



# -RXUQDO RI &DQFHU 6FLHQFH 7KHU

5HVHDFK \$UWLFOH

2SHQ \$F

## 6Q SFHVMBUJPO PG .JTNBUDI 3FQBJ5 1BUIXBZ \*NQMJDBUJPO POT PO UIF VTF PG 5FNP[PMPNJEF

+DULVKDP PLNDPDUDQD\DNH HW DO VVRGHWK RRPDXUNLSXSGQ 0DULH 0DDQVDD6WEGSLNDNDLQHQQD .DLNNRQH  
 0LLD 7DDYLW7DDLDHQRWJLHO 3DUNHHSUSFQGD +HUWXXDOD  
 0ROHFXODU 0HGLFLQH 5HVHDFK \*URXS \$ , 9LUWDQHQ ,QVWLWXWH 8QLYHUVLW\ RI (DVWHUQ )LQODQG  
 6FLHQFH 6HUFLH &HQWUH DQG \*HQH 7KHU\S 8QLW .XRSLR 8QLYHUVLW\ +RVSLWDO .XRSLR )LQODQG  
 &RUUHVSRRGLQJ\SRWKRQ +HUWXXDOD 0ROHFXODU 0HGLFLQH 5HVHDFK \*URXS \$ , 9LUWDQHQ ,QVWLW  
 )LQODQG 7HO )D[ (PDLO VHSSR \ODKHUWXXDOD#XHI IL  
 5HF GD-WQH \$FF GD\$XHXVW 3XE GD\$XHXVW  
 &RSULJKW 6DPDUDQD\DNH + HW DO 7KLV LV DQ RSHQ DFFHVV DUWLFOH GLVWULEXWHG XQGHWK  
 XQUHVWULFWHG XVH GLVWULEXWLRQ DQG UHSURGXFWLRQ LQ DQ\ PHGLXP SURYLGHG WKH RULJLQDO D  
 (TXDOO\ FRQWULEXWHG

\$EVWUDFW

2EMHFWKH GHSHQGHQF\ RI WKH HIILDFD\ RI WHPRJRORPLGH 70= RQ FHOOXOD  
 WKHUDSHXWLFDOO\ HIIHFWLYH LQ DSSUR[LPDWHO\ KDOI RI PDOLJQDQW JOLRPD 0\*  
 UHSDLU \V\WHP \$GHQRYLUXV PHGLDWHG +HUSHV VLP\$GH+9 WNKVXWK\BHG LQH NLQD  
 JHQH WKHUDS\ LV HIIHFWLYH LQ WKRVH DV ZHOO DV LQ 0\* SDWLHQWV ZLWK D IXQF  
 WRJHWKHU WKHVH WZR WKHUDSLHV VKRZ HYLGHQFH RI \QHUJLVWLF F\WRWR[L  
 EHHQ TXHVWLRQH G DV WKH H\DFW PHFKDQLVP KDV EHHQ XQNQRZQ

0HWKRQH XQGHU\LQJ PHFKDQLVP ZDV VWXGLHG LQ UDW DQG KXPDQ 0\* FHOO  
 RUWKRWRSLF \QJHQHLF UDW 0\* PRGHO

5HVXOWKH UHVXOWV IRU WKH ILUVW WLPH UHYHDOHSGDQKZDUHQXO'DWHLQVRIP  
 E\G+69 WN WKHUDS\ DQ DGM\$G+69 WNIH\$SRWRSRSRWRLF WKHUDSHXWLF PRGH RI  
 HQKDQFHG WKH F\WRWR[LFLW\ RI \$G+69: WNKVXWK\BHG QZLLWDOO\ UHVLVWDQW 0\*  
 VHQLVWLJHG WR 70= WUHDWPHQW 7KH HQKDQFHGHYODWRD VD+QVIHFLEWFLZDUHDONP  
 VXUYLYDO DQG D UHGXFWRQ LQ WXPUR JURZWK UDWH ZLWKRXW DIIHFWLQJ WKH

&RQFOXVLRQ VWXG\ GHPRQVWUDWHV \$G+69 HUND\*QGLFORXWFRPMPRIQW FRPELQDWL  
 XQGHU\LQJ PHFKDQLVP IRU WKH \QHUJ\ DQG D SRVVLEOH LPSURYHG WKHUDSH  
 ILQGLQJV PD\ KDYL DQ LPSDFW RQ IXWXUH FOLQLFDO XVH RI WKLV WUHDWPHQ  
 FKHPRWKHUWV ZKLFK \$G+69 HUND\*QGLFORXWFRPMPRIQW DFWRQ

.HIZRUQDOLJQDQW JOLRPD 6XLFLGH JHQH=WZKULB5\LVHDFKORRPHWKHUDS\ DSSUR  
 0LVPDWFK UHSDLU 6\QHUJ\ \$GHQRYLUXV\OLRESODN\$RIPD PXOWLIRUPH \*%0 > @  
 DON\ODWLQJ DJHQW WKDW FURVSHULW\W\H  
 ,QWURGXFWRQ  
 0\*V DUH DJJUHVVLYH EUDLQ WXPURV FDUWKHQXQDQWLRQWISJRUQSDWZQV QD  
 VSLWH RI WKH FXUUHQW VWDQGDUG RI FDUH QZKPHWKQF QXGHV\XUWLVFDQ\*0H VHFV  
 IROORZHG E\ UDGLRWKHU\S ZLWK UHSDERPLWDQW JROGH\DESDNDQWIXQFWLF  
 FKHPRWKHU\S > @ WKH RXWFRPHLRI ZLWKHQWDFWVYQOLQHPSSUR[LPDWHO\  
 XQPHW FOLQLFDO QHHG KDYLGRHQWWRPHWUHQWLYHWDOH\$69\MPDQW WKHUDSHXV  
 H\HFVWLVHDFWPHQWV IRU WKLV FDQFHU RI DFWLRQVHFWORWLV PHFKDQLFQYVWFKV  
 SDWLHQWV\KBUHYLRYXVWYGLHYKDYH  
 H[SHULPHQWDO WKHUDSHXWLF RSWLRQ FKHU@SHDWHGVS\DLQFLSDGGRKOHU  
 SUR GUXJ DFWLYDWRQ +69 WN HQ]PH\PROYHUVFHW%HHQVXLFPSRXQGV WKHU  
 VXFK DV \*&9 LQWR WR[LFWDEROLWV\EV @ DOHDELQWKRHV > @ EYWKH  
 FHOO F\FOH GHSHQGHQDQKHU GLYLGLQJFHOV  
 &\WRWR[LFLW\ RI +69 WN \*&9 EYWKH WUHDWPHQWVHDFK WUHDWPHQW D  
 > @ DQG ORFDO DQG \VWHPLF LPPXQHUVSRQV69 @NDQGDWFRPLQDQWLVH  
 PRVW ZLGHQ\ VWXGLHG VXLFLGH JHQH=ZWKHUXSDH\$SRWRSRSRWLFQZDQK SDYDQYHOC  
 HyFDEQ VHYHUDO FOLQLFDO WULDOV > LQDQ LPPXQRFPSHWHQW RUWKRWRSLF  
 W\HFDRI WUHDWPHQW FRPELQDWLVHDFV

WXPRU YROXPH DQG DQLPDO VXUYU\ VUW HXUW UH V X O MSH D J K F W G D W Y H L W R U R J K H & D  
WLPK WKH XQGHUO\LQJ PHFKDQL\ S P + 6 R P D O K H D F V Q X H U H U V P S E U R W Z R H R Q 51\$ ZDV UH Y  
W/N \*8DQG 70= )XUWKHUPRUH ZH KDYX / S H U C H L Y H U D M H G U D Q S R W H S O W L D H 0%, )HUP  
WUHDWPHQW SURWRFRQ WR FRPELQH W K I O V H P S Z S O W K Y H U D S L Z H U H Q P W O M X H U [ S G F E W D U  
RI PD[LPL]LQJ WKH WKHUDSHXWLVH FRM W R W R H I D 3 R P W H Q 3 & 5 L D V D G Y H U H \$ S S O L H G % L R V \ V  
WUHDWPHQW FRPELQDWLRQ ZHUH DOVRV Y H D P H G H H [ S U H V V L R Q D V D V \ S S O

ODWHULDOV DQG OHWKRGV

\$GHQRYLUXV YHFWRU

\$G+69 & WUHSURHPSOLFDWLRQV W H J H Q H O W 7 R V K R Z X S U H J X O D W L R Q L Q D K X P D Q 0\* F  
( GHOHWG VHURWISH DGHQRYLUXV G Y H F W W O F D U P O L G D \ + 6 8 W N W U H D W H G Z L V  
GULYHQ E\ D F\WRPHJDORYLUXV SURPRW H U D P R O H V I N U Z D V 3 & 5 + H O H H E B O O W W E W H  
D Q S X U L F H G H Q V L W \ J U D G L H Q W F H Q W U L I X J U D W L R Q @ 8 Q W U H D W H G L F H O O V Z H U H X  
\$UNHUDSHXWLVH ) L Q O D Q G V V R F N W H W W H G W H G E H J U H H  
RI UHSOLFDWLRQ FRPSHWHQW YLUXV H V O L S R S R O V D E F K D U L G H D Q G D R W K H U  
ELRORJLFDO FRQWDLQDQWV KDG D Q H U P D O \ D F F R U G L Q J W R W K H P D Q X I D F W X  
SDUWLFOHV PO U H Y H U V H W U D Q V F U L E H G W R F I S E \ 5 H Y  
6\QWKHVLV . H W P R L V 6 H U H Q V \ F : D O W K D P

&HOO OLQHV DQG SKDUPDFHXWLFDO

5DW %7 & > @ L V H O P U R X W H U V L W \ R I 8 \$ H U X V S H F U Z H Y  
DQG KXPdq 8 0\* \$7&& +7% 0\* F H O O V Z H U H J U R Z & \$ L Q 86\$ IRU KXPdq 0/+  
'XOEH PFRGM\ H O J O H V D P H G L X P D Q G K X P D Q 0 6 + 7 + + \* D \* H O O V D Q G E H W D D F W L Q T  
\$7&& &5/ %RU\$V 6ZHGHQ ZHUH Q R Z P Q L D P L R P D O H V V H Q W L D O  
PHGLXP FRQWDLQLQJ / JOXWDPLQH DQG JOXFRVH VXSSOHPHQWHG ZLWK  
IHWDO ERYLQH VHUXP +\FORQH /RJDQ Q 8 7 H B S H U L S P O H Q W D O P R L Q H O Z H U H  
DGKHUHQW DQG JURZQ DW r & L Q 7 0 # K H P S U H Y H Q F H S R I W H Q W & 2 L Q E U H G P D O H %  
7HPRG D O K H U L Q J 3 O R X J K O H U F N : K L W H K F X V H 6 W D W L R Q D O F H 8 6 \$  
PJ FDSVXOHV ZHUH GLVVROYHG LQ D V G R F U L E H G H W K V P Z K Y O S K R I L G J E H D U L Q  
VDOLQH GDLO\ EHURH WKH LQMFWLRQV D V G R F U L E H G H W K V P Z K Y O S K R I L G J E H D U L Q  
ZDV SUHDUHG DFFRUGLQJ WR P D Q X I D F W X U H U V L Q W W U X F W L R Q V W K H W L D H G U D  
PJ PO VWRFN VROXWLRQ \* R 3 3 R P K M H Q M S R R W K H U L J K W R I E U H J P D L R O W D R G H S W K R I  
)LQODQG ZDV GLOXWHG LQ P O R I Z D W H U W O \ D P L O W R Q V \ U L Q H \ D P L O W R Q  
PJ PO VWRFN VROXWLRQ S O D F H G R Q D V W H U H R W D F W L F G H Y L F H \$ O  
E\ WKH (WKLFDQ &RPPLWWHH RI WKH 8QLY  
WKH HWKLFDO SHUPLW QXPEHU (6/+

, Q Y e f f e c t i v e n e s s D Q G V \ Q H U J L V P H [ S H U L P H Q W V

7R GHWHUPLQOH WUHSURHPSOLFDWLRQV W H J H Q H O W 7 R V K R Z X S U H J X O D W L R Q L Q D K X P D Q 0\* F  
DQG V\QH 3 & 5 IRU 06+ 70= %7 & 8 0\* D Q G V H O F H R I W H X U R E H G 0 2 D R Q S R V W  
7 \* FHOOV SHU ZHOO ZHUH SODWHG H R O V R Z H O O S O D W H V R Q G D \ ( R O O R :  
WUDQVGFXL\ S G L F S Q Z W W O 2 , V D Q G % 7 & D G G V D Q G D V G H V F U L E H G H O V H Z K  
D Q G D Q G 8 0 \* L Q Z H O O S S O D W H A V T R O L G D \ G X E H G R Z H U K D Q G V R D X O M D O F H G  
02, V ZHUH XVHG ZLWK 8 0\* FHOOV EHF\XVH R I W K H L U Q J I D U H P H V P H O V L W L V R I W  
WR WKLW WKHUDS\ &HOOV ZHUH WUHDWHG Z L W K D O W I P O \* & 9 D Q G R I G F 7 0 D W R Q  
GRVH RI RU W P R O O R Q G D \ I R V H U I D E H G W U H D W H G F H O O V Z H U H  
XVHG DV FRQWUROV &HOO Y L D H M O H D W P Z D W P H D W X U H S R Q W L D H G 8 Q L W \ Q R Y D 3 D  
XVLQJ D G L P H W K \ O W K L D J R O \ O J H Q F D D E R I P H W K R O D O L P D J H V O R S I Y L H Z V R K L  
VXOIRSKHQ\O + WHWUD]ROLXP 076 TM D V D P 3 R P H J D Q & H O O T L W H U  
\$TXHRXV 2QH 6ROXWLRQ &HOO 3UROH U H D W L R Q S V V D V D F F R U G L Q J W R W K H V  
PDQXIDFWXUHUV LQVWUXFWLRQV \$ E V R Z X P P R O X P H Z D V D F F R U G L Q J W R E V G H O  
D V S H F W U R S K R W R P H W H U O H D Q V R I W K H W U L S O L F D W H Y D O X H V D U H S U H V H Q W H G

57 3&5 IRU 0\*07 06+ DQG 0/+

7R HYDOXU D M R H V W H G 9 W N D \* 6 9 7 0 = R Q 0 \* 0 7 D Q G \$ V H W K H V W 0 5 , D Q L P D O V Z H U H W U H D W H G R F  
005 SDWKZD\ %7 & FHOOV ZHUH SODWHG S H U Z H O O R O W R W Z H O O  
SODWHV RQ GD\ S V U D Q V X F H G Z L W K G D \ J U R X S W K D W T P E P 6 9 W N D \* 6 9 7 0 = F R P E L Q  
WUHDWHG ZLWK W J P O \* & 9 D Q G V D R S G R W R F R O L Q F O L Q L F D O W U L D O V Z K H U H  
IRU 57 3&5 ZHUH FROODFWXUHG D Q G G R W U L F O R Q W L D G D V W U L F O R Q W L D G V I H U I R O O R Z H G E \ F R P P  
8QWUHDWHG FHOOV ZHUH XVHG DV FRQWUROV 7 R W D O 51\$ ZDV H [ W U D F W H G I U R P

&LWDW 6X LFLGH \*HGH 7KHU DS \ ,PSOLFDWLRQV RQ WKH XVH RI 7HPR]RORPLGH 7UHDGPHQW L

JURXS \$ FORVHO\ UHSUHVHQWV WKLV LFO IUDFFKH GW U, IOD OWSLGR WIRRXS H [FRHSEW Q B U  
UHGXFWRQ RI \*&9 WKH UDS\ WR GDWU HDQW RHU G W ZHU HF RPSLOWHWHG EVR RV KW H V W  
WKH UDSLHV EHIRUH WKH PHGLDQ VXUYLYDO \$ DW KZD V E V R I W W K I W D Q J H U F D W K H O P R G H C

&HOO O	7.	*&9	9LDELOLW	9LDELOLW	70= PRO O	*&9	70= PRO O
%7 &	02,	J PO	PRO O	7. 02,		7. 02,	
K							
8 0*	02,	J PO	PRO O	7. 02,		7. 02,	
7 *	02,	J PO	PRO O	7. 02,		7. 02,	
K							

7KH V\QHUJLVP IRU WKH FRPELQDWLRQ RI \$G+69 WN \*&9 DQG 70= ZDV GHULYHG DUE DUB FWHORQ DO DSEURGX  
WUHDWPHQW ZLWK \$G+69 WN \*&9 DQG 70= WKH UHSUHVHQWV WKLV LFO IUDFFKH GW U, IOD OWSLGR WIRRXS H [FRHSEW Q B U  
GUXJ FRPELQDWLRQ LV DGGLWLYH HIIHFWV\QHUJ\ LQ EROGLW DQGDJRQLVP \$G+69 WN 02, V DQG  
FHOOV DQG DQG IRU \$ PO \*FHOVDVZEVWELQHG ZLWKPRO O DQG DQG WKH YLDELOLW\ GHWHUPLQHG  
+ +RXUV 02, 0XOWLSOLFVW\ RI ,QHFWRQ 7. 7K\PLGLQH .LQDVH +HUSHV 6LPSOH\ 9LUXV 70= 7HPR]

7DEOH\ QHUJ\ GHWHUPLQDWLRQ E\ IUDFWLRQDO SURGXFW PHWKRG RI :HEE > @

7UHDWPHQW WKH DQLPDOV ZHUH REVHUYHG GDLO\ PHDVXUHPHQWV WULDEOHKH FULWHUGD\ QREUGHXV  
H \$G+69 JHQH WUDQVIHU ZHUH FRQGXFWRQ IRU HUSVFW\ GDRY (DQGHUO ) LOODQG  
\$ WRWDO YHFWRU YROXP RI W & PDLWVH G F H U H G X V L Q J D  
+DPLWRQ V\ULQJH SODFHG RQ D VWHUHRWDFWLF GHYLFH \$ YROXP RI O SHU  
ORFDWLRQ ZDV LQMHFWHG DW YHUWLFDO GHSWKV RI PP DQG PP IURP  
EUHJPD QHYHODWPHQW SURWHUWV SVRLV SODV\HV RI EORRG DQG VHUXP VDPSC  
VXPPDULJHG LQ 7DEOH ,QWUD SHULWRQHPRG DQG \*VH ZR V DP SURFSLHU L BR O U  
WKH GDWU DVW JHQH WUDQVIHU VWXUHQHURXS OORRORRQ V RXQW )%& DQG FOL  
WUDQVIHU 6WXG\ JURXS V DQG DW ELWRUWEDQGRVHURDWLQJH GDONHOLHW S  
JLYHQ LQ WZR HTXDQ GRWHVIRUK FROUWFEQWYHGDVHVDVH \$/7 DW .XRSR8QLY  
ZDV SURYHFVWLDHQVW 0\* LQ VHYHUDO SUH' FOLQLFDO &' FHOOD FRXQWR ZHW R P B W D  
FOLQLFDO VWXGLHV > @ ,3 LQMHFV\ SDFRWR = ,DV%D %L R V E H G R V H R I D Q -R V  
PJ NJ GD\ IRU FRQVHFXYLYH GDV\ ZHUWLEHGUHHG \$R X W O R X V A H Y G W L E H S W L Q ' ;  
7DEOH 70= GRVH DQG WKH GXUDWLRQ & ZRU X H G S W L U B D Q H S' E D V % C R R Q L H Q F H V  
OLWHUDWXUH > @

6XUYLYDO 6WDWL VWLFDO DQDO\HVH \$OO VWDWLVWLFDO GDWD ZHUH DQDO\H  
6XUYLYDO ZDV FDOFXODWHG IURP WKH GDWD WRWZDQVH SDFRWR LQR F\DO DRVLRQ &R  
WKH GD\ RI HXWKDQDVLD RU GHDWK RIYD FURQ PLO DELXULVJ DWK 57\ \$ 85 JURHQV HG





&HOO OLOH FRPELQDWLRQ				'RVH LQGLYLGLXDO GUXJ IRU VDP (5,)DIROG				
7. 02,		70=	(IIHFW	7. 02,		70=	7. 02,	70=
*&9 J PO		PRO O	)D	*&9 J PO		PRO O	*&9 J PO	
% 7 &								
8 0*								
7 *								

'5,V GHULYHG IURP WKH &RPSX6\Q DQDO\HVH > @ K DIWHU WUHDWPHQW UHYHDOV D PXOWL IROG U  
 VDPH IIIHFW LQ PRVW LQVWDQFHV LQ EROG ZKHQ WKH WZR WUHDWPHQWV DUH LQ FRPELQDWLRQ FR  
 \$GHQRYLUXV OHGLDWHG +HUSHV 6LPSOH[ 9LUXV 7K\PLGLQH .LQDVH '5, 'RVH 5HGXFWRQ ,QGH[ )D )UD  
 7K\PLGLQH .LQDVH +HUSHV 6LPSOH[ 9LUXV 70= 7HPR]RORPLGH

7DEORH RVH UHGXFWRQ LQGH[ '5, IURP WKH &RPSX6\Q > @GDQDQXZLWIRUWKHQR

H H[SUHVVLQR RI 0/+ DQG VLQL)P505RDUVJURZWK  
 HOHYDWHG LQ DOO SURXSW WUHDWPHQWV  
 ( ORUH WKDQ DQG IROG LQFUHDVHV LQ WUHDWPHQW WKH WUHDWPHQW FRPELQD  
 ZHUH REVHUYHG DUWLQJ \*&9 WKH \$069 RUWKRWRSLF V\QJHQHLF %7 & > @ UDW 0  
 WU \*DQG FRPELQDWLRQ JURXS UHVSHFWLYHO\ D PRGH WKDW KDV HDUOLHU  
 LQFUHDVHV ZHUH ! DQG IROG IRU WKH WUHDWPHQWV UHSHFWLYHO\  
 )LJXUH ( +RZH QHUFODD VHV ZHUH REVHUYHG \$ QUB51\$  
 OHYHOV LQ WKH XQVWUHQWLG FRQVORQH DQRXS  
 DW WKLW WLP SRLQW RU DQ HDU D WUHDWPHQWV KDG D WUHQG WRZDUGV D ORZH  
 WUHDWPHQW 5HVXOWV LQGDVW VDWKZDW LPSDUXS WR JKXYS 6WXGJULRQDZHOV  
 VHDQHU WLP ODJ RI \$GK69KQGE \*R&KDUH PHDQ WXP RU YROXPHV ZKHQ FRPSD  
 SUHVHQW ,W LV SRVVLEOH WKDW WKH VSWH RI VVXG) JURXS QRW HHHYH60R  
 SHULRGV EXW WRRU)URXQGHORLQDQVHUY%RI FRPELQDWLRQ WUHDWPHQWV LQFRXSO  
 WUHDWPHQW FHOOV GLG QRW VXUYLYH EHLQGH WXP RU YROXPHV FRPSDUXS WR JUR  
 0/+ DQG 06+ P51\$ OHYHOV ZHUH REVHUYHG SRVVLEOH QZ WK 0 VWK0 V&QV XUDXSDH UD  
 FHOODVH \$K+69 WNW09 WUHDWPHQW )LJXUH VXUYLYLQJ DQLPDV 05,V UHSUHVHQWDW  
 IRU HDFK JURXS IURP S L GD\V XSSHU  
 LQ )LJXUH &











JOLRPD \$63(BQGRSPRSHQ ODEHO SKDVH W3DDNLDQDQHW 2QFRHO HU +7 0F'RQDOG ./  
UHSDLU PHFKDQLVPV WR GHWHUPLQLQJ FKHF  
&ORXJKHV\ )'\$ DFFHOHUBMCHG\VDSELDYDORPDRPD - &OLQ 1HXURVFL  
/DQFHW 2QFRO 7DNDJL < +LGDND 0 6DQDGD 0 <RMKLGHDQW  
2VWHUPDQQ 6 &VDMND & %XFOLQ 7 /HYUQLWLDQMYWHA) RHWSRQ SWRVLV LQGXFHG E  
3ODVPD DQG FHUHSRVSOLDODORQ SKDUPDFR%NRQKMLSVKDRPDRFO  
WHPR]RORPLGH LQ PDOLJQDQW JOLRPD SDMLLMQWV\$K&DQ) &DQFKHROVNDV \$ 6DPDUDQDVA  
H V\QJHQHLF %7 & UDW PDOLJQDQW JOLRPD  
1HZODQGV ( 6WHYHQV 0 :HGJH 6 :KHHOKRORP\$R%FVNF EHOOV LQ WXPURV &DQFHW  
7HPR]RORPLGH \$ UHYLHZ RI LWV GLVFRYHU\RKHP.LFDVOKSRSHJMKLHV SUH 3HLLQFDOL]H  
GHYHORSHPHQW DQG FOLQLFDO WULDOV &DQFHLRZODDWRPHY 0\*07 SURPRWHU PHWU\ODW  
.DLQD &KULVWPDQQ 0 1DXPDQQ 6 5RRV :3 0\*07 \$ NH\  
QRGH LQ WKH EDWVOH DJDLQVW JHQRWR[LFLWLOCFD3FLHQYRQHQ LFLW%HWQGVNSFSV&RVGL/ 3  
LQGXFHG E\ DON\ODWLQJ DJHQWV '1\$ 5HSDU'RVV RI WKH PLVPDWFK UHSDLU SURWHLQ 0  
'd\$W6L \*UD]LDQL \* /DFDO 30 1LVWLF' 9 \*DVEFLVLDWHG ZWW6OWXPRU SURJUHVVLRQ GX  
JWWHQXDWLRQ RI 2 PHWK\OJXDQLQH '1\$ PHWU\ODVQVVIHUDVH DFWLYLW\ DQG  
P51\$ OHYHOV E\ FLVSODWLQ DQG WHPR]RORPLGH LQ MXUNDVQDQH006WXS3KBUPLDFRO HW D  
([SHU 2 PHWK\OJXDQLQH PHWK\OWUDQVIHUDVH 0  
+HJQ( 'LVHUHQV \$& \*RUOLD 7 +DPRX 0) 'H ZUWERFQLQ LFDQWRXW FRPHV LQ JOLREODVWRP  
0\*07 JHGH VLOERERHQWDRPHPR]RORPLGH LQ JOLREODVWRP 1 &OLQ 2QFRO  
(QJO - OHG +HULVWRQXPSS % :LFN : :LVFKKXVHQ - 1D  
4XLQQ -\$ -LDQJ 6 5HDUGRQ '\$ 'HVMDUGLQV PSHWK\OJXDQLQH '1\$ PHWU\OWUDQVIHUDV  
3KDVH , WULDO RI WHPR]RORPLGH 70VHPR]RORPLGHVHFDQVHFDQV LQV LQKXPDPDO  
DGXOWV ZLWK QHZO\ GLDJQRVHG JOLREODVWRPD PXOWLIRUPH EHIRUH  
UDGLRWKHUDES\ - 1HXURRQFRO /L 6 -LDQJ 7 :DQJ = ,PSDFW RI S  
5DLQRY )HOV & 'URJH -: 6FKDIH & .UDPWHPR]RORPLGH LQ ORZ 0\*07 H[SUHVVLRQ J  
7HPR]RORPLGH HQKDFHV KHUSHV VLPSONHYLQVW WKHPLQGHVNLQDQVH  
DQJFLFORYLU WKHUES\ RI PDOLJQDQW JOLREODVWRPDQDQV)OHQ 2 '1\$ UHSDLU QXFOH  
6WHGW6DPDUDQD\DNH + 3LNNDUDLQHQ - 0DDWWD \$0 SODVDDUHOD / HW DO  
,PSURYHG WKHUODPHXWLEDDQW JOLRPD ZHWW\IDSHUQRTYLUDDQDQDQDPI&URPSWRQ 1( HW D  
VXLFLGH JHGH WKHUES\ FRPELQHBUZLWK WHHFR]ROBPLGH\$ 'HSHHVVRQ RQ WUHSXHUQR  
GH}FLHROVRQ FDQFHU FHOO OLQH +&7 &DUF  
7\QHO6DQGGPDLU \$0 7XUXQHQ 0 9DQQLQHQ 5RL9DLQEPD8 SHV&DDXKDQ&DBUH&KHUHWQD6  
\$GHQRYLUXV PHGLDWHG KHUSHV VLPSONHYLQVW WKHPLQGHVNLQDQVH DQJFLFORYLU  
WKHUES\ LQ %7 & UDW JOLREOD PRGHO &DQFHLFURQVWHOOLWH LQVWDELOLW\ DQG UHG  
/DHU2P 5DMHZVN\ 0 1HRSODVWLF WUDQWLURPVRWVROHULQGHV DQDFRORQ WXPURV F  
EUDLQ FHOODVHQRXVXWUWR HWK\OQLWURV KXUHPXW DQVYRQ - &DQFHU 5HV  
&DQFHU ,QVW &KULVWPDQDQD % 1XFOHDU WUDQVORF  
6DPDUDQD\DNH +' 3LNNDUDLQHQ -7 :LUWK 5URWHLQW 06+HVDQ 06+HVDQ UHVSQVH R  
6ROXEOH YDVFXODU HQGRWKHOLD JURZLQ 6FHPUR UHFHSWRU HQKDFHV WKH  
HyFDRI VXLFLGH JHGH WKHUES\ LQ DQ DQJLZLHROHVLV LQ6SKKHQHQWDFP6QSHU:LQVRQ 7  
+XP \*HGH GH}FLHROV DQFHV WXPURV FHOO VHQVLLWLYLW  
)ULHGPDQ +6 'RODQ 0( 3HJJ \$( 0DUFHOOHQ .HLO 6 HW DO  
\$FWLYLW\ RI WHPR]RORPLGH LQ WKH WUHDVWHQVORV FHOQVUHO/FOHUYHXV- VLVWHP HW  
WXPURVURJUSDDQV FHU 5HV DON\ODWLRQ WROHUDQWGHFPHWUODW66PDSH F  
%ORXJK 0' %HDXFKDPS '& :HVWJDWH 05 PH0DQWFK &HSDUFRVURF\*1DWO \$FDG 6FL 86\$  
(vHFM DEHUUDQW S IXQFWLRQ RQ WHPR]RORPLGHVHFDQVHFDQV LQVWLYLWYROYHPHQW RI W  
JOLRPD FHOO OLQH V DQG EUDLQ WXPURV LQVWVWVLIQ 66VQOHRSQDQVWLLFEGDXWRPHV/LVW  
1HXURRQFRO  
:DQJ ; &KHQ - /LX < <RX & 0DR 4 0XWDDQW 73\$HEIQ6DQFRZVORR0% RI '1\$ PLVPDWFK  
UHVLLVWQFH RI JOLREODVWRPD FHOOV WR GHPR]RORPLGHVHFDQVHFDQV XSOULQJ &DQFHLQ 51ZV  
PHWK\OJXDQLQH '1\$ PHWK\OWUDQVIHUDVH 18ORJROVHU - ( \*HQWU\ 0% 'URWVFKPDQQ  
&KRX 7& 0DUWLQ 1 VRVZDRPHXGJQJ FRPELQDQVLRQV DOWHU FLVSODWLQ FWRWR[LFL  
DQG IRU JHGHVQDORVHV DQG XVHUV JXLGHORPISQVWDEQDLW\ 1XFOHLF \$FLGV 5HV  
3DUDPXV 1- >,QWHUQHWA &RPSX6\Q ,QF &RPSX6VQ +25Q63UDDPXU10: %UXHQLQJ \$-  
86\$ UROH IRU '1\$ PLVPDWFK UHSDLU LQ VHQ  
:HEE -/ (vHFM PRUH WKDQ RQH LQKLELWRURQ 0JPHRODQHQ 2QFRJHGH  
0HWDEROLF ,QKLELWRUV :HEE -/ HGV \$FDGSHFLQDQVLRQGHZ <RNRJQLR6\$WL ( %LJQDP  
SS FRQVHTXHGHV RI WROHUDQFH WR PHWK\OD  
.DLQD '1\$ GDPDJH WULJJHUHG DSRSWRPHLOOVU&WUFDORURQHVRM '1\$  
UHSDLU GRXEOH VWUDQG EUHDNV FHOO SUROLIHUWLRQ DQG VLJQDOLQJ %LRFKHP  
3KDUPDFRO