Risk Stratification

A discussion paper for NSW Health’s approach to Risk Stratification

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# TABLE OF CONTENTS

1. EXECUTIVE SUMMARY .......................... 1

2. BACKGROUND .................................... 4
   2.1 Introduction .................................. 4
   2.2 Objectives .................................... 4
      2.2.1 Developing a Risk Stratification Process ... 5
   2.3 The NSW Context .............................. 5
   2.4 Methodology ................................... 7
   2.5 Target Groups ................................. 7
      2.5.1 Target Groups across the Care Continuum ... 10

3. RISK STRATIFICATION TOOLS AND MODELS .... 12
   3.1 Types of Risk Stratification Tools ............ 12
   3.2 How the tools are applied ..................... 13
   3.3 Risk Stratification Tools and Processes ....... 14
      Tools available across acute settings and Primary Care ... 14
      Tools available in the Primary Care setting ... 15

4. COMPLEXITY .................................... 17
   4.1 Principal Complexity Variables (Refer to Table 3) ... 18
   4.2 Amplifying Complexity Variables ............. 20
   4.3 Complexity Variables - Primary Care data extraction (see Table 3) ... 22
   4.4 Complexity Variables - Inpatient Data extraction (See Table 3) ... 23
      Patient Flow Portal as an Enabler ............... 23
   4.5 Complexity Variables - Emergency Department (ED) and Ambulance -- enabling ‘real time’ flagging ... 25

5. RELATIONSHIP BETWEEN RISK STRATIFICATION & INTEGRATED CARE INTERVENTIONS .... 27

6. CHALLENGES AND OPPORTUNITIES ............ 29
   6.1 General Practice ............................. 29
   6.2 Local Health Districts and Specialty Health Networks (LHDs/SHNs) ... 29
   6.3 Emergency Department (ED) .................... 30
   6.4 NSW Ambulance Service ...................... 30

8. NEXT STEPS ..................................... 31

10. CONCLUSION .................................... 33

11. REFERENCES .................................... 34

12. APPENDICES .................................... 36
    Appendix 1. MATRIX ............................ 36
    Appendix 2 Complexity Weightings ............... 37
    Appendix 3 NBMLHD Admission and Discharge Risk Assessment ... 38
1. **Executive Summary**

The NSW Agency for Clinical Innovation (ACI) has been tasked by the NSW Ministry of Health to develop a tool or approach for identifying patients at risk of a hospital presentation or health deterioration. It is the intention that this process will assist the NSW Health system to direct ‘Integrated Care Strategies’ to those people most in need.

‘Risk Stratification’ uses a process or ‘model’ to identify people likely to suffer health deterioration or an unplanned hospital admission, so that appropriate coordinated care is provided to them. Risk prediction tools or models in isolation have no impact on health outcomes but rather their effectiveness depends on the interventions performed with identified patients\(^1\), and the behaviours that are undertaken at a system and individual clinician level. Risk Stratification is one part of a complex process that optimises technology to provide a prompt for action and a way of thinking about care delivery, and the patient experience.

This discussion paper has been produced to provide information, guidance and background to the development of Risk Stratification or patient selection processes in NSW, and will be the first in a series of papers. It will be followed by further discussion and feedback groups.

A preliminary literature review and consultation processes was carried out to inform this paper. A key finding is that there is no one approach or tool that can be directly transferred into the NSW context. Poor compatibility of data platforms, enabling linkage results in the need to risk stratify across several care settings. These settings will require a combination of ‘real time’ flagging of patients and population based data retrieval.

Risk Stratification across a range of health care settings should provide the trigger for planning, communication and monitoring of care plans. Identified settings for this work are Hospitals, Emergency Departments, Primary Care and Ambulance services. Evidence based, coordinated care strategies should then be planned according to identified need.

Specific criteria that are appropriate to a range of settings have been identified from the evidence, grey literature and consultation process. The criteria have been weighted where the evidence is available. These criteria will need to be built into everyday systems within the NSW Health context and aligned to the Primary Care context. They will then need to be tested, validated and manipulated over time, against the cohort retrieved for predictive validity and accuracy.

**Summary findings include:**

1. There are no international or national Risk Stratification solutions that can be readily applied to the NSW context. A series of complexity variables have been identified for testing and validation in the various settings for identified risk categories

2. Risk Stratification is optimally applied across the whole of the system, but the complexity variables must be tailored and weighted to the setting in which they are applied, such that they identify the population most sensitive to intervention. The moderate risk group are ideally identified in Primary Care or
by Ambulance services. The high and very high groups will most likely be identified in hospital settings.

3. Further work needs to be conducted regarding the process of extraction and recording of some specific data elements from pooled data sets.

4. A social disadvantage measure (living alone), or measures should be considered as a mandatory field item in all data collection systems.

**Primary Care**

5. A data extraction process using nominated identifiers must be tested for validity within a Primary Care environment, with GPs willing to participate. It is recommended that those patients with three or more variables in either the moderate or high risk category should be flagged for specific care co-ordination services.

6. There is inadequate evidence and understanding regarding complexity predictors of hospitalisation from Primary Care. ACI has commissioned further work to confirm and examine the complexity determinants of hospitalisation from Primary Care. This will be undertaken in 2015.

**Inpatient Setting**

7. The data elements identified for hospital based Risk Stratification need to be tested and validated in an inpatient setting using the modified Patient Flow Portal (PFP) to gather a cohort.

8. It would be useful to link the Admission and Discharge Risk Assessment process that is mandatory in every hospital, to the modified PFP to identify moderate and high-risk cohorts for validation.

9. Consult with the Chief Clinical Information Officer (eHealth) to explore the link between the electronic Medical Record (eMR) and PFP with respect to using an electronic system, as a vehicle to support inpatient Risk Stratification.

There are key barriers and challenges that must be addressed in order to successfully develop and implement a Risk Stratification process. The lack of access to linked data will be a challenge to overcome or work around in the short term. The absence of key social determinants in data systems must be addressed in order to accurately reflect risk. Key criteria must be routinely built into and collected through the day-to-day processes to ensure minimal administrative burden and ensure sustainability. Finally, allowing flexibility in the approach for local implementation will be necessary for the varying geographic and demographic regions within NSW. In 2015, consultation will continue with arranged workshops to seek out feedback and promote discussion. In subsequent phases of the process, it will be necessary to further explore application of the process for other priority populations including Mental Health, disability and Paediatrics.

Ongoing investigation of the current systems and data platforms will be essential. The results of the literature review being commissioned will highlight or validate Primary Care determinants of hospitalisation that can be built into the system as it is developed. Piloting the tool/process or model in Primary Care and the acute setting
will be critical to test and improve the approach prior to further development and implementation.

Finally, this approach is iterative with the whole of system learnings along the way incorporated into the process. It is anticipated that healthy discussion and feedback will ensue.
2. **Background**

2.1 **Introduction**

The NSW Agency for Clinical Innovation (ACI) has been tasked by the NSW Ministry of Health to develop a tool or process for identifying patients at risk of a hospital presentation or **health deterioration**. It is the intention that this process will assist the system to direct ‘Integrated Care Strategies’ to those people most in need, and those most likely to benefit from preventive care. Therefore, this process is not necessarily restricted to the high or very high risk population. On the contrary, it encourages full exploration of those patients in the moderate Risk Stratification categories, as the evidence is equivocal as to where the maximum benefit lies for the system and for the individual. Risk Stratification is one step in the process of facilitating timely provision of appropriate care to people, closer to their home.

This discussion paper has been produced to provide information, guidance and background to the development of a Risk Stratification or patient selection process in NSW. It is the first in a series of papers that will be produced concurrently with evolving and developing understanding of Risk Stratification.

A preliminary scan of the international and national literature has been undertaken and a range of tools identified that assess absolute or relative risk elements, either at an individual or a population level. Conceptual guidelines will be provided in determining risk or complexity, with some discussion of integrated care intervention selections matched to identified risk profiles. Certainly, it is important to align evidence based interventions to the risk profile, individual characteristics and the needs of the person. This aspect will require additional review of the literature at a future time.

Risk prediction tools or processes in isolation have no impact on health outcomes but, “rather, their effectiveness depends on the interventions performed with identified patients”, and the behaviours that are undertaken at a system and at an individual clinician level. Risk Stratification is one part of a complex process that optimises technology to provide a prompt for action, and a way of thinking about care delivery and the patient experience.

2.2 **Objectives**

This discussion paper aims to:

- Provide an overview of the NSW context and discuss target groups for Risk Stratification

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* A Risk Stratification tool is a product that uses a standardised process to gather information in a pre-determined manner.

† A risk stratification process or model involves a range of different tools, approaches or guidelines that may be applied with variation to a range of settings
2.2.1 Developing a Risk Stratification Process

The two priority objectives in the application of a Risk Stratification process are:

Priority 1
To develop a Risk Stratification process that will identify the risk of health deterioration and/or hospital admissions for medium, high and very high risk patients who will maximally benefit from integrated care.

Priority 2
To provide decision support guiding appropriate care management for identified levels of risk. Ideally, this will result in targeting and meeting the specific needs of a local population, using local solutions.

2.3 The NSW Context

The costs of healthcare in NSW are expected to rise due to the ageing population and the large number of people who are living with multiple long term medical conditions with physical and cognitive impact. As these patient cohorts often have a high utilisation of inpatient care, it is proposed that they would benefit from more coordinated and integrated care. As such, NSW has invested $120 million in an integrated care strategy to better meet the needs of NSW.

There is strong international evidence that the core capability required to implement integrated care on a population basis is to be able to identify defined populations and stratify groups of patients according to predicted or actual health status, levels of health utilisation or access to acute care services. This is based on the premise that people identified as moderate to high risk will have higher service utilisation, particularly in the acute sector. Data from the United Kingdom illustrates that patients identified as moderate risk have nearly twice as many outpatient attendances, 70% more unplanned admissions and 40% more emergency admissions than the average person. Similarly, a person is more than twice as likely to have excessive health service utilisation if they regularly take between five and nine different medications per month.

However, the key benefit of Risk Stratification, other than providing a cohort of people at which to direct care, is to provoke a communication platform facilitating mutual goal setting between patient and provider, and shared care, understanding and co-ordination of services between providers. This ‘shared care platform’
optimally occurs in the GP environment, for example within a Medical Home, but also ideally by ambulance and community services, Emergency Departments (ED), and by inpatient services, in order to truly effect Integrated Care.

For a Risk Stratification process within a NSW context to be successful in directing timely provision of integrated care and improved outcomes in relation to hospital admissions and the patient experience, the following considerations are necessary:

The Risk Stratification process should:
- focus on person centred care, not system centred care
- provide oversight of all risk groups identified through stratification, enabling local tailoring to address defined target groups that may be linked to the Planning Innovation Fund activity
- address moderate complexity as a priority group, sensitive to interventions
- address multi-morbidity as well as single morbidity and extend beyond the chronic diseases selected by the NSW Chronic Disease Management Program – Connecting Care in the Community (CDMP)
- facilitate responsive communication across the continuum and providers
- result in timely access to health and social services in the community
- be scalable to a whole of system approach
- result in shared cross platform and visible multi-disciplinary plans
- involve ongoing monitoring and review
- consider patient selection for past, present and future admissions

Some critical markers of success of the Risk Stratification and the Integrated Care Strategy are:
- improved patient outcomes
- better patient experience
- more connected and visible provision of services for patients and providers

Much work has been carried out in the area of Risk Stratification for chronic disease management and frail elderly people. Traditionally, risk tools have been developed within medical specialities and for specific conditions, but it is now recognised that those patients who experience multiple hospital admissions or are at highest risk, often have a combination of different health and social care problems that interact with each other. Preventive interventions and risk tools should therefore recognise this phenomenon and attempt to take a broad approach to addressing these issues.6
Risk tools and models are an important part of the strategy for managing patients with chronic illness or conditions. They can be used to identify patients most at risk of future unplanned hospital admissions, and those in the later stages of disease. They can also assist in identifying people with low to moderate risk in other disease categories, or complexity, who may benefit from preventive measure. If accurate, they can direct the necessary preventive interventions efficiently and economically to prevent crises.\textsuperscript{6, 7}

2.4 Methodology

This paper has been informed by a preliminary literature review and initial consultations with key stakeholders. Search terms included Integrated Care, Risk Stratification, Risk Stratification tools, chronic and complex diseases, and preventable hospitalisation. Gaps have been identified resulting in commissioning of a further literature review to be conducted by the SAX Institute. The results of this will be available April 2015.

2.5 Target Groups

NSW Integrated Care Demonstrator sites have selected specific and sometimes tightly defined target groups to apply and test selected integration interventions (e.g. Complex and Aged Health) for those with long term complex and chronic conditions. However, there is a broader issue of directing appropriate care to people with emerging health problems, those with disability and ageing, or those living in the community in vulnerable socioeconomic circumstances compounding a health issue.\textsuperscript{4} There is an assumption, and equivocal evidence, that providing intervention to the very high risk patients changes the trajectory over time. This is clearly dependent on the care that is planned and indeed delivered, and the natural course of disease.

The role of NSW Health and ACI in guiding the system to target identified risk profiles with selected care strategies is critical in bringing about whole of system change. Accordingly, it is useful to think about target groups in relation to their complexity and likelihood for hospital admission. From Figure 1, the top 5\% of patients accessing health care are considered very high risk for hospitalisation. This patient cohort consumes 10\% of the costs, and is likely to have been admitted several times over the last 1-2 years. This cohort can be referred to as \textbf{past admissions}. This group are also highly likely to be admitted this year – referred to \textbf{current admissions}.
The group in the yellow moderate risk zone (15%) and below can be considered **future admissions**, and are therefore highly sensitive to evidence-based interventions addressing key risk factors. Conversely, people in the moderate risk zone are highly vulnerable to hospitalisation, if their risk factors are not addressed and managed. Therefore, intervening at this level is recommended as a priority for future planning. Additionally, Figure 2 demonstrates that there is a substantial group in the moderate risk **yellow/orange** zone that are at tipping point in relation to their risk profile as each year passes.

**Figure 1 Risk and cost distribution for a GP Practice with 10,000 patients in the UK**

<table>
<thead>
<tr>
<th>% of patients</th>
<th>No. of patients</th>
<th>% of cost</th>
<th>Nature of Morbidity</th>
<th>Potential Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>1%</td>
<td>100</td>
<td>10%</td>
<td>High risk – multiple LTCs, frail, social care needs, unstable, end of life</td>
<td>Intensive case management</td>
</tr>
<tr>
<td>4%</td>
<td>400</td>
<td>17%</td>
<td>High risk – multiple LTCs, less unstable, some social care needs</td>
<td>Case management &amp; disease management</td>
</tr>
<tr>
<td>15%</td>
<td>1500</td>
<td>25%</td>
<td>Moderate risk – one or two chronic illnesses and/or risk factors, Health likely to deteriorate over time</td>
<td>Condition management, health coaching &amp; lifestyle management</td>
</tr>
<tr>
<td>80%</td>
<td>8000</td>
<td>48%</td>
<td>Low risk – morbidity due to time limiting, or acute illness rather than chronic conditions. Patients at risk of developing chronic conditions</td>
<td>Health education, health promotion &amp; prevention strategies, lifestyle change programmes</td>
</tr>
</tbody>
</table>

Data available from General Practice reports indicate that preventable hospitalisations correspond with a heightened use of health care services, such as GP visits in the preceding time period. Reports indicate that on average per year, NSW patients have:

- 6.7 GP visits for people with no hospital admissions
- 11.6 GP visits for people with 1 hospital admission
- 14.2 GP visits for people with 2 hospital admissions
- 16.4 GP visits for people with 3-5 hospital admissions
- 20.2 GP visits for people with 6+ admissions

From the data, in the lead up to an admission:

- 14.4% of people saw a GP on the same day
- 31.5% of people saw a GP within 1 week
- 64.9% of people saw a GP within 1 month
- 84.2% of people saw a GP within 3 months

The above data relating to GP visits has been extracted from the preliminary findings from the Assessing Preventable Hospital Indicators (APHID) Study.
This data supports the view that in the lead up to hospitalisation, there are opportunities for interventions that can be initiated from General Practice. There is an assumption that this intervention will change the course of activity and reduce the risk of hospitalisation. The SAX literature review underway will validate or place in question this assumption.

**Figure 2. Percentage of Patients in Each Risk Band (via case mix analysis)**

The moderate risk group are therefore ideally identified in Primary Care or by ambulance services, where there is greatest potential to intervene. The high and very high groups will most likely be identified in ED and at the point of discharge following a hospital admission, where there is also a high potential for inadequate communication between discharging hospitals, community and Primary Care services. (See Figure 3).
2.5.1 Target Groups across the Care Continuum

Figure 3 Risk Stratification

Evaluation from Risk Stratification work (Hospital Risk Admission Programme) conducted in Victoria indicated that 8% of patients died in the period following admission with the highest mortality being in the complex diagnostic group. Premature or poorly coordinated discharge from hospital is a risk factor for readmission, resulting in increased mortality, delays in treatments and community supports, additional primary health care visits, preventable admissions, and a high level of consumer dissatisfaction.\textsuperscript{11}

The Risk Stratification model for NSW therefore requires application across the range of settings and should provide the impetus for planning, communication and monitoring of care plans. Risk models will therefore rely on different sets of criteria to indicate risk; ambulatory sensitive criteria for community and Primary Care, and hospital impact criteria for people in the high and very high-risk population (See Table 1).
Table 1 Target settings

<table>
<thead>
<tr>
<th>Setting</th>
<th>Likely Risk Profile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inpatient environment prior to discharge</td>
<td>Very high risk patients</td>
</tr>
<tr>
<td>Emergency Department, non-admitted</td>
<td>High risk patients</td>
</tr>
<tr>
<td>Ambulance service</td>
<td>Moderate to high risk patients</td>
</tr>
<tr>
<td>Primary Care</td>
<td>Moderate risk patients</td>
</tr>
<tr>
<td>Community health</td>
<td>Low to moderate risk patients</td>
</tr>
</tbody>
</table>

Figure 4 A Whole of Health focus for Risk Stratification

Summary Finding 1
Risk Stratification is optimally applied across the whole of the system, but the complexity variables must be tailored and weighted to the setting in which they are applied, such that they identify the population most sensitive to intervention. The moderate risk groups are ideally identified in Primary Care or by ambulance services. The high and very high groups will most likely be identified in hospital settings.
3. Risk Stratification Tools and Models

3.1 Types of Risk Stratification Tools

There are a range of options in applying Risk Stratification. Four methods are outlined below: clinician prediction, disease based Risk Stratification, criteria based Risk Stratification and predictive modelling.

1. Clinician prediction
   While clinicians are in an excellent position to reflect on those people with high risk, it has been found that clinicians predicting risk into the future was no better than chance.\(^6,12,13\) They are susceptible to a range of cognitive biases that make it difficult to translate observation at an individual level to estimations across a population.

2. Disease based Risk Stratification
   There are many types of screening tools that effectively stratify risk within specialties, however, disease based coding and stratification is problematic in a multi-morbidity context and on a background of social and demographic factors, which are currently not recorded in most of the data portals available.

3. Criteria based or threshold based Risk Stratification
   This involves a process of defining selected criteria to identify a cohort. For example, choosing a risk score threshold of 70 would mean that all patients with a particular score greater than 70 would be offered the preventive integrated care service. Alternatively, selecting on the basis of criteria may include those aged over 65 years with two or more chronic conditions.

4. Predictive modelling
   Predictive modelling uses regression analysis available within a particular platform to identify and stratify risk across the population. It utilises routinely collected data to gather up cohorts of patients meeting specific pre-determined criteria and establish a statistical relationship between the variables and the occurrence of an adverse event in a defined future period. The predictive ability varies between the available models that have been developed in The United States, the United Kingdom, New Zealand, and Canada. Predictive risk modelling is susceptible to regression to the mean such that, if a preventive intervention is to be successful and cost-effective, it needs to be offered to people who are at risk of the event it is trying to prevent – namely a future unplanned hospital admission. A predictive tool requires a model and a software package and will necessitate regular review, as well as calibration. They are therefore susceptible to error without regular review, and high maintenance cost has meant that some of the international tools have been decommissioned.
3.2 How the tools are applied

From the literature and extensive cross sector consultations, it is evident that there are two main types of Risk Stratification.

1. **Real time identification of eligible patients**
   
   Real time identification or screening uses risk prompts or flags to communicate with clinicians that the individual they are presently consulting with, requires consideration in relation to their risk profile. This is helpful in being able to specify, arrange and deliver tailored integrated care strategies to the person in need, at the time they require it. Real time flagging promotes and supports behaviour change in the health professional assessing the individual’s needs, and is the ultimate goal of Risk Stratification. The disadvantage is that in busy environments, such as General Practice or the hospital environment, where the clinicians are often working in a specialty area or are focussed on one aspect of care delivery, compliance and practical application of this is noted to be poor. The other significant limitation of this approach is that it only captures patients that are already in contact with the system.

2. **Case Finding**
   
   Case finding uses a predictive model and software platform to create a tool whereby risk factors are captured and weighted through an algorithm producing a list of ‘at risk’ patients. They can also be used to predict anticipated utilisation costs. Predictive modelling needs to identify those elements of a person’s health which are undesirable to the patient, have economic significance to the health service, are preventable, and accessible routinely through a stable data platform. The disadvantages of this approach include:
   
   - depending on the predictive accuracy of the tool, it will identify large numbers of people not necessarily requiring intervention, or those that perhaps will be unresponsive to preventive care.
   - it requires large data warehousing and system capacity
   - the accuracy is optimised by a shared data platform between Primary Care, ED and inpatient services. This is currently not available, nor foreseeable in NSW in the near future
   - the cost of development
   - the system requires rescaling and recalibration on an annual basis to ensure accuracy

A combination of both approaches can improve accuracy by applying clinical oversight to filter selection of the cohorts gathered up through a case finding process. (See Table 2)
### Table 2. Application of Risk Stratification Tools/Processes in the NSW context

<table>
<thead>
<tr>
<th>Setting</th>
<th>Risk Zone</th>
<th>NSW Context</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inpatient environment prior to discharge</td>
<td>Very high risk patients</td>
<td>Case finding using an electronic tool e.g. Patient Flow Portal</td>
</tr>
<tr>
<td>Emergency Department (ED) (non-admitted)</td>
<td>High risk patients</td>
<td>Real time flagging using First net</td>
</tr>
<tr>
<td>Ambulance Service</td>
<td>Moderate to high risk patients</td>
<td>Real time using Ambulance data systems</td>
</tr>
<tr>
<td>Primary Care</td>
<td>Moderate risk patients</td>
<td>Case finding and real time flagging using GP software, and Pen cat</td>
</tr>
<tr>
<td>Community health</td>
<td>Low to moderate risk patients</td>
<td>Case finding and real time flagging</td>
</tr>
</tbody>
</table>

### 3.3 Risk Stratification Tools and Processes

Most of the national and international tools or models being used are based on accessibility to large data sets of information. In general, these are obtained through the census or other population data, and then matched to inpatient data and in some instances outpatient and Primary Care data. However, at the Primary Care end of the spectrum, the reliability and accuracy of data input and collection becomes more questionable. (See Appendix 1 for more details)

#### Tools available across acute settings and Primary Care

1. **Hospital Admission Risk Prediction (HARP)**
   The HARP tool identifies a number of patient variables that are predictive of future hospitalisations and generates a risk score within 2 timeframes; 30 days and 15 months. It originated and is validated for use in Ontario.

2. **Victorian HARP**
   The HARP was modified and implemented in Victoria in the late 1990s with the specific aim of decreasing avoidable hospital demand for people with chronic and complex needs. It is based on the Ontario HARP and the Kaiser Permanente Chronic Care Framework. It attempts to capture the top 5% risk band of patients by restricting eligibility to those who have had at least one hospital admission in the previous 12 month period. It is not validated.

3. **John Hopkins ACG tool**
   This predictive model measures illness burden across a population to explain variation in health care consumption. It produces a summary of output data to quantity current morbidity, as well as predicts future risk. The ACG model generally outperforms six other similar models in predicting hospitalisations and particularly when predicting the highest top 10% cost users.\(^1\)\(^4\) It is validated for use in the US and UK.
4. PARR (Patients at Risk of Readmission), the SPARRA (Scottish Patients at risk of Re-admission and the SPARRAMH (SPARRA Mental Health)
   These tools are predictive for those meeting certain hospital based criteria requiring previous hospitalisations to be selected.

5. Combined Predictive Model
   The Combined Predictive Model supplements PARR data with data from outpatient, ED and General Practice. It makes predictions based on the entire population. The broad application of the Combined Model allows segmentation of an entire population into relative risk segments and facilitates matching the intensity of intervention with the risk of unwarranted secondary care utilisation. It is validated for use in the UK.

6. CHADS (Congestive heart failure, Hypertension, Age >75 years and Diabetes, prior Stroke)
   CHADS is an example of a condition specific tool which identifies a cohort at risk of stroke using the specific criteria above.

7. LACE
   This is an acute hospital tool that uses Length of stay, Acuity of admission, Co-morbidities, and emergency admissions to determine a risk score for readmission and death.

8. PRISM (Canadian)
   This tool is an ‘off the shelf’ predictive stratification tool requiring data warehousing.

9. Healthnumerics-RISC
   This tool predicts the risk of patients with chronic conditions having unplanned chronic admissions in a 12 month period by combining entire population data sources (inpatient and Primary Care) to risk stratify. It is an ‘off the shelf’ product utilising multiple data variables.

10. Charlson Index
    This is a tool designed to predict mortality on the basis of clinical diagnoses of co-morbid conditions.

Tools available in the Primary Care setting
There are far fewer tools that are applicable in the Primary Care setting. Many of them are specific to particular conditions. There are a couple of examples listed below and of these, the Qadmission score has significant alignment with the complexity variables highlighted in Table 3 below.
1. **Qadmissions**
   This is a real time risk prediction tool that calculates an individual’s risk of emergency admission over the next 1-2 years at the point of care. It can also be collected through review of GP data systems. From the tools reviewed, it is probably the best tool available for use from Primary Care; however the UK provides incentives to GPs for this process to occur. This is a validated tool for use in the UK.

2. **EARLI (Emergency Admission Risk Likelihood Index)**
   This is a UK tool for use in Primary Care. It is a 6 item questionnaire developed from data from patients aged over 75 years.

3. **PEONY (Predicting Emergency Admissions over the next year)**
   This is a UK tool for use in Primary Care for those aged 40-65 years.

In early 2015, it is anticipated that the list of tools in Appendix 1 will be directly linked to the most relevant literature. International tools do not consider Aboriginality as a key variable, and so adoption of any of the tools must consider the addition of this variable as a significant complexity factor adding to risk.

### Summary Finding 2
There are no international or national Risk Stratification tools or solutions that can be readily applied to the NSW context. A series of weighted complexity variables have been identified for testing and validation in the various settings.
4. **Complexity**

In order to understand the risk of health deterioration that a person or a population has, it is necessary to understand the elements of complexity that make up any given risk for that individual or population. (See Figure 5) The literature and data help to facilitate understanding of the contributing elements, which create a risk profile in the hospital setting. The elements that will predict hospitalisation from the Primary Care setting are far less clear. A review of the literature in this area is currently being commissioned from the Sax Institute. It is hoped that the evidence will give weight to the identification of the complexity parameters relevant in predicting hospitalisation from Primary Care or home, requiring ambulance or community intervention.

**Figure 5 - Complexity Variables**

Some variables can be considered **principal factors** and are independently, highly predictive of hospitalisation, whilst other variables may be considered as risk **amplifying factors**.
4.1 Principal Complexity Variables (Refer to Table 3)
Six principal complexity variables are described below. They are increasing age, presence of comorbidities, chronic conditions/disability, Aboriginality, previous admission(s) and medication use. The relative risk weighting for each of these are identified in Appendix 2 (where literature has been available to support).

**Increasing Age**
Age is the most significant predictor of hospitalisation.\(^\text{16}\) Two out of every three people aged over 65 years of age have at least one chronic condition, and a third of these people will have multiple chronic conditions. From NSW hospital data, adults over the age of 65 are up to 4.8 times more likely to be hospitalised for a chronic condition than those aged between 15 and 44 years of age.\(^\text{16}\) Between 75 and 85, the relative risk is magnified to 7.15. People aged over 65 will have a one in four chance of a subsequent ED visit within 90 days, so ED is a natural target to screen for a risk profile that has a high probability of re-presentation to ED or hospital.\(^\text{17}\)

**Figure 6**

**NSW Health: Age specific hospitalisation rates by age bands (0-85+ years)**

![Graph showing age specific hospitalisation rates by age bands](image)

**Co-morbidity**
Comorbidity is highly associated with hospitalisation such that people with more than three conditions, are twice as likely to be admitted, than those with one condition. The rate increases to three times for those people with five or more co-morbid conditions.\(^\text{16}\)

**Chronic conditions/Disability**
Aside from the chronic system diseases addressed through the Connecting Care Programme, there are a range of other identified conditions including renal, liver and other metabolic diseases, neurological conditions and cancer that similarly result in long-term ill health and potential hospitalisation. All chronic conditions result in disability at some level.
Intellectual, cognitive and physical disability from birth, or resulting from trauma such as spinal cord or brain injury, can be considered a chronic condition requiring lifelong self-management, or supported self-management by carer or paid workers. Usually care is managed by the person with a disability in the home environment. The multiple and often inadequately understood care needs of the disabled during or in the lead up to hospitalisation result in a high likelihood for poorly coordinated and responsive care, and rapid discharge planning. Many times, this can result in readmission.\textsuperscript{11,2}

When considered in isolation, disability does not necessarily result in hospitalisation, but when compounded by other social factors such as reduction in care hours available, ill health of the carer, other newly emerging chronic conditions, and ageing with the disability, the effects of the disability are magnified. In 2007–08, 46 per cent of people aged 15-64 years with severe or profound disability reported poor or fair health, compared to only 5 per cent for those without disability. The average person with a disability has more than three additional long-term or chronic health conditions that may not be directly associated with their disability. People with disability aged 35 to 64 years have the highest health cost of any NSW citizen.\textsuperscript{2}

Aboriginality
Aboriginal people in NSW are disadvantaged in accessing and receiving benefit from health care services. This disadvantage occurs for many reasons, including the need to recognise the impacts of past government policies and practices that continue to negatively impact on trust, access and engagement, that are not necessarily apparent to non-Aboriginal staff. Apart from identifying those at risk, a dedicated Aboriginal workforce is critical in providing an Aboriginal perspective, while identifying individual/community needs and assisting to develop and deliver culturally appropriate integrated care strategies.\textsuperscript{11,18}

In NSW, Aboriginal people are hospitalised at twice the rate on non-Aboriginal people and suffer chronic disease and morbidity accordingly.\textsuperscript{19} The greatest contributors to higher mortality rates are chronic disease, in particular cardiovascular disease, mental health problems, diabetes, cancers, and injury. The estimated average years of equivalent healthy life without a disability are approximately 15 years less than the average population. The largest gap is within the age groups of 35 - 54 years of age for the Aboriginal population. This data forms the background for a higher relative risk of hospitalisation in the lower age bracket. (See Appendix 2) Other factors such as mental health and substance misuse are represented across the Aboriginal population, and therefore the aggregated risk can be higher.\textsuperscript{20}

Previous hospital admissions
Following a first admission for a chronic or complex condition irrespective of age, subsequent admissions are more likely.\textsuperscript{16}

Medication use
Medication use has been specifically identified as a predictor of hospitalisation. As the complexity of illness increases, so does the number of medications taken.\textsuperscript{16,21} Polypharmacy of 5 or more medications is a predictor of hospitalisation, particularly
when those medications are for management of respiratory, diabetic and cardiovascular conditions.⁶

4.2 Amplifying Complexity Variables

Nine amplifying complexity variables are described below; these are culturally and linguistically diverse (CALD) groups, falls, mental health conditions, cognitive impairment, biomedical markers, socio economic factors, geographic factors and rurality, cigarette smoking and alcohol and substance misuse.

Culturally and Linguistically Diverse (CALD) groups
Challenges to health and well-being for CALD groups are often represented simplistically as communication issues which can readily be resolved through the use of interpreters. However, other more important aspects about how different cultural groups interpret health and health care are often not considered in planning and coordinating care. There are significant associations between ethnicity and hospitalisation, however the studies are confounded by other socioeconomic and ethnic variation.¹¹

Falls
Falls, particularly in the older person or associated with a chronic condition, are indicative or considered a proxy for frailty or physical decline. People who fall are more likely to call the ambulance service, which in turn, are more likely to transport to hospital.²² A fall or history of falls is not routinely collected in hospital or Primary Care data. There may be additional functional measures or indicators that should be explored. However, measures ultimately selected need to be easily and readily assessed in a clinical setting, and recorded in a data system. For the purposes of discussion and differentiation of risk, the terms ‘one fall’ and ‘more than one fall’ have been used in Table 3.

Mental Health¹⁶
Whilst having a mental health condition in isolation does not increase the risk for hospitalisation, it can magnify difficulties associated with self-care, particularly when combined with ageing and the effects of other chronic conditions. For the purpose of discussion, a point of differentiation is the relative stability of the condition, so the terms ‘unstable’ and ‘stable’ are used in Table 3.

Cognitive Impairment
Cognitive impairment may arise as a result of dementia, brain injury, or intellectual disability. Irrespective of the causal factor, it significantly increases morbidity and mortality for the older adult.¹⁷ For the purpose of discussion, a point of differentiation is the functional independence of the person with cognitive impairment, so the terms ‘independent in activities of daily living’ and ‘requiring assistance for activities of daily living’ have been applied.
Biomedical markers
Biomedical factors are significant predictors of hospitalisation for specific chronic disease conditions. The factors considered important are: dyspnoea, hypertension, body mass index, the presence insulin treatment or elevated HBA1C levels, home oxygen and steroid treatment.\(^\text{16}\) For LHDs or settings choosing to use these disease specific variables to stratify risk within populations, consideration must be given to all other variables in a multi-morbidity context.

Socio economic factors
While it is believed that social determinants of health are a key driver for preventable hospital admissions, there are a limited number of studies supporting living alone for example, as a predictive factor for hospitalisation.\(^\text{16}\) This may well be related to the lack of input data in hospital, ambulance and Primary Care settings.

There are many factors that can be considered indicative of social disadvantage that may also be strongly predictive of hospitalisation. These include education, income, living alone, carer stress and so on. Unfortunately, the most basic data is not routinely and accessibly collected within the various health settings.\(^\text{16}\)

Living alone is a data item that can be built into most systems as a first step. Low self-reported health scores is also considered predictive and should be considered an inclusion for data collection.\(^\text{16}\)

Geographic factors/Rurality
Some studies have reported relationships between hospitalisation and geographic factors, including remoteness and topographic issues limiting access. However, the findings are inconclusive, as confounding factors such as access to Primary Care and distance from hospitals makes interpretation difficult from population based studies.\(^\text{16}\)

Cigarette smoking\(^\text{23}\)
As a lifestyle factor, cigarette smoking is a predictor of poor health. It amplifies other principle variables.

Alcohol and substance misuse
Within the Australian population, the prevalence of alcohol use disorders, including abuse and dependence is 6.1% of the Australian population.\(^\text{23}\) Alcohol-related conditions have been found to account for:
- up to 40% of ED presentations
- up to 30% of hospital admissions
- about 50% of outpatient clinic activity\(^\text{24}\)

(See Figure 7 for international evidence summary)
Figure 7 demonstrates that hospitalisation is not the result of any single factor, but a complex interplay of many social, physical and environmental factors. On a population basis however, it is possible to weight the various complexities in terms of their real and potential impact on hospital systems (See Appendix 2). These relative risk weightings have been linked to assist in defining the cohorts ‘high’ and ‘moderate’ complexity in Table 3.

The information available can be further extrapolated to define very high risk cohorts or low to moderate risk cohorts.

4.3 Complexity Variables - Primary Care data extraction (see Table 3)

Combining the evidence, the review above and the weightings from Appendix 2, Table 3 identifies the data elements considered important for review and extraction, identifying people at risk of their first avoidable hospital admission from within a Primary Care setting. These items will be validated or otherwise brought into question in the near future through the SAX Institute Evidence Rapid Review, and also by a process of testing and validation in Primary Care.
Summary Finding 3
A data extraction process using identifiers A_G (More heavily weighted variables) in Table 3 as a priority will be tested for validity within a Primary Care environment with GPs willing to participate. It is recommended that those patients with three or more of the variables in either the moderate or high-risk category should be flagged for specific care co-ordination services.

Summary Finding 4
There is inadequate evidence regarding complexity in Primary Care. ACI must commission further work to confirm and examine the complexity determinants of hospitalisation from Primary Care. This is currently underway.

4.4 Complexity Variables - Inpatient Data extraction (See Table 3)
The elements identified in Table 3 are considered important for review and extraction from inpatient data systems identifying people at risk of subsequent emergency department visits or inpatient admission. Certainly, the presence of two or more of items A-G in both moderate and high risk categories would provide a cohort of moderate risk and high-risk patients to investigate, test and validate in relation to the need for coordinated care. Items H-N would need to be inserted as mandatory fields in the system to be helpful, as there is no precedence for this data to be routinely collected.

Patient Flow Portal as an Enabler
As a part of the consultation process, the Patient Flow Portal (PFP) team were consulted to further understand the purpose and current utilisation of this tool within NSW. The Patient Flow Portal (PFP) aims to improve patient flow within a hospital or health district assisting staff, and improving patient experience (http://www.health.nsw.gov.au/pfs/Pages/pfp.aspx). The portal is currently accessible to all public hospitals within NSW and captures data and patient information for patients within NSW public hospitals at the present time. There is a component of the tool that highlights “admission risk”. Currently the risk criteria are based upon eligibility for the Chronic Disease Management Program (CDMP).

The Admission and Discharge Risk Assessment Forms (ADRAF) are completed in various formats throughout the state and are to be completed within 24 hours of admission according to Ministry of Health’s policy (See Appendix 3 for an example). When assessing this form against the criteria listed within the discussion paper, it contains many but not all of the variables (known locally to be completed with other processes). The ADRAF is an enabler for Risk Stratification as this process is already undertaken locally and further work will need to be commenced to electronically collect this data to be used for Risk Stratification.

The PFP can be modified to collect additional risk profiles. It is understood that the use of the PFP is varied, but generally underutilised across NSW. The risks factors currently captured on the PFP include:
Risk 1: Multiple admissions under any speciality (specific to CDMP)
Risk 2: Multiple admissions under a specified specialty (specific to the CDMP) identified by the speciality of the Admitting Medical Officer
Risk 3: Multiple admissions under the Same specialty
Risk 4: Re-admission within 28 days with ED presentation
Risk 5: Re-admission within 28 days
Risk 6: > 5 ward moves this admission
Risk 7: Aboriginal and Torres Strait Islander
Risk 8: Remoteness
Risk 9: More than one of the above risks

(Please see the following website for more information on the Admission Risk component of the PFP

While the risk factors above are useful as a starting point, it would be helpful to align the complexity items from Table 3 with the Admission and Discharge Risk Assessment Form and the PFP. Key additional items to the PFP would include ‘any readmission regardless of timeframe’, living alone, and falls history. A modified PFP will include the additional data elements referred to in the paper, but not currently collected.

In terms of data capture, the PFP extracts data from the PAS system to allow for real time patient information. Therefore, this tool needs to be further explored to understand how it can be utilised for real time patient flagging for risk of rehospitalisation.

Summary Finding 5
Further work needs to be conducted regarding the process of extraction and recording of data elements in the inpatient setting. (E_N)

Summary Finding 6
A social disadvantage measure (Living alone) or measures need to be inserted as a mandatory field item in all data collection systems.

Summary Finding 7
The data elements identified in Table 3 need to be tested and validated in an inpatient setting using the PFP to gather a cohort.

Summary Finding 8
Linking the Admission and Discharge Risk Assessment process, mandatory in every hospital, to the PFP to identify moderate and high-risk cohorts for validation is desirable. The data items identified above in Table 3 need to be aligned with the Admission Risk Form and the PFP.
4.5 Complexity Variables - Emergency Department (ED) and Ambulance – enabling ‘real time’ flagging

In Australia, avoidable hospitalisations are concentrated among people with chronic conditions. In Victoria, 12% of ED presentations were recorded as presenting on at least four other occasions. Therefore ED and ambulance services, which frequently transport this cohort, should be a major target for real time flagging of selected risk profiles. It is suggested for example, that those who have 2 or more variables present should be flagged. Further discussion is required with ED to investigate this more fully. Of those patients not transported, falls form the largest group, however the cumulative re-attendance rate for all cases not transported to hospital is 16% within 28 days, and this rate increases as people age, such that re-attendance rates peak at 9.23% for 80-84 year olds. Falls also account for one quarter of all non-transported cases re-attended within 24 hours of an initial visit.
Table 3 Complexity variables for Primary Care, emergency department (ED)/ambulance and inpatient settings

<table>
<thead>
<tr>
<th>All risk data elements</th>
<th>Moderate risk identifiers</th>
<th>High risk identifiers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Primary Care</td>
<td>ED/Ambulance</td>
</tr>
<tr>
<td>A Age</td>
<td>Age&gt;65</td>
<td></td>
</tr>
<tr>
<td>B Aboriginal or Torres Strait Islander</td>
<td>Age &gt;45</td>
<td></td>
</tr>
<tr>
<td>C Chronic condition/disability</td>
<td>Presence of 1 or more chronic diseases, conditions or disabilities</td>
<td>Presence of 2 or more chronic conditions, diseases or disabilities</td>
</tr>
<tr>
<td>D Previous Hospital Admissions (including ED presentations)</td>
<td>NA</td>
<td>First admission</td>
</tr>
<tr>
<td>E Previous ED presentations</td>
<td>NA</td>
<td>First presentation</td>
</tr>
<tr>
<td>F Previous ambulance call outs</td>
<td>NA</td>
<td>First call</td>
</tr>
<tr>
<td>G Medication use/polypharmacy</td>
<td>Presence of three or more medications</td>
<td>Presence of 5 or more medications</td>
</tr>
<tr>
<td>H Falls</td>
<td>One</td>
<td></td>
</tr>
<tr>
<td>I Mental health condition</td>
<td>Stable</td>
<td></td>
</tr>
<tr>
<td>J Cognitive impairment (dementia, behavioural disturbance, brain injury)</td>
<td>Independent for Activities of daily living</td>
<td>Requiring assistance for activities of daily living</td>
</tr>
<tr>
<td>K Social disadvantage (living alone, recent death of spouse, carer strain)</td>
<td>Amplifier</td>
<td>Amplifier</td>
</tr>
<tr>
<td>L Lifestyle variables (smoking, drug and alcohol misuse)</td>
<td>Amplifier</td>
<td>Amplifier</td>
</tr>
<tr>
<td>M Disease specific clinical variables</td>
<td>Amplifier</td>
<td>Amplifier</td>
</tr>
<tr>
<td>N CALD</td>
<td>Amplifier</td>
<td>Amplifier</td>
</tr>
</tbody>
</table>

**NB** Patients with a history of one or more preventable hospital admissions or ED presentations, would already be considered high risk
5. **Relationship between Risk Stratification & Integrated Care interventions**

The successful provision of tailored integrated or coordinated care is dependent upon accurate identification of patients (Risk Stratification or patient selection), high level partnerships and networks, and effective governance, responsibility and accountability. The focal point for care coordination after a patient has been selected must be the patient themselves.

When determining types of interventions provided to specific cohorts it is important to consider the risk complexity variables as a starting point. However, a further detailed assessment process is required to assess functional cognition, activity level, social and environmental barriers, domestic suitability, availability of carers, transport options and compliance with medications.

Evidence based strategies need to be applied to each aspect of identified need for the client and in a manner that is adjusted to the level of risk. Options include case management, Medical Assessment Units, multidisciplinary management, virtual wards (e.g. Hospital in the Home), transition support nurses, timely access to specialist outpatient clinics, 24 hour support telephone lines, personalised care plans and telehealth or telecare, for those requiring more intensive support. For people with moderate risk identified, options such as self-management, care provided through a Health One Service, self-monitoring, group education and support sessions etc. may be appropriate.

The Chronic Care for Aboriginal People Programme by way of example, was established to improve coordination and management of care for Aboriginal people to which a dedicated 48 hour follow up position has been allocated within each LHD. The aim is to follow up 90% of clients with a phone call within 2 working days of discharge for those with a chronic condition. The aspects of ongoing care addressed through this follow up telephone intervention include medication check, referrals, general wellbeing, and linkage to a GP. 48 hour follow up will be further reviewed to explore how more supportive care can be provided to selected cases.
The case study below highlights how the complexity variables identified in Table 3 can be used to structure care delivery in order to minimise the risk for hospitalisation. The capability of PEN CAT to extract the following variables specific to Frederique’s case needs to be explored:

Age>65 years, CALD, Lives alone, recent loss of partner, falls risk, > 2 chronic disease/condition (type 2 Diabetes, Multiple Sclerosis), polypharmacy.

Frederique has 3 variables from items A-G as well as additional amplifying factors. This puts her at high risk of hospitalisation.

**Frederique’s risk profile**

- 68 y Spanish speaking migrant with no English
- Her husband recently passed away. She lives alone
- She has multiple sclerosis affecting her balance
- Recently diagnosed with Diabetes Type 2 which is poorly controlled
- She takes 5 medications.
- She has not presented to emergency or been admitted

**Primary Care Risk:** HIGH

**Frederique’s Shared Care plan**

- Case management/care navigation
- Falls review- home safety assessment
- Home support and transport requirements assessment
- Bi weekly exercise group
- Multi-disciplinary diabetes management: system review, foot clinic, dietitian, ophthalmology
- GP shared care plan
- Home Medicine review
- Pharmacy Liaison
- 24 hour phone support line with access to interpreter
6. Challenges and Opportunities

In regards to the implementation and sustainability of a Risk Stratification process, there are a number of key challenges in each of the settings described above, which also become opportunities to bring about change.

6.1 General Practice

- Access to “clean”, reliable and accessible General Practice data will be a key challenge for the future and will have further complication with the establishment of the Primary Health Networks. From the consultations, it is evident that there is large variation in data capture and analysis across GP practices. There is also variation in the use and review of PEN CAT data system, as it carries a significant administrative burden. There are opportunities to test the identified data elements, extraction process and capability within GP systems to risk profile. Some essential data elements will need to be added to GP data sets e.g. living status and falls. It will be necessary to incorporate data collection and analysis into everyday processes to minimise administrative costs and resources.

- GPs lack incentives to collect and review data available from their systems. Initiatives should only be implemented with sustainable outcomes in mind. The use and promotion of shared care platforms and GP management plans using appropriate MBS item numbers may provide opportunity to explore participation with GPs.

- GPs are in a ‘real time’ position to flag risk. Intuition supported by data adds validity. Access to timely and tailored integrated care options are important enabler to reinforce, promote and provide incentives for participation.

6.2 Local Health Districts and Specialty Health Networks (LHDs/SHNs)

- LHDs/SHNs fundamentally vary in their demographics and local context. Any risk model must have the flexibility to adapt to the local constraints and population.

- Incorporating data collection, analysis and review and applying it to a broader risk assessment and management philosophy on a day to day basis will require a cultural change for the organisations, and behaviour change from clinicians. Resources to address education, support and training will be required. Using the criteria identified from Table 3, the Admission and Discharge Risk Assessment and modified PFP become enablers for this process, however more investigation is required as to how the process can be automated, and ultimately linked to the EMR.

- LHDs/SHNs do not routinely collect data that assesses social contributors to health.

- Some additional essential data items need to be built into the system as mandatory fields.
Regardless of the risk category targeted, significant planning and liaison must be undertaken leading up to discharge to convert a risk profile into an evidence based, integrated care plan tailored to the person and their family, that is communicated back to Primary Care. This requires allocation of resources and a transfer of information process.

6.3 Emergency Department (ED)

- EDs are busy departments with pressure on patient flow. Once triaged, a patient must be discharged, or admitted. For those not admitted, there is an opportunity for ‘real time’ flagging of moderate or high risk individuals, but this must be automated into data collections systems.
- For those requiring coordination of care, time is required to liaise, plan and communicate care with the patient, carers and Primary Care agencies. A shared data and care plan between Primary Care and NSW Health facilities would assist this.
- Care options must be available and accessible e.g. Medical Assessment Unit, 48 hour follow up, transitional nursing support teams, virtual wards etc.

6.4 NSW Ambulance Service

- Whilst ambulance workers ‘risk stratify” routinely for every call out, and have in place many protocols that support this, the elements of the process are not routinely collected in a data system that is transferable to hospitals or GPs currently. A process has not been formally adopted or supported to assist paramedics in seeking out appropriate referral pathways as alternatives to hospitalisation.
- For those not transported to ED, time is required to liaise, plan and communicate care with the patient, carers and Primary Care agencies. Accessible and timely care options must be available as alternatives to repeat ambulance or ED attendances.
8. **Next Steps**

Consultations will continue throughout the coming months to facilitate best understanding and ensure maximum promotion and awareness across the sectors. This discussion paper will form the basis of the next round of consultations. The approach is iterative with modifications embedded along the way. It is important to state that clinicians need to be involved in trialling and further developing aspects of the tools. Working groups may be configured to provide such an opportunity for inpatient staff, ED and Primary Care staff to participate. Nine steps have been identified.

1. The discussion paper will be distributed widely and a workshop for stakeholders will be convened in 2015 to enable discussion, further development and review of the model and approach. Demonstrator sites are free to use the information in this document to support and or modify the work already underway.

2. It is proposed to initiate a data review, collection, validity testing and analysis strategy from two priority points: Primary Care and the inpatient setting. Separate discussions and considerations will occur in relation to the Ambulance Service and ED at a later date.

3. It is proposed that pilot sites be identified in:
   - An LHD/SHN to test the inpatient data elements and collection aspects
   - Primary Care to commence a data capture and validity process. A Medicare Local or Primary Health Network are ideally positioned to support and promote this work amongst GPs.

4. Data linkage and platforms will need to be investigated to further understand how we can implement Risk Stratification tools/process into the NSW context, and furthermore indirectly link the two systems (NSW Health and Primary Care data) via a platform such as LinkedEHR and CDMNet. Further investigation is required to understand the wider applicability of these programs. Concurrently, consultations with PFP, and eHealth, will further inform the possibility of a state wide build for shared care plans and data linkage platforms for Primary Care and tertiary care.

5. The SAX Evidence Review will be undertaken and the results available by April 2015.

6. Mapping integrated care strategies to patient cohorts selected by ‘Risk Stratification’ will be an associated activity. There are many integrated care approaches being undertaken, piloted and evaluated across the state, however not all of them are evidence based and certainly, not all of them mapped to level of risk identified. Most of the innovations have been applied, to meet local need within a local context, and this aspect is commended. Further mapping of integrated care interventions matched to risk profiles is encouraged at a local levels.
7. There are populations that require particular attention and perhaps a different approach. Examples of these populations include Mental Health, Paediatrics and Addiction. More concentrated consultation will occur in 2015 with these target groups.

8. A future body of work could investigate community health services as a logical and associated setting, capable of risk stratifying and aligning coordinated care around a person.

9. A literature review may be commissioned to review integrated risk interventions matched to risk profiles.
10. Conclusion

Central to any Risk Stratification and case identification strategy is the accuracy and utility of the method used to assess the risk profile. In general, a Risk Stratification model needs to be developed using data from the setting where it will subsequently be used. It needs to:

- distinguish between patients who do, or do not experience the events of interest (discrimination) and accurately quantify the level of risk (calibration)
- predict the outcome of interest (e.g., emergency admission) for the population of interest (e.g. all adult patients registered with the general practitioner)
- apply over the relevant time period (e.g. 1–2 years) assuming that sufficient time is needed for interventions to have an effect
- include predictors with good clinical face validity and, ideally, include some clinically relevant factors which are amenable to change (i.e., help reduce risk of emergency admission)
- preferably incorporate socioeconomic measures, Aboriginality and ethnicity not only in recognition of the role these factors have as predictors of major diseases, but also to prevent widening health inequalities which can occur when new programmes are introduced
- have the potential to be updated or recalibrated, and its performance should be tested in a population of patients separate from that used to develop the tool to demonstrate that it can reliably identify the target population
- suitable for implementation in clinical practice

All of these aspects will be considered as we move into the next steps of development.
11. References


9. Falster M, Jorm L. Key Findings from the APHID Study. 2014.


24. Charalambous MP. Alcohol and the accident and emergency department: a current review. 01/07/2002
30. CEHSEU. Potentially preventable hospitalisations; a review of the literature and Australian policies. Victoria Clinical Epidemiology & Health Service Evaluation Unit 2009.
12. Appendices

Appendix 1 MATRIX
<table>
<thead>
<tr>
<th>Model</th>
<th>Purpose</th>
<th>Jurisdiction</th>
<th>Disadvantages/Advantages</th>
<th>Inclusion of Social Determinants</th>
<th>Source of Data</th>
<th>Disease specific or holistic</th>
<th>Real time Case Finding or Population based</th>
<th>Complexity Variables</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combined predictive</td>
<td>Identifies risk of emergency admission within the next 12 months</td>
<td>England</td>
<td>Disadvantage: Flips the top 5% requires a large data warehouse. Validated in the UK</td>
<td>No</td>
<td>Patient, Hospital, ED &amp; Primary Care</td>
<td>Holistic</td>
<td>Population based</td>
<td>Multiple variables including Polypharmacy, Chronic disease—COPD Depression</td>
<td>Off the shelf product that addresses health risk across the continuum and across the population. Requires large data warehouse and is built on an accessible data platform. It is not directly transferable to the NSW context.</td>
</tr>
<tr>
<td>Health Numerics Inc (DPT UK)</td>
<td>Obsesses patients most at risk of an unplanned admission within a 12 month period</td>
<td>Newcastle, NSW</td>
<td>Disadvantage: looks at all aspects of care during hospitalization including Episode Treatment Groups pharmacy complex interplay of data</td>
<td>Yes</td>
<td>Primary Care and Equivalent</td>
<td>Holistic</td>
<td>Population based</td>
<td>Mental Health, Social Care</td>
<td>Off the shelf product for UK population</td>
</tr>
<tr>
<td>SPARRA</td>
<td>Scottish PARR (SIMPLE)</td>
<td>Scotland</td>
<td>Disadvantage: marginal</td>
<td>Not currently</td>
<td>Patient, Outpatient and Primary Care</td>
<td>Holistic</td>
<td>Population based</td>
<td>Stratifies into 1 of 32 categories using multiple data points</td>
<td>Off the shelf product which predicts hospitalisations with good accuracy for top 20% of high cost users.</td>
</tr>
<tr>
<td>John Hopkins Adjusted Clinical Groups</td>
<td>Tools to prevent avoidable hospital presentations and admissions. It targets the top 5% of the risk band by restricting eligibility to those who have had at least one hospital admission in the previous 12 month period</td>
<td>USA, Canada, Netherlands</td>
<td>Advantage: Predicts hospital and other outcomes for the highest risk 5% of patients. Validated for use in US and UK</td>
<td>Not currently</td>
<td>Patient, Outpatient and Primary Care</td>
<td>Holistic</td>
<td>Population based</td>
<td>Stratifies into 1 of 32 categories using multiple data points</td>
<td>Off the shelf product which predicts hospitalisations with good accuracy for top 20% of high cost users.</td>
</tr>
<tr>
<td>HARP Victoria</td>
<td>Tools to prevent avoidable hospital presentations and admissions. It targets the top 5% of the risk band by restricting eligibility to those who have had at least one hospital admission in the previous 12 month period</td>
<td>Victoria</td>
<td>Advantage: can use to stratify patients for connecting care – chronic disease specific</td>
<td>Not currently</td>
<td>Patient and ED</td>
<td>Holistic</td>
<td>Real Time</td>
<td>Chronic Disease—Cardiac, Liver disease includes psychosocial complex issues, Mental Health, Self Care capacity, Hospital Factors, polypharmacy, ≥5 medications, Biomedical markers for specific conditions, Cancer, Stress, Cognitive Impairment, Chronic Pain, Disability, CAAD, Indigenous, Readiness to change - self management</td>
<td>Tool for use by GPs within the hospital environment targeting the top 5% risk band. Is inclusive of many of the conventional factors important in NSW, however lags validity and access to the noted data points is difficult from routine data systems</td>
</tr>
<tr>
<td>HARP Ontario (VALUE)</td>
<td>Captures 10 variables to predict 1 month and 12 month readmissions for top 6 conditions</td>
<td>Canada</td>
<td>Disadvantage: Only captures people in an acute setting</td>
<td>Discharge destination only</td>
<td>Patient and data can be used in primary care</td>
<td>Holistic</td>
<td>Real Time &amp; Population based</td>
<td>Algorithm Data available from NSRI as data set Number of acute admissions in the previous 12 months Number of ED visits in the 12 months prior EHR Discharge destination (COPD, Heart failure, Ischemic Bowel Disease, GI obstruction, chronic disease)</td>
<td>Only captures those who have had an acute presentation in the high to very high risk band</td>
</tr>
<tr>
<td>HARP Ontario (Complex)</td>
<td>Identifies risk of hospitalisation at 30 days and 12 months</td>
<td>Canada</td>
<td>Disadvantage: Hospital improvement on the simple ability to predict</td>
<td>Discharge destination only</td>
<td>Hospital and other social variables</td>
<td>Holistic</td>
<td>Real Time &amp; Population based</td>
<td>Emergency admission place of discharge presence of 18 top conditions Chronic care mortality index</td>
<td>Tool for use by GPs within the hospital environment targeting the top 5% risk band. Is inclusive of many of the conventional factors important in NSW, however lags validity and access to the noted data points is difficult from routine data systems</td>
</tr>
<tr>
<td>O-see assessment</td>
<td>Identifies patients at risk of emergency admission from primary care over the next 1-2 years</td>
<td>England</td>
<td>Advantage: Validated tool that is effective in identifying risk of hospitalisation Disadvantages: limitations of GPs</td>
<td>No</td>
<td>Primary Care</td>
<td>Holistic</td>
<td>Real Time &amp; Population based</td>
<td>Emergency admission place of discharge presence of 18 top conditions Chronic care mortality index</td>
<td>Tool for use by GPs within the hospital environment targeting the top 5% risk band. Is inclusive of many of the conventional factors important in NSW, however lags validity and access to the noted data points is difficult from routine data systems</td>
</tr>
<tr>
<td>ACE</td>
<td>Identifies the risk of readmission using information from a current admission</td>
<td>Ottawa</td>
<td>Advantage: Does not include social determinants, Criteria based – 1 or more admissions, limited co-morbidities. Advantages: Simple. Can be pulled from inpatient data, Electronic health – virtual ward or primary care EMR systems</td>
<td>No</td>
<td>Patient Limited Emergency department data</td>
<td>Holistic</td>
<td>Population based</td>
<td>Short identification by criteria</td>
<td>Tool for use by GPs within the hospital environment targeting the top 5% risk band. Is inclusive of many of the conventional factors important in NSW, however lags validity and access to the noted data points is difficult from routine data systems</td>
</tr>
<tr>
<td>PAIR</td>
<td>Does current data to predict the risk of readmission by accessing the previous 2 years to predict admissions in the next 3 months. Targets the top 1-2% risk band very high risk</td>
<td>England</td>
<td>Disadvantage: Captures very high risk patients only however no burn out sensitivity and has been decommissioned in UK</td>
<td>Age, sex, socioeconomic systems scores similar to SEIFA</td>
<td>Census matched to inpatient only</td>
<td>Holistic but limited</td>
<td>Population based and Real time capacity</td>
<td>Age 12 Admissions in last year and month Derived from the Charlson index disease based</td>
<td>Tool for systems wide use within the hospital environment targeting the top 5% risk band. Has low sensitivity to high risk group</td>
</tr>
<tr>
<td>PRM [Predictive risk stratification model] equivalent to the CPHM</td>
<td>Used to link hospital GP data that predicts the likelihood of an ED admission over the next 12 months</td>
<td>Wales</td>
<td>Disadvantage: lacks social care data Contains many data elements</td>
<td>Training</td>
<td>Hospital, Outpatient &amp; Primary care</td>
<td>Holistic</td>
<td>Population based</td>
<td>5 different variables are stratified into 4 risk levels variables are biomarker specific E.g. eGFR hearing aids</td>
<td>Off the shelf product that uses case identification</td>
</tr>
<tr>
<td>DSAU [early admission risk likelihood index]</td>
<td>Predicts the likelihood of emergency admission for those aged over 75</td>
<td>UK</td>
<td>Advantage: 6 items, validated for use in the UK</td>
<td>Yes</td>
<td>Primary care</td>
<td>Holistic</td>
<td>Real time case finding</td>
<td>Admissions, self reported, mobility, cognition, function</td>
<td>Primary care tool validated for use in the UK for 75 years without specific application to the general population</td>
</tr>
<tr>
<td>PDOS [Predicting emergency admission over the next year]</td>
<td>Producing emergency admission over the next year for people aged between 40 and 85</td>
<td>UK</td>
<td>Not validated for use in the UK</td>
<td>Yes</td>
<td>Primary care</td>
<td>Holistic</td>
<td>Population based</td>
<td>Age Number of hospital admissions medication</td>
<td>Relates to likelihood of emergency admission based on previous admissions</td>
</tr>
<tr>
<td>Charlson co-morbidity index</td>
<td>Uses co-morbidities to predict complicated to predict hospitalisation and mortality</td>
<td>Canada</td>
<td>Disadvantage: Predicts risk of mortality over 3 years to predict the risk of one year mortality</td>
<td>No</td>
<td>Disease specific</td>
<td>Population based</td>
<td>Condition specific</td>
<td>Uses the presence or absence of 23 conditions to assign a score from 1-20 to predict risk of one year mortality</td>
<td></td>
</tr>
</tbody>
</table>
## Appendix 2 Complexity Weightings

<table>
<thead>
<tr>
<th>Complexity variable</th>
<th>Relative Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age &gt; 65-74</td>
<td>4.796</td>
</tr>
<tr>
<td>Age &gt; 75-84</td>
<td>7.146</td>
</tr>
<tr>
<td>Age &gt; 85</td>
<td>7.621</td>
</tr>
<tr>
<td>Aboriginality</td>
<td>5</td>
</tr>
<tr>
<td><strong>Previous hospital admissions within a 12 month period</strong></td>
<td></td>
</tr>
<tr>
<td>3+ admissions</td>
<td>7.49</td>
</tr>
<tr>
<td>2 admissions</td>
<td>4.44</td>
</tr>
<tr>
<td>1 admission</td>
<td>2.74</td>
</tr>
<tr>
<td><strong>Chronic disease</strong></td>
<td></td>
</tr>
<tr>
<td>5+ chronic conditions</td>
<td>Not available</td>
</tr>
<tr>
<td>3 + chronic conditions</td>
<td>3.77</td>
</tr>
<tr>
<td>Diabetes type 1</td>
<td>2.17</td>
</tr>
<tr>
<td>Diabetes type 2</td>
<td>1.37</td>
</tr>
<tr>
<td>Renal disease</td>
<td>1.8-2.1</td>
</tr>
<tr>
<td>Epilepsy</td>
<td>1.59-1.71</td>
</tr>
<tr>
<td>Liver/pancreas</td>
<td>1.54</td>
</tr>
<tr>
<td>AF,CVD, CCF</td>
<td>1.19-1.36</td>
</tr>
<tr>
<td>Mental health</td>
<td>1.37</td>
</tr>
<tr>
<td>Cancer</td>
<td>1.35-1.44</td>
</tr>
<tr>
<td>Asthma/COPD</td>
<td>1.2</td>
</tr>
<tr>
<td>Polypharmacy</td>
<td>1.5-1.68</td>
</tr>
<tr>
<td>CALD</td>
<td>Not available</td>
</tr>
<tr>
<td>Falls</td>
<td>1.27-1.36</td>
</tr>
<tr>
<td>FEV1, HT, BMI, HBA1C</td>
<td>Not available</td>
</tr>
<tr>
<td><strong>Lifestyle and Socioeconomic Factors</strong></td>
<td></td>
</tr>
<tr>
<td>Alcohol moderate</td>
<td>0.8</td>
</tr>
<tr>
<td>Smoking moderate</td>
<td>1.3-1.4</td>
</tr>
<tr>
<td>Living alone</td>
<td>Not available</td>
</tr>
<tr>
<td>Substance Misuse</td>
<td>Not available</td>
</tr>
<tr>
<td>Home oxygen</td>
<td>Not available</td>
</tr>
<tr>
<td>Cognitive impairment</td>
<td>Not available</td>
</tr>
<tr>
<td>Malnourished</td>
<td>Not available</td>
</tr>
<tr>
<td>Rurality</td>
<td>Not available</td>
</tr>
</tbody>
</table>
Appendix 3 NBMLHD Admission and Discharge Risk Assessment
1. INFECTION RISK SCREEN

- Previous Multi Resistant Organism (MRO) No / Yes
- History of infectious disease No / Yes
- Additional isolation precautions: airborne / contact / droplet No / Yes

If risks identified consider isolation / MRO Fact Sheet / refer to Infection Control CNC & ADD TO ACTION SUMMARY

Completed By:
- Name: __________________________
- Signature: ________________________
- Date: __________
- Time: ________

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**INFECTION RISK SCREEN**

- Previous Multi Resistant Organism (MRO) No / Yes
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- Additional isolation precautions: airborne / contact / droplet No / Yes

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Completed By:
- Name: __________________________
- Signature: ________________________
- Date: __________
- Time: ________
2. THERAPEUTIC INTERVENTIONS
• Is the patient receiving: CPAP / Home O₂? No Yes
• AIRWAY – is the patient a neck breather? tracheostomy / laryngectomy No Yes
• Is the patient receiving: Haemodalysis / Peritoneal dialysis? No Yes
• Does the patient receive infusions? Specify: No Yes
• Does the patient have a CVAD? Port / PICC / Central Line No Yes

** ALL IDENTIFIED RISKS **
• If risks identified consider refer to Respirology CNC / Renal CNC / Oncology CNC / ICU CNC & ADD TO ACTION SUMMARY

3. EMOTIONAL WELLBEING
• If the patient has acute and active mental health symptoms, has the patient seen Psychiatry? No Yes
• Is a state of anxiety/depression impacting on patient’s treatment/management? (possible symptoms include excessive or too little sleep or appetite) No Yes
• Is there evidence/history of episodes of delirium, confusion/fluctuation in cognition or wandering? No Yes

** ALL IDENTIFIED RISKS **
• If risks identified consider refer to MO / Social Work / Consultation Liaison Psychiatry Team & ADD TO ACTION SUMMARY

4. COGNITION / COMMUNICATION
• Is the patient: Alert    Cooperative Withdrawn Apathetic Lethargic Hallucinating Other: No Yes
• Are there changes to memory, concentration, thinking, decision making? No Yes
• Is there a known diagnosis of dementia? No Yes
• Is the patient aware of the reason for admission? No Yes
• Is the patient orientated to: Time / Place / Person? No Yes
• Is there evidence/history of episodes of delirium, confusion/fluctuation in cognition or wandering? No Yes
• Patient can’t follow commands or has communication deficits (eg aphasic) secondary to neurological disease/disability (confirm with carer) No Yes

** ALL IDENTIFIED RISKS **
• If cognition risks identified complete CAM, Top 5 and consider referral to MO / OT / Speech Pathology & ADD TO ACTION SUMMARY

5. POLYPHARMACY
• Does the patient suffer from pain, acute or chronic? No Yes
• Does the patient take > 4 medications? No Yes
• Medications brought in to hospital are sent home or stored appropriately? No Yes
• Does the patient take their medications as prescribed? No Yes
• Patient uses a blister pack? No Yes

** ALL IDENTIFIED RISKS **
• If risks identified consider potential risks to MO / Pharmacy & ADD TO ACTION SUMMARY

6. ALCOHOL / SUBSTANCE USE
• Does the patient take opioid substitute? methadone / buprenorphine / buprenorphine and naloxone No Yes
• Does the patient have a stoma? ileostomy / Colostomy No Yes
• Urinary incontinence / dysfunction? No Yes
• Does the patient have: IDC  / SPC   / Urosotomy              Catheter change due: No Yes

** ALL IDENTIFIED RISKS **
• If risks identified consider stool chart / urinalysis / referral to Continence Advisor / Stomal Therapist  & ADD TO ACTION SUMMARY

7. ELIMINATION
• Is there evidence of changes in skin appearance (eg, rash, redness, bruising, localised heat, oedema, induration, skin breakdown, skin erythema) No Yes
• Does the patient have:      IDC  /    SPC   /   Urosotomy              Catheter change due: No Yes

** ALL IDENTIFIED RISKS **
• If risks identified consider ordering special diet / referral to Speech Pathology & ADD TO ACTION SUMMARY

8. (a) NUTRITION
• Does the patient have diabetes? No Yes
• Does the patient have nausea or vomiting? No Yes
• Does the patient require feeding assistance? No Yes
• Does the patient have difficulty chewing certain foods? No Yes

** ALL IDENTIFIED RISKS **
• If risks identified consider ordering special diet / referral to Speech Pathology & ADD TO ACTION SUMMARY

9. SKIN INTEGRITY
• Is there evidence of a wound / skin ulcer? No Yes
• Does the patient live alone and likely to require help? No Yes
• Is the patient likely to have self-care problems? (eg walking, showering, dressing, eating) No Yes

** ALL IDENTIFIED RISKS **
• If risks identified consider wound care / referral to Wound CNC / OT / MO / enter IIMs / documented on WATERLOW & ADD TO ACTION SUMMARY

10. DISCHARGE RISK SCREEN
• Is the patient likely to have self-care problems? (eg walking, bathing, dressing, wound dressing) No Yes
• Does the patient live alone and likely to require help? No Yes
• Does the patient have a carer or do they have caring responsibility for others? (eg, person, animals) No Yes
• The patient have multiple unplanned admissions within 6 months? No Yes
• Did the patient use community services prior to this admission (eg, Community nursing, Meals on Wheels, Home Care)? Who? No Yes
• Has the community service been notified of hospitalisation? No Yes
• Have you any recent changes or concerns at home that may delay discharge (eg, homelessness, safety, hoarding) No Yes

** ALL IDENTIFIED RISKS **
• If risks identified consider referral to Continuing Care / Social Work / Physiotherapist / Occupational Therapist / giving Walking with Carers Booklet & ADD TO ACTION SUMMARY

Completed By:

Name: __________________________ Signature: __________________________ Date: __________ Time: __________