We introduce an innovative intervention in Limpopo Province, South Africa (SA) that was designed to respond to complex aspects of the HIV/AIDS landscape. The embryonic findings suggest that this style of intervention may be a step towards developing a biosocial response to the epidemic that the Joint United Nations Programme on HIV and AIDS (UNAIDS) has called for in the context of ending AIDS by 2030. The reflection is structured in the following way: we explain how we incorporated complex adaptive systems into the intervention design, followed by a brief overview of the findings. In the discussion we highlight the possibility that something similar may have happened in Zimbabwe, from 1997 to 2007, and then discuss the plausible ramifications of this type of intervention in the context of 2030.

The focus of the partnership
The partnership is between an HIV/AIDS-focused community-based organisation called the Waterberg Welfare Society (WWS) and the University of Limpopo. The primary focus of the partnership was to respond to frustrations identified by WWS about the effectiveness of the tools and techniques that were at their disposal to promote wellness within the communities they work with. The partnership became influenced by Vision 90-90-90 and the claim by UNAIDS that ‘business as usual’ is unlikely to achieve the end of AIDS by 2030.[1] It was also influenced by the UNAIDS statement that ‘we need to develop a biosocial response’ to reinforce the biomedical opportunities that are now available to achieve the 2030 ambition.

Managing complex adaptive systems
Managing a complex adaptive system requires knowledge about the basics of complexity theory and the laws associated with the functioning of complex adaptive systems. The literature on the former is colossal and the literature on the latter is equally daunting.[1] However, managing complex adaptive systems has been synthesised into more compact bundles. Managing a complex adaptive system places emphasis on working with the dynamics of the system within which the challenge is situated because the dynamics are co-constitutive parts of the challenge.

An iceberg metaphor and the dynamics of complex adaptive systems
Futures scientist, Inayatullah[4] developed an iceberg metaphor to describe the workings of...
complex systems. He argued that the visible aspect of the metaphor is one
descriptive layer of the phenomenon that is generally represented in the
name attributed to the challenge, such as 'stigma' or 'disclosure'. He then
argued that the submerged aspect of the metaphor represents discrete
layers that influence, sustain and co-constitute the visible descriptor.[4]

In complex adaptive systems, the visible part of the iceberg represents
the characteristics of the issue and the submerged aspects of the
metaphor demonstrate some distinctive properties which co-constitute
the visible descriptor. Feedback between – and within – all of the layers
provides a dispositional, self-regulating identity to the system. The
properties include: a variable number of interacting agents, with an
agent being anything that influences the system; feedback mechanisms
that connect and influence different agents within the system; and
linear – or cause-effect – and non-linear interactions (Fig. 1).

The dispositional, self-regulating identity of complex adaptive
systems reflects two issues: first, although there are multiple inter-
actions between agents, these interactions are constrained – or
restricted – within permeable boundaries; second, the agents tend to
interact more with specific aspects of the complex adaptive system
than with other parts. The sites within the system with which agents
most commonly interact are called ‘attractor sites’. In social systems,
the interactions with specific attractor sites ‘are reflected in patterns
of behaviour which are never exactly repeated but are always similar
to each other’,[5] such as the ebb and flow of rumour and myth
associated with HIV/AIDS.[6]

**Incorporating attractors into the intervention framework**

From the perspective of an intervention design, attractors become
critical for both methodological reasons and implementation.
Methodologically, most of the functionings of a complex adaptive
system are so discrete that it is impossible to identify them, let alone
modify them. However, it is possible to identify attractors using
qualitative research techniques which open a window of analytic
opportunity.[7]

From the implementation perspective, because complex adaptive
systems are unstable and adaptable, it is possible to disrupt them
further, catalysing downstream ripple effects as new attractors
emerge, and/or existing attractors are modified, as the agents
adaptively reorganise around the disruption. During, or after, the
submerged reorganisation processes, the shifts in the overall attractor
landscape can be monitored and the visible social, or behavioural,
emergence associated with each shift in the attractor landscape can
be evaluated. Once there is clarity about which attractor(s) is/are
influencing preferred social practices and/or promoting cognitive
perspectives that contribute to risk reduction, it is then a matter of
reinforcing those attractors to expand the impact and, if possible,
to simultaneously destabilise the attractors that detract from the
project goal. The advantage of this approach is that the intervention
is firmly rooted within the functioning of the system, rather than
focusing exclusively on the visible characteristics of the system.

**Method**

In order to identify existing attractors and to create new ones, two
catalysing influences were applied: an educational package containing
up-to-date information about HIV/AIDS and enabling the participants
(n=21) with the autonomy to introduce the content of the educational
package into their work in ways that they thought would add value. The
findings that were presented were identified using an adapted version of
a qualitative research technique called causal layered analysis[37]
12 months after the educational package was introduced.[38]

**Findings**

Four principal wellness attractors that contributed to reducing the
aggregate community viral load were identified during the interven-
tion pilot: ‘movement from HIV being perceived as a death sentence
to a chronic condition’, ‘the viral load’, ‘relating new knowledge about
HIV/AIDS to personal experience’ and the ‘origins of HIV’. Each of
these wellness attractors was associated with altered social practices
and/or cognitive perspectives that contribute to risk reduction, there-
by reducing the aggregate community viral load (Table 1).

The first three wellness attractors have a self-evident logic to
them. The fourth was a mystery to the university component of
the partnership, but this was explained by WWS. The power of the
‘origins’ attractor, in the context that WWS works, is that it counters
localised rumour and myth about the ‘origins of HIV’ which are
factors that detract from the ambition of reducing the aggregate
community viral load. (Two other pilot studies have been initiated
in other parts of the province and preliminary reports indicate that
the ‘origins’ and the ‘viral load’ attractors are also emerging in one of
them. However, these reports are unsubstantiated at this time.)

Examining the same findings in a slightly different way suggests
that a combination of wellness attractors influence the same social
practices and/or cognitive perspectives that contribute to risk
reduction (Table 2).

The ‘origins’ attractor remains a mystery from this perspective
because it continues to be a source of much positive discussion at
WWS, yet its influence remains ambiguous.

<table>
<thead>
<tr>
<th>Wellness attractor</th>
<th>Associated changes among clients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Movement from HIV being perceived as a death sentence to a chronic condition</td>
<td>More accepting of status (n=2); disclosure (n=3); testing (n=2); improved client management of HIV (n=9); testing (n=8); improved messaging to clients (n=1)</td>
</tr>
<tr>
<td>The viral load</td>
<td>More accepting of status (n=2); understanding false-negative tests (thus the need to return for a second test) (n=5); testing (n=3); understanding co-infections (n=1); disclosure (n=1); understanding serodiscordant couples (n=2); reduction in stigma (n=1)</td>
</tr>
<tr>
<td>Relating new knowledge about HIV/AIDS to personal experience</td>
<td>More accepting of status (n=1); understanding the window period (n=2); disclosure (n=2); overcoming the legacy of ABC (n=1); testing (n=3); understanding serodiscordant couples (n=3)</td>
</tr>
<tr>
<td>The origins of HIV</td>
<td>Relating HIV to personal experience (n=1); easy to explain with new knowledge (n=8); understanding transmission (n=1)</td>
</tr>
</tbody>
</table>

ABC = Abstain, Be faithful, Condomise.
Based on Burman and Aphane.[5]
Discussion

Partially constrained, patterned instability that contains some non-linear interactions makes complex adaptive systems prone to emergent incremental change and innovation. For example, zoonosis happens because of the gradual coalescing of the interactions and feedback between novel agents as different systems become compressed into a complex adaptive system, giving rise to emergent possibilities that may adapt into qualitatively new phenomena – such as the emergence of HIV about a century ago. Despite limited numbers, we have demonstrated that during the first pilot study it has been possible to generate emergent social practices and/or cognitive perspectives that contribute to risk reduction and identify the submerged wellness attractors that are associated with the emergence. The partnership is now in the process of reinforcing these attractors to determine if this will increase the impact of the intervention.

In the discussion that follows we will only claim abductive plausibility because we believe that further work is required to determine the effectiveness of the intervention design.

What could have happened in Limpopo?

Many of the WWS participants expressed frustration with the inadequacies of their existing tools and techniques to promote risk-reducing social practices. This could indicate that prior to the intervention dispositional characteristics of the system were: (i) frustration; and (ii) a desire to respond to this frustration by developing new tools to improve the impact of their work. A comprehensive educational package was delivered and the participants began the low-cost process of incorporating the new knowledge into their work. The educational package could have acted as a catalyst that produced disproportional changes – the new wellness attractors – and 12 months after the attractors were identified WWS continues to work with them because ‘structure and coherence’ is developing to such an extent that they believe they are the foundations of future prevention and risk-reduction tools.

Other plausible examples of complex adaptive change processes

The most striking example is the dramatic decline in HIV prevalence – in the absence of widely accessible antiretroviral medication – in Zimbabwe, from 1997 to 2007. In Table 3 an analysis that was published in 2011 is re-examined from the perspective of plausibility and complex adaptive systems.

It is plausible that a range of discrete feedback loops and relationships gradually altered the attractors on a significant scale in the Zimbabwean HIV landscape that enabled spaces to emerge for a shift in specific social practices and/or cognitive perspectives that contribute to risk reduction that may account for the dramatic, home-grown, biosocial decline in HIV prevalence. One thing is certain, the 2011 account was developed by high-level academics and despite deliberate attempts to identify specific rational causes of the overall decline, none was identified, which goes some way to plausibly suggest that the perspective we have presented may have the potential to be applied on a national scale.

Table 2. Attractors that influenced more than one social practice and/or cognitive perspectives that are associated with risk reduction

<table>
<thead>
<tr>
<th>Surface descriptor/characteristic</th>
<th>Date of window period (n=18)</th>
<th>Death sentence→chronic</th>
<th>Relating to prior experiences</th>
<th>Viral load</th>
<th>Tools and techniques</th>
<th>Origins of HIV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Encourages testing (n=11); including awareness about the implications of the window period (n=18)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Encourages disclosure (n=7)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accepting status (n=3)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Understanding serodiscordant couples (n=5)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Messaging to community (n=11)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Based on Burman and Aphane.15

Table 3. A plausible perspective of the dramatic decline in HIV prevalence in Zimbabwe

<table>
<thead>
<tr>
<th>Could complexity explain what happened in Zimbabwe to reduce HIV prevalence from 29% in 1997 to 16% in 2007?</th>
</tr>
</thead>
<tbody>
<tr>
<td>An unstable context</td>
</tr>
<tr>
<td>Identified drivers: ‘causal pathways’ (but no proof)</td>
</tr>
<tr>
<td>Plausible wellness attractors</td>
</tr>
<tr>
<td>Emergent social practice</td>
</tr>
<tr>
<td>Reinforced by</td>
</tr>
<tr>
<td>Was there a dominant linear (cause-effect) driver? No</td>
</tr>
<tr>
<td>Similarities to the Limpopo findings? Yes</td>
</tr>
</tbody>
</table>

Based on Halperin et al.16 analysis of the Zimbabwean decline in prevalence.
techniques designed to work with complexity, including electronic monitoring and evaluation tools that could be aligned to SA’s eHealth strategy,\textsuperscript{11,15} to warrant further investigation. This would require further pilots to empirically determine if this style of intervention could contribute to developing one of the biosocial responses that UNAIDS calls for.

Conclusion

We have introduced some embryonic findings from Limpopo which suggest that working with HIV risk reduction and prevention using management techniques associated with complex adaptive systems may hold potential to open innovative biosocial spaces that could contribute to the ambition of ending AIDS by 2030. In this instance one educational package, followed by experimental efforts to apply the knowledge, catalysed the emergence of four wellness attractors that influenced biosocial factors that affect the trajectory of the epidemic. By reinforcing these attractors it is plausible that ‘disproportionately major consequences’ that reduce the aggregate community viral load could occur. It is also plausible that this style of intervention could contribute to developing a biosocial response, as called for by UNAIDS. The striking resemblance between the Zimbabwean and the Limpopo attractors could indicate that wellness attractors can influence the epidemic on a national scale. The emergence of HIV was enabled by complex zoonotic processes almost a century ago.\textsuperscript{30} It is plausible that complexity can now contribute to reducing its presence in the build-up to 2030.

What could the implications be for developing a biosocial response to the contemporary epidemic as a contribution to ending AIDS?

It is plausible that this style of intervention could be applied to diverse aspects of the treatment and care continuum that demonstrate complex instability. The process would include identifying instability along the continuum, catalysing the emergence of new attractors that make sense to the target groups and working with the attractors to develop and reinforce appropriate strategies to reduce the aggregate national viral load. The ‘value add’ in this approach is that, when there is instability that is difficult to manage using conventional mechanisms, the identification of relevant attractors and reinforcement of those attractors enables a targeted response that makes sense in different contexts because the process is hard-wired to incorporate localised characteristics of the HIV/AIDS landscape.

Despite the limitations of the pilot study in Limpopo, there has been sufficient international growth in management tools and understanding to incorporate localised characteristics of the HIV/AIDS landscape. What could the implications be for developing a biosocial response to the contemporary epidemic as a contribution to ending AIDS?

\begin{table}
\centering
\begin{tabular}{ |c|c|c| }
\hline
\hline
15 - 24 years & \checkmark Down 60\% & \xmark Up 67\% \\
25 - 49 years & \xmark Up 17\% & \xmark Up 25\% \\
\hline
\end{tabular}
\caption{Changes in new infections (incidence) – SA}
\end{table}

\begin{table}
\centering
\begin{tabular}{ |c|c|c| }
\hline
15 - 44 years & 2.28\% & 1.21\% \\
2012 incidence & 1 in 44 women became infected in 2012 & 1 in 83 men became infected in 2012 \\
\hline
\end{tabular}
\caption{2012 incidence}
\end{table}

\begin{figure}
\centering
\includegraphics[width=\textwidth]{fig2.png}
\caption{HIV incidence 2002 - 2012, SA (based on the South African National HIV Prevalence, Incidence and Behaviour Survey, 2012\textsuperscript{11,12}).}
\end{figure}


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