td>Responders high start vs. Responders medium start</td>
<td>56.7 (1)</td>
<td>p &lt; .05</td>
<td>.10</td>
</tr>
<tr>
<td>Responders low start vs. Responders medium start</td>
<td>.70 (1)</td>
<td>p = .40</td>
<td>.04</td>
</tr>
</tbody>
</table>
distress improved the precision with which risk of deliberate self-harm could be estimated in this sample.

For example, Non-Responders (individuals who reported severe symptoms and did not improve over seven consecutive days) were significantly more likely to use deliberate self-harm than any other group (see Figures 2 and 1). Further, when group membership was regressed on deliberate self-harm, being a Non-Responder significantly increased the odds of deliberate self-harm by a factor of 6.67 compared to just 1.20 by higher symptom scores on day 1. In addition, Responders High Start and Responders Medium Start (see Figure 2) began with similar distress severity; but it was the magnitude of change between days 1 and 2 (i.e. early change) which appeared to significantly distinguish them in terms of risk of deliberate self-harm. In this way, the use of daily monitoring made it possible to differentiate between those who were significantly more likely to use deliberate self-harm based on their group membership. It is however, important to note that the monitoring and grouping of inpatients would act as adjuncts to existing clinical risk evaluation procedures. For example, if a potentially high risk individual was flagged via existing risk management procedures, and continuous monitoring revealed that they did not report any improvement by day three; according to Figure 2, they would likely be a Non-Responder. More specifically, by identifying a Non-Responder who was at a 14.6% risk of deliberate self-harm (compared to a population risk of 4.3%, see Figure 1) one can predict with 3.4 times more accuracy if that individual will engage in deliberate self-harm.

Given the potential link between non-suicidal and suicidal deliberate self-harm were studied in this sample, results suggest that a potential shared ‘risk’ is a lack of early improvement in psychological distress during treatment.

In summary, higher levels of psychological distress, together with a lack of early improvement during treatment appear to place individuals in this population at the highest risk of deliberate self-harm. This is consistent with previous research which found that sub-groups of inpatients changing in reported suicidal ideation at different rates were at different risks of engaging in deliberate self-harm [29], and that early change in distress results in more positive outcomes for individuals undergoing psychological treatment [25,26]. Indeed, identifying sub-groups of individuals who change in distress at different rates led to superior predictions in risk of deliberate self-harm than distress scores on day 1 suggesting that continuously monitoring psychological distress amongst inpatients at this psychiatric hospital provided an innovative and useful avenue for risk prediction, and potentially prevention.

Predicting group membership

Preliminary analyses showed that females were more likely to be Non-Responders than males in this sample. It was also found that patients with personality disorders were significantly more likely to be Non-Responders. Given that 47 out of 48 individuals with personality disorders had diagnoses of Borderline Personality Disorder (BPD), these findings are consistent with previous research which found high rates of deliberate self-harm in patients diagnosed with BPD [41] and a study which found higher mortality rates, including death by suicide in female vs. male patients diagnosed with personality disorders [60]. Due to the predominance of BPD, the lack of early improvement in distress amongst Non-Responders, continued high reported levels of negative affect and deliberate self-harm may all be related to other symptoms of BPD such as emotion dysregulation and intolerance of negative affect [61,62]. Still, more detailed analyses are required to determine why gender appears to be a significant predictor of risk, and which aspects of personality disorders contribute to deliberate self-harm. For example, it was found that higher levels of ‘confusion about self’ and ‘unstable interpersonal relationships’ were associated with both repeated non-suicidal deliberate self-harm and suicide attempts amongst adolescents displaying traits consistent with BPD [42]. Nevertheless, the significant associations of gender and diagnoses with group membership suggest that females and individuals with diagnoses of personality disorders should be closely monitored for risk of deliberate self-harm during treatment.
Conversely, having substance use disorders made individuals significantly less likely to be Non-Responders, placing them at a lower risk of deliberate self-harm in this sample. This could be due to inpatients not having access to substances in a psychiatric facility, which would then reduce the likelihood of them engaging in impulsive behaviours such as deliberate self-harm while intoxicated. However, studies have also found associations between substance abuse and deliberate self-harm. For example, one study found that not only was substance abuse associated with deliberate self-harm during adolescence, but that deliberate self-harm increased the risk of substance abuse during adulthood [63]. Further, a systematic review found deliberate self-harm and psychological distress to be significant correlates of substance abuse [64]. Perhaps, the lack of association between being Non-Responders and substance abuse in this sample may also be because only primary diagnoses were examined. Substance abuse may have been a comorbid problem in some cases.

Finally, contrary to expectations, age was not a significant predictor of group membership. This could be due to the wide range of ages found in this sample (\(M = 38.95, SD = 14.64\)), including much fewer individuals under 18 years old (8.2%) than over 18; and results of previous research suggesting that deliberate self-harm is more common, and chronic in adolescents experiencing psychological distress than in adults [2,65]. This may also explain the low overall rate of deliberate self-harm (7.1%) in this sample.

Undoubtedly, relationships between diagnoses and group membership need to be explored in more detail before strong conclusions about risk of deliberate self-harm can be drawn. Further study is important, because if information about group predictors can be used to make accurate predictions of individuals at the highest (and lowest) risk of deliberate self-harm, based on their probable group membership; it can help prevent adverse incidents from occurring at all. Future research should explore more predictors of group membership and any interactions between them. For example, dividing risk factors into demographic (e.g. gender), clinical, psychosocial (e.g. social support) and institutional factors (e.g. staff training) may help disentangle predictors of deliberate self-harm and group membership [66]. Finally, studying relationships between theoretical constructs such as perceived burdensomeness, thwarted belongingness and acquired capability for suicide [10], together with diagnoses and demographic factors; and their effects on group membership may provide characteristics which place individuals at higher risks of deliberate self-harm.

**Limitations**

Firstly, the selection of participants in this study may have resulted in a sample consisting of more severe patients (inpatients for a minimum of seven days, and consisting only of people who reported suicidal ideation). Further, the level of missing data on certain days may limit the generalizability of risk values found in this sample. Missing data on some days may have been due to procedural reasons (e.g. newly admitted patients, or soon to be discharged) or a number of other factors such as a lack of opportunity to complete the measure due to missing a treatment session. Therefore, the numbers in Figure 1 regarding the risk of deliberate self-harm should be interpreted with caution. Rather than absolute risk values which can be generalised to all inpatient populations, they should be seen as the relative difference in risk of deliberate self-harm in this sample. Nevertheless, the process of determining group membership and resulting risk of deliberate self-harm through continuous measurement can still be applied to other populations.

Secondly, since the number of deliberate self-harm events recorded in this sample was based only on those reported by hospital staff; there may have been incidents which staff were not aware of, and this might explain the low reported rate of deliberate self-harm in this population.

Furthermore, it was found that five individuals who exhibited deliberate self-harm did so before reporting suicidal ideation. This could be because these incidents did not indicate an acquired capacity for future suicidal behaviour, or that suicidal ideation developed as a result of the deliberate self-harm. Nonetheless, since this model aimed to predict deliberate self-harm based on changes in psychological distress after self-reported suicidal ideation; predicting deliberate self-harm which did not follow reported thoughts about suicide are beyond the scope of this study.

Finally, it was found that the two individuals who attempted suicide (self-reported) were grouped as Non-Responder and Responder High Start. Therefore, measuring non-suicidal deliberate self-harm and suicide attempts separately; and how they may be distributed in groups provides an avenue for future research with larger samples. Indeed, separating non-suicidal and suicidal deliberate self-harm could help clarify both the link and the differences between risk factors for the two behaviours. This separation may also clarify relationships between any predictors of group membership, and future research should take this into account.

**Conclusions**

Results suggest that amongst inpatients reporting suicidal ideation; the daily monitoring of their indicators of psychological distress allowed them to be meaningfully grouped according to shared early change during
treatment. This grouping allowed significantly more precision in predicting risk of deliberate self-harm according to group membership compared to cross-sectional measures alone. For example, the group with high initial distress and no early change was at the highest risk of deliberate self-harm. Results also suggest that females and those with diagnoses of personality disorders should be closely monitored for risk of deliberate self-harm. These findings present a novel and practical approach for the first steps in mitigating the risk of deliberate self-harm in clinical populations.

Competing interests
The authors declare that they have no competing interests.

Authors’ contributions
ACP and GRH organised data collection at Perth Clinic and supervised the data analysis, interpretation, writing up and editing of this manuscript written by first author SK. All authors read and approved the final manuscript.

Authors’ information
SK, PhD Candidate, School of Psychology, University of Western Australia, Perth, Western Australia. GRH, Director of IT, Perth Clinic, Perth, Western Australia. ACP, Winthrop Professor, School of Psychology, University of Western Australia and Research Consultant at Perth Clinic, Perth, Western Australia.

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Author details
1 School of Psychology, The University of Western Australia, 35 Stirling Highway, Crawley 6009, Western Australia. 2Perth Clinic, 21 Havelock Street, West Perth, WA 6000, Australia. 3University of Western Australia & Perth Clinic, Perth, Western Australia.

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