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Estimating forecast for vaccines and immunization supplies

Guidance Manual on Forecasting and Supply Planning

for Vaccines and other Immunization Supplies

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Contents

Estimating forecast for vaccines and immunization supplies

This guidance manual provides an overview of the various forecasting methods, including the steps involved in implementing each method. Examples illustrating how each method can be applied are also provided. The document is organized into the following sections.

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Acronyms

Acronym	Definition
AMC	Average monthly consumption
ARIMA	Autoregressive integrated moving average
FIP	Fully immunized person
FSP	Forecasting and supply planning
GIS	Geographic information system
LMIS	Logistics management information system
WHO	World Health Organization

Definition of terms

Term	Definition
Average monthly consumption (AMC)	The average quantity of product administered to the end users over a defined period (≥3 months), including reasonable waste that will be experienced during service delivery for vaccines.
Consumption	The quantity of product administered to end users over a defined period, including reasonable waste that will be experienced during service delivery for vaccines.
Consumption-based forecasting method	A forecasting method that uses past consumption trend to predict future consumption. Forecasting using this method can vary from a simple adjustment of past consumption by an agreed growth factor, to more sophisticated modelling (or trend analysis) techniques.
Demographic/wastage factor forecasting method	A forecasting method that uses demand (based on demographic information, programme target and immunization schedule) and allowable wastage to estimate future consumption.
Forecasting	The process used to estimate the quantity of doses of each vaccine that will be consumed or utilized for a specific period in the future. This process can be based on observed trends or patterns from adjusted demographic, health services utilization and/or logistics data. The output of this process is the estimated projected consumption.
Forecasting and supply planning (FSP) consultation meetings	Meetings that target individuals with some specific skills and expertise that are not available within the FSP team to obtain required inputs for FSP.
FSP workshop	The platform for reviewing the historical programme and FSP performance, discussion and ratification of the FSP data and assumptions, and the final forecast and supply plan. The workshop should include a diverse group of stakeholders involved in programme planning and implementation.
Fully immunized person	An individual that has received all the doses of a given vaccine as stipulated in the country's immunization schedule.
Logistics management information system (LMIS)	An organized system for collecting, processing, reporting, and using logistics data for informed decisions.

Term	Definition
Multidose vial policy	The policy that stipulates the conditions and how long unused doses of opened multidose vials can be reused.
Quality data	Data that are accurate, timely, consistent, reliable and complete.
Reporting rate	The proportion of expected reports that were submitted.
Stock-out	A situation in which no usable product is available for use.
Stratified forecasting	A vaccine forecasting process that uses disaggregated health and logistics data (for subgroups with common properties) to more accurately predict vaccine demand, in order to improve immunization coverage for traditionally underserved populations such as urban poor, remote rural and conflict-affected populations.
Target coverage	The proportion of eligible individuals that is desired to be reached for any given vaccine.
Target population	The segment of the population that is desired to receive a given vaccine.
Vaccination session forecasting method	A forecasting method that estimates future consumption using estimated demand, vaccination session characteristics, prevailing multidose vial policy, and expected closed and avoidable open vial wastage.
Wastage	The quantity of vaccines lost for various reasons and never administered to the end user. Vaccine wastage is broadly classified into (1) closed vial wastage (vial has not been opened with wastage due to expiry, heat damage, freezing, breakage and/or missing inventory), and (2) opened vial wastage (wastage that occurs when the vial has been opened). Opened vial wastage is categorized as avoidable (due to errors or accidents made during immunization sessions) and unavoidable (due to discarding unused doses of multidose vials at the end of the immunization session).

Overview of forecasting

Forecasting is the process used to estimate the quantity of doses of each vaccine that will be consumed or utilized for a specific period of time in the future. Projected vaccine demand is based on observed trends or patterns from adjusted demographic, health services utilization and logistics data. The output of this process is the estimated projected consumption. This output is used as an input into supply plans. One key activity during the forecasting phase is for relevant stakeholders to discuss and ratify forecasting data and assumptions. Depending on the type and quality of available data, three major methods can be used as explained briefly below.

Method	Description	Guidance
Demographic/ wastage factor	This method uses demand (based on demographic information, programme target and immunization schedule) and allowable wastage to estimate future consumption.	Depending on the age or recency of the data, programmes should explore triangulation of projected population census data with data from more recent alternative sources, e.g., aggregated microplan.
Vaccination session	Future consumption is estimated using estimated demand and vaccination session characteristics, including planned sessions, prevailing multidose vial policy, and expected closed and avoidable open vial wastage.	This method is only recommended at the health facility level, and the FSP team is expected to collate all estimates at the national level.
Consumption	The past consumption trend is used to predict future consumption. Forecasting using this method can vary from a simple adjustment of past consumption by an agreed growth factor to more sophisticated modelling techniques. Ideally, wastages are included in the consumption data.	This method is only suitable for programmes with reliable consumption data; adjustments can be made for stock-outs and reporting rates.

Depending on the capacity of country personnel, programme managers can use various tools that range from simple Microsoft Excel, to more sophisticated software using the three methods described above.

Additional trend analysis approaches or models

With consumption data, various trend analysis models can be used to determine forecasts. Below is a list of methods:

- **Linear regression** assumes a linear relationship and estimates future consumption based on a linear trend. This approach is not suitable for non-linear or seasonal data.
- **Moving average** relies on the use of averages of past consumption to estimate future consumption.
- **Weighted average** is an extension of moving average that ascribes more weight to recent historical data than to less recent data.
- **Exponential smoothing** uses a weighted average of past observations with the weights decreasing exponentially as the observations become older. This helps to capture the trend and seasonality patterns in the data and produce a forecast that is updated as new observations become available.
- **Autoregressive integrated moving average (ARIMA)** uses a combination of autoregressive (current values depend on or are correlated to values in the past) and moving average models to estimate future consumption.

Forecasting using these modelling approaches is better done using forecasting software, but can be done in Microsoft Excel, although this can be time-consuming. Some of the available software allows programmes to forecast using multiple methods, following which the "most representative forecast" can be chosen by reviewing forecast errors.

Stratified forecasting

Stratified forecasting helps countries to develop more accurate forecasts, and should be considered when there is significant subnational variation in coverage performance, geographic and population characteristics, and planned interventions. This forecasting approach involves generating forecast estimates for the different strata (based on predetermined parameters), which are later combined to give the national estimate.

Forecasting for epidemics, pandemics and new programmes

Forecasting for epidemics, pandemics and new programmes present unique challenges as there are usually no historical programme, service and consumption data. The forecasting process is therefore heavily reliant on demographic and epidemiological data. As epidemics and pandemics usually evolve rapidly, assumptions can easily become obsolete. Similarly, uptake of new programmes may not align with earlier projections. More frequent monitoring and review of assumptions where indicated is therefore critical to ensure that projections align with evolving needs.

Forecasting steps

#	Task	Description	Guidance	Responsible
1	Review, ratify and collate forecasting data and assumptions	During the forecasting and supply planning (FSP) consultations and/or workshop: – The FSP team should present the forecasting data and assumptions, as well as associated analyses. – Stakeholders should review and ratify all forecasting data and assumptions, as well as associated analyses. – The FSP team should implement the ratified changes to the data and assumptions. – The FSP team should then collate ratified forecasting data assumptions. This should cover the entire forecasting period and minimum data requirements for each forecasting method (Table 1) and should be stratified when stratified forecasting approach is being used.	The presentation by the FSP team should cover the type of data, source of data, quality considerations (availability, recency) and related analyses. When reviewing, the FSP team should suggest solution(s) to any issue related to the data and associated analyses. For example, when essential data is missing or of questionable quality, the team should formulate and agree on assumptions on future programme performance.	FSP team
2	Decide on forecasting method	Based on the available data and assumptions, a decision on which forecasting method(s) and tool(s) to apply should be made.	It is recommended to use multiple forecasting methods.	FSP team
3	Estimate forecast	To estimate a forecast, the forecasting data and assumptions are entered into relevant tools to determine the product quantities based on agreed method(s).	Depending on the capacity of forecasting stakeholders, the FSP team can use various tools that range from simple Microsoft Excel, to more sophisticated software.	FSP team
4	Select or combine forecasts	When multiple methods are used, forecasting stakeholders should decide on the 'final' estimate, considering the quality of the data that have informed each forecasting method, current and future programme performance, the country's political economic outlook, and other events that can have an impact future consumption or service utilization. The final decision could be any of the following: – Select a forecast that is based on a single (one) method – Combine forecasts from multiple (two or more) methods using equal weighting – Combine forecasts from multiple (two or more) methods using different weighting	This step does not apply when only one forecasting method is used (though this is not recommended), as there is only one estimate.	FSP team

Table 1: Minimum data requirements

Forecasting

Demographic	Vaccination session	Consumption
Target population+	Target population	Historical consumption
Target coverage	Target coverage	Historical reporting rate per stratification*
Dropout rate	Dropout rate	Historical stock-out days per stratification*
Number of doses per person	Number of doses per person	Population data*
Wastage rate	Number of vaccination sessions per period	Projected growth rate
	Number of weeks per period	
	Number of doses per vial	
	Number of weeks of reuse for opened multidose vial	
	Number of supply chain levels	
	Closed vial wastage	
	Avoidable opened vial wastage	

Some of the data are required for individual product.

+ Usually estimated as a percentage of the total population, i.e., the total population multiplied by A%, where A% represents the proportion of the total population that is eligible for the vaccine.

* Required for adjustment of historical consumption where indicated.

Forecasting formula and illustrative examples

I. Demographic/wastage factor method

Formula

The general formula for forecasting using the demographic method is:

Target population × coverage × number of doses per fully immunized person (FIP) × wastage factor

Where wastage factor = $\dfrac{100\%}{100\% - \text{wastage rate}}$

Target population is usually estimated as a percentage of the total population.

The formula above assumes there is no dropout for vaccines requiring multiple dosing. When dropout is being considered, an alternative formula can be used:

Target population × sum of coverage for all doses in the schedule × wastage factor

The first three parameters of the formula (target population × coverage × number of doses per FIP) estimate demand, i.e., the number of doses to be administered, while forecasted consumption is calculated by adjusting this demand by wastage factor, since some level of wastage is expected partly because most of the vaccines used in the immunization programme are multidose, and some may have to be discarded at the end of the immunization session or within six hours, whichever comes first.

Illustrative example 1

The following example covers demography/wastage factor-based forecasting when there is no significant subnational variation in coverage (single national forecast). Two scenarios, with and without dropout, are considered.

Case description

Country A, with a projected total population of 212.5 million, plans to forecast for pentavalent vaccine for the upcoming year. Only children under 1 year of age are eligible for this vaccine, representing 4 per cent of the total population. Three doses of pentavalent vaccine are required to immunize each child fully, and the country expects a wastage rate of 25 per cent for the preferred 10-dose vial.

For **scenario 1**, the country assumed that 90 per cent of eligible children would receive all three doses, i.e., no dropout. However, for **scenario 2**, the country assumed that 5 per cent of children that receive the first dose would not get the second dose, while 9 per cent of those that receive the first dose would not get the third dose.

Assumptions

The assumptions for these two scenarios are summarized in Table 2.

Table 2: Summary of assumptions

Forecasting assumptions	Scenario 1	Scenario 2
Total population	212,500,000	212,500,000
Proportion of total population eligible	4%	4%
Target coverage – first dose	90%	90%
Target dropout rate – first to second	0%	5%
Target dropout rate – first to third	0%	9%
Number of doses per fully immunized child	3	3
Wastage rate	25%	25%

Solution: Unstratified forecasting

Steps	Description	Formula		Scenario 1 – no dropout	Scenario 2 – dropout considered
1	Estimate target population	**Total population × proportion of total population eligible**		212,500,000 × 4% = 8,500,000	212,500,000 × 4% = 8,500,000
2	Determine target coverage for each dose	**Target coverage (2nd and 3rd doses) = first dose coverage × (100% — dropout rate)**	1st dose	90%	90%
			2nd dose	90%	90% × 95% = 85.5%
			3rd dose	90%	90% × 91% = 81.9%
3	Estimate demand	**Target population × target coverage**	1st dose	8,500,000 × 90% = 7,650,000	8,500,000 × 90% = 7,650,000
			2nd dose	8,500,000 × 90% = 7,650,000	8,500,000 × 85.5% = 7,267,500
			3rd dose	8,500,000 × 90% = 7,650,000	8,500,000 × 81.9% = 6,961,500
			Total	22,950,000	21,879,000
4	Estimate wastage factor	$\frac{100\%}{100\% - \text{wastage rate}}$		$\frac{100\%}{100\% - 25\%} = 1.33$	$\frac{100\%}{100\% - 25\%} = 1.33$
5	Estimate forecast	**Demand × wastage factor**		22,950,000 × 1.33 = 30,523,500	21,879,000 × 1.33 = 29,099,070

Illustrative example 2

The example below illustrates demography/wastage factor-based forecasting when there is significant subnational variation in coverage (stratified forecasting). Two scenarios, with and without dropout, are considered.

Case description

Country Y, with a projected total population of 212.5 million, plans to forecast for pentavalent vaccine for the upcoming year. However, due to significant subnational variation in coverage, the country has different coverage targets for different regions. Similarly, the expected wastage rate varies across regions for their preferred 10-dose vial. Only children under 1 year of age are eligible for this vaccine, representing 4 per cent of the total population across regions. Three doses of pentavalent vaccine are required to immunize each child fully.

For scenario 1, the country assumed that there would be no dropout (Table 3). However, for scenario 2, the country assumed that some children who received the first dose would miss their second and third doses (Table 4).

Table 3: Data/assumptions, no dropout

Forecasting assumptions	Region 1	Region 2	Region 3	Region 4
Total population	63,750,000	74,375,000	42,500,000	31,875,000
Proportion of total population eligible	4%	4%	4%	4%
Target coverage – first dose	95%	80%	70%	50%
Target dropout rate – first to second	0%	0%	0%	0%
Target dropout rate – first to third	0%	0%	0%	0%
Number of doses per fully immunized child	3	3	3	3
Wastage rate	15%	20%	25%	30%

Table 4: Data/assumptions, dropout considered

Forecasting assumptions	Region 1	Region 2	Region 3	Region 4
Total population	63,750,000	74,375,000	42,500,000	31,875,000
Proportion of total population eligible	4%	4%	4%	4%
Target coverage – first dose	95%	80%	70%	50%
Target dropout rate – first to second	4%	5%	6%	7%
Target dropout rate – first to third	6%	7%	8%	9%
Number of doses per fully immunized child	3	3	3	3
Wastage rate	15%	20%	25%	30%

Solution: Stratified forecasting, no dropout

Steps	Description	Formula		Region 1	Region 2	Region 3	Region 4
1	Estimate target population	**Total population × proportion of total population eligible**		63,750,000 × 4% = 2,550,000	74,375,000 × 4% = 2,975,000	42,500,000 × 4% = 1,700,000	31,875,000 × 4% = 1,275,000
2	Determine target coverage for each dose	**Target coverage (2nd and 3rd doses) = first dose coverage × (100% — dropout rate)**	1st dose	95%	80%	70%	50%
			2nd dose	95%	80%	70%	50%
			3rd dose	95%	80%	70%	50%
3	Estimate demand	**Target population × target coverage**	1st dose	2,550,000 × 95% = 2,422,500	2,975,000 × 80% = 2,380,000	1,700,000 × 70% = 1,190,000	1,275,000 × 50% = 637,500
			2nd dose	2,550,000 × 95% = 2,422,500	2,975,000 × 80% = 2,380,000	1,700,000 × 70% = 1,190,000	1,275,000 × 50% = 637,500
			3rd dose	2,550,000 × 95% = 2,422,500	2,975,000 × 80% = 2,380,000	1,700,000 × 70% = 1,190,000	1,275,000 × 50% = 637,500
			Total	7,267,500[a]	7,140,000[a]	3,570,000	1,912,500
4	Estimate wastage factor	$\frac{100\%}{100\% - \text{wastage rate}}$		$\frac{100\%}{100\% - 15\%}$ = 1.18	$\frac{100\%}{100\% - 20\%}$ = 1.25	$\frac{100\%}{100\% - 25\%}$ = 1.33	$\frac{100\%}{100\% - 30\%}$ = 1.43
5	Estimate forecast	**Demand × wastage factor**		7,267,500 × 1.18 = 8,575,650[a]	7,140,000 × 1.25 = 8,925,000[a]	3,570,000 × 1.33 = 4,748,100[a]	1,912,500 × 1.43 = 2,734,875[a]
6	Combine forecast	**Region 1 + region 2 + region 3 + region 4**		~24,983,630			

[a] Rounded up to the nearest vial size

Solution: Stratified forecasting, dropout considered

Steps	Description	Formula		Region 1	Region 2	Region 3	Region 4
1	Estimate target population	**Total population × proportion of total population eligible**		63,750,000 × 4% = 2,550,000	74,375,000 × 4% = 2,975,000	42,500,000 × 4% = 1,700,000	31,875,000 × 4% = 1,275,000
2	Determine target coverage for each dose	**Target coverage (2nd and 3rd doses) = first dose coverage × (100% — dropout rate)**	1st dose	95%	80%	70%	50%
			2nd dose	96% × 95% = 91.2%	95% × 80% = 76.0%	94% × 70% = 65.8%	93% × 50% = 46.5%
			3rd dose	94% × 95% = 89.3%	93% × 80% = 74.4%	92% × 70% = 64.4%	91% × 50% = 45.5%
3	Estimate demand	**Target population × target coverage**	1st dose	2,550,000 × 95% = 2,422,500	2,975,000 × 80% = 2,380,000	1,700,000 × 70% = 1,190,000	1,275,000 × 50% = 637,500
			2nd dose	2,550,000 × 91.2% = 2,325,600	2,975,000 × 76% = 2,261,000	1,700,000 × 65.8% = 1,118,600	1,275,000 × 46.5% = 592,875
			3rd dose	2,550,000 × 89.3% = 2,277,150	2,975,000 × 74.4% = 2,213,400	1,700,000 × 64.4% = 1,094,800	1,275,000 × 45.5% = 580,125
			Total	7,025,250	6,854,400	3,403,400	1,810,500
4	Estimate wastage factor	$\frac{100\%}{100\% - \text{wastage rate}}$		$\frac{100\%}{100\% - 15\%}$ = 1.18	$\frac{100\%}{100\% - 20\%}$ = 1.25	$\frac{100\%}{100\% - 25\%}$ = 1.33	$\frac{100\%}{100\% - 30\%}$ = 1.43
5	Estimate forecast	**Demand × wastage factor**		7,025,250 × 1.18 = 8,289,795	6,854,400 × 1.25 = 8,568,000	3,403,400 × 1.33 = 4,526,522	1,810,500 × 1.43 = 2,589,015
6	Combine forecast	**Region 1 + region 2 + region 3 + region 4**		~23,973,340			

~ Rounded up to the nearest vial size

II. Vaccination session-based method

For this method, the FSP team only needs to collate and sum up all vaccination session-based forecasts across all health facilities/districts in the country. The World Health Organization (WHO) provides detailed guidance on how to estimate forecast using this approach.

III. Consumption

The calculation steps involved in estimating forecast using this consumption-based approach are summarized as follows.

Step	Action		Formula	Comments
1	Collate (monthly) consumption		Not applicable	
2	Adjust (monthly) consumption if required		Chapter 3 'Preparing for forecasting and supply planning' (Table 3) provides the formula for these adjustments.	Since the consumption-based method uses historical performance to predict the future, it is important to adjust consumption for stock-out, incomplete logistics management information system (LMIS) reporting, avoidable losses, and other anticipated programmatic changes, for example change in vial size or improvement in health-care workers' practices, such as improved adherence to multidose vial policy. Doing this will help prevent underestimation of forecast and, in some cases, reinforcement of health-care workers' poor practices.
3	Calculate (adjusted) average monthly consumption		$\dfrac{\textbf{Total (adjusted) consumption for the review period}}{\textbf{\textit{Number of months in review period}}}$	
4	Project future consumption by applying growth rate(s)	Monthly	**Fully adjusted AMC × (100% + projected growth rate)**	This step involves projecting futuristic consumption by considering the expected increase in programme performance. Population growth and anticipated improvement in programme performance should be considered.
		Annual	**Monthly forecast × 12**	

Notes:

- For multiyear forecasting, apply the expected year-on-year growth rate.
- More sophisticated modelling techniques are available for consumption-based forecasting. The adjustments described may still be required when using these modelling techniques.

Illustrative example 3 – forecasting using the consumption method

Country F plans to forecast the pentavalent vaccine requirement for the upcoming year using historical consumption. From the available LMIS data, 30 million vaccine doses were consumed in the last 12 months. On average, the programme has access to LMIS reports from 80 per cent of the health facilities in the country, while there was stock-out for an average of 20 days in the year. Stakeholders projected that 5 per cent of the pentavalent vaccine consumption in the prior year was due to poor adherence to multidose vial policy and heat damage due to the untimely activation of the contingency plan at the central warehouse. The country expects an improvement in compliance with the policy in the coming year, as health-care workers were recently trained. At the same time, on-site mentoring and adherence monitoring are now prioritized during routine supportive supervision. Measures have also been put in place to ensure prompt activation of the contingency plan at the central store. The programme anticipates a 5 per cent growth in programme performance in the upcoming year.

Step	Action		Formula	Result	Comments
1	Collate historical consumption data		N/A	30,000,000	
2	Adjust consumption for*	Stock-out	$\text{Unadjusted consp.} \times \frac{\text{Review period months}}{\text{Review period months} - \text{months of stock-out}}$	$30{,}000{,}000 \times \frac{12}{12 - 0.66}$ = 31,746,031.75 *Assumes an average of 30.5 days per month	Assumes the consumption during the stock-out period is the same as the period when the stock was available
		Reporting rate	$\text{Partially adjusted consp.} \times \frac{100\%}{\text{Reporting rate}}$	$31{,}746{,}031.75 \times \frac{100\%}{80\%}$ = 39,682,539.68	Assumes consumption in reporting and non-reporting health facilities are the same
		Potential decrease in avoidable wastage	$\text{Partially adjusted consp.} \times (100\% - \%\ \text{decrease in consp.})$	31,746,031.75 × (100% – 5%) = 37,698,412.70	
3	Calculate adjusted average monthly consumption (AMC)		$\frac{\text{Total (adjusted) consumption for the review period}}{\text{Number of months in review period}}$	$\frac{37{,}698{,}412.70}{12}$ = 3,141,534.39	
4	Project future consumption by applying growth rate(s)	Monthly	Fully adjusted AMC × (100% + projected growth rate)	3,141,534.39 × (100% + 5%) = 3,298,611.11	Consider population growth and anticipated improvement in programme performance
		Annual	Monthly forecast × 12	3,298,611.11 × 12 = ~39,583,340	

Notes: consp. = consumption

* Adjustment in this example was done for a year at once. Adjustment can be conducted for individual months and, where feasible, could also be stratified (see Chapter 3 'Preparing for forecasting and supply planning', for example).

IV. Select or combine forecasts

When multiple methods are used, programmes will need to decide on the 'final' estimate considering the quality of the data that informed each forecasting method, stakeholders' confidence in the various approaches, and how well forecast estimates align with historical consumption patterns (where available) and anticipated programme growth, including historical consumption and expected programme performance. The possible considerations and final decisions are reflected in illustrative example 4.

Illustrative example 4 – select or combine forecasts
The annual pentavalent vaccine forecast for countries A, B and C using three different methods is shown below. Assume the three countries have the same forecast for each method.

Forecasting method	Forecast in doses
Demography/wastage factor	35,000,000
Vaccination session	40,000,000
Consumption	45,000,000

If the following details reflect country stakeholders' appraisal of each method, determine the possible decision(s) of stakeholders and the final forecast for each country.

Method	Methods appraisal
Country A	– The data used for demography/wastage factor-based forecasting is reliable. – Vaccination session and consumption data are of poor quality.
Country B	There is reasonable confidence in the data that informed the three methods.
Country C	– The data that informed the demographic and vaccination session-based forecasting are of reasonably good quality. However, the team has more confidence in the demographic/wastage factor method. – The quality of consumption data is poor.

Possible decisions

Country	Decision			Comment
	Decision type	Method(s) chosen	Final forecast	
Country A	Choose one forecast	Demography/wastage factor	35 million	
Country B	Combine forecasts from different methods (equal weighting)	– Demography/ wastage factor – Vaccination session – Consumption	(35 million + 40 million + 45 million) / 3 = 40 million	Choosing any of the three forecasts will also be appropriate
Country C	Combine forecasts from different methods (different weighting)	– Demography/ wastage factor – Vaccination session	If the team assigns a weight of 0.6 to the demography/wastage factor forecast and 0.4 to the vaccination session forecast, the final forecast will be (35 million × 0.6) + (40 million × 0.4) = 37 million	The weight assigned in this example is for illustration. Stakeholders' informed opinions should inform the final weight.

V. Forecasting for auto-disable syringes, reconstitution syringes and safety boxes

a. Auto-disable syringes

This only applies to vaccines that require auto-disable syringes for administration. The forecast discounts open vial wastage, as an auto-disable syringe is not required for vaccines that are not administered, i.e., discarded.

General formula

Number of auto-disable syringes per vaccine =

Demand × anticipated wastage factor (for auto-disable syringes)

When determining the requirements for multiple vaccines requiring auto-disable syringes of the same size, the calculation steps are:

1. Estimate the number of auto-disable syringes per vaccine
2. Add up the estimated same-size auto-disable syringes for all vaccines in the immunization schedule

Note: Different vaccines may require different sizes of auto-disable syringes.

b. Reconstitution syringes
Reconstitution syringes are only required for vaccines that require reconstitution.

General formula

$$\text{Number of reconstitution syringes} = \frac{\text{Forecast}}{\text{Number of doses per vial}} \times \text{wastage factor*}$$

*wastage factor for reconstitution syringes

When determining the requirements for multiple vaccines requiring reconstitution syringes of the same, the calculation steps are:

1. Estimate the number of reconstitution syringes per vaccine
2. Add up the estimated same-size reconstitution syringes for all vaccines in the immunization schedule

Note: Different vaccines may require different sizes of reconstitution syringes.

c. Safety boxes
Safety boxes are required for the safe disposal of auto-disable syringes and reconstitution syringes.

Formula

$$\frac{\text{Total autodisable syringe units} + \text{total reconstitution syringe units}}{\text{Maximum units allowed per box}} \times \text{wastage factor*}$$

*wastage factor for safety boxes

Notes:

- Countries may choose not to fill safety boxes to maximum capacity.
- A 10 per cent wastage rate assumption is considered sufficient if there is no country data to inform the wastage rate for auto-disable syringes, reconstitution syringes and safety boxes.
- When a consumption-based method is used, the historical trend can be applied to predict future immunization supply consumption. However, adjustments for stock-out and reporting rate may still be required.

Illustrative example 5 – forecasting for auto-disable syringes, reconstitution syringes and safety boxes

Using the assumptions provided in Table 4.5, estimate the total number of auto-disable syringes, reconstitution syringes and safety boxes required by country Y. Assume the two vaccines require the same size of auto-disable syringe and only vaccine A requires reconstitution.

Table 5: Assumptions for auto-disable syringes, reconstitution syringes and safety boxes

Assumptions	Vaccine A	Vaccine B
Total population	212,500,000	212,500,000
Proportion of total population eligible	4%	4%
Target coverage (doses 1, 2 and 3)	90%	90%
Number of doses per FIP	1	3
Vaccine wastage rate	40%	40%
Vial size (number of doses per vial)	10	10
Anticipated wastage rate for auto-disable syringes, reconstitution syringes and safety boxes	10%	10%
Maximum number of syringes allowed per safety box	100	

Solution: Auto-disable syringes

Steps	Description	Formula	Vaccine A	Vaccine B
1	Estimate vaccine demand	**Total population × proportion of total population eligible × coverage × number of doses per FIP**	212,500,000 × 4% × 90% × 1 = 7,650,000	212,500,000 × 4% × 90% × 3 = 22,950,000
2	Estimate anticipated wastage factor	**100% + expected wastage rate**	100% + 10% = 1.1	100% + 10%=1.1
3	Estimate auto-disable syringe forecast	**Demand × anticipated wastage factor**	7,650,000 × 1.1 = 8,415,000	22,950,000 × 1.1 = 25,245,000
4	Add up the estimated auto-disable syringes	**Vaccine A forecast + Vaccine B forecast**	8,415,000 + 25,245,000 = 33,660,000	

Solution: Reconstitution syringes

Steps	Action	Formula	Vaccine A
1	Estimate vaccine forecast	**Total population × proportion of total population eligible × coverage × number of doses per FIP**	212,500,000 × 4% × 90% × 1 × 1.67 = 12,775,500
2	Estimate unadjusted reconstitution syringe forecast	$\frac{\textbf{Forecast}}{\textbf{No. of doses per vial}}$	$\frac{12,775,500}{10}$ = 1,277,550
3	Estimate anticipated wastage factor	**100% + expected wastage rate**	100% + 10% = 1.1
4	Estimate forecast	**Forecast (in vials) × anticipated wastage factor**	1,277,550 × 1.1 = 1,405,305

Solution: Safety boxes

Steps	Action	Formula	Vaccine A
1	Estimate unadjusted forecast	$\frac{\text{Total autodisable and reconstitution syringes}}{\text{Maximum units allowed per box}}$	$\frac{33{,}660{,}000 + 1{,}405{,}305}{100}$ = 350,653.05
2	Estimate anticipated wastage factor	100% + expected wastage rate	100% + 10% = 1.1
3	Estimate forecast	Unadjusted units of safety boxes × Anticipated wastage factor	350,653.05 × 1.1 = ~385,719

Key takeaways

- **Forecasting involves the estimation of future consumption** using agreed data and assumptions.
- **One key activity during the forecasting phase is for relevant stakeholders to discuss and ratify forecasting data and assumptions.**
- **Forecasting methods for vaccines and immunization supplies** can include (1) demographic/wastage factor, (2) vaccination session and (3) consumption-based forecasting.
- It is **highly recommended to forecast using multiple methods**, following which a final decision as to whether and how forecasts will be combined should be made.

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